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MAILING THE ELECTRICAL WORLD.

The present number of The Electrical World will be mailed folded once lengthwise, thus leaving, when opened, a crease in the page. Should we learn from our readers that this is found objectionable, we will endeavor to mail the paper in such form as to obviate any cause of complaint.

THE DIGEST FOR 1893.

Some idea of the field which has been covered by our weekly Digest may be had from the fact that during the past eleven months, since it was started, there were published in this department over 2,000 abstracts and references, which required the careful reading of over 800 issues of journals, of which about two-thirds were in foreign languages. If this were a mere index of the titles of articles, such figures would mean very little, but by far the larger part of the Digest is formed of abstracts containing what are believed to be the most important parts of a paper or article, or whenever an article does not admit of being abstracted we endeavor to give an idea of its general nature in order that readers may know before looking up the original whether it would be likely to be of interest to them, a feature in which this department differs greatly from a mere index. Furthermore, whenever an original article in a foreign language which we have abstracted is subsequently translated and published in an English journal, we always call attention to the translation for the benefit of those who are not conversant with the foreign language, but would like to read the original.

THE TELEPHONE PATENTS.

As pointed out by Mr. W. A. Rosenbaum in another column, the patent on the metallic diaphragm telephone will expire on Jan. 30, after which date it will be possible to use the telephone for commercial purposes on shorter lines, and even to operate an exchange system in competition with the monopoly which has so long reaped a magnificent harvest. Had the ordinary course been followed in the Patent Office in relation to the Berliner patent, the principle of telephony by means of variable contact resistance would also soon be public property, and until this patent expires or is annulled, the Bell monopoly cannot be very seriously affected. If by proper means this patent was retained in the Patent Office for fourteen years, by this process practically prolonging the life of an absolute monopoly to that extent, a monstrous state of affairs is admitted which, if it cannot be otherwise remedied, would almost justify the entire abolition of the patent system. It is true that the government has now a suit to annul this patent for reasons stated in the article, but a recent statement as to its condition does not give much encouragement for a speedy decision, and it has already cost the government \$80,000. With the wide knowledge of the subject which the Attorney General should have from his former connection with the telephone interests, it would seem that more haste might be made, particularly as, if the suit is finally successful, every day after Jan. 30 will result in a gross injustice to the public through the continuance of the monopoly. Mr. Rosenbaum refers to a fact that may be very significant, which is that the Blake application of Jan. 3, 1879, has not yet, as far as can be ascertained, resulted in a patent. After what has occurred regarding the Berliner patent, we may expect anything from the Patent Office, and it would not be a matter of any great surprise if the Blake, or some other telephone patent now held, were

to develop into a second Berliner case if the government is not successful in its suit. There are a great many things to which Congress is now devoting its attention that are of less importance to the public than an investigation of the Patent and Attorney General's offices might be.

HIS APPEAL DECIDED AGAINST HIM.

Mr. Martin's appeal from the judgment rendered against him in favor of The W. J. Johnston Company, Limited, has been decided by the Appellate Court adversely to Mr. Martin. Three judges of the Superior Court agree in deciding that Mr. Martin is wrong. This decision sustaining the decision of the other able judge who decided the case as referee ought to satisfy Mr. Martin that as a litigant he is not a success, and that if what he is seeking to have administered in his contest is justice, there is no likelihood of the scales coming down in his favor. Courts of justice are not as easily fooled as are sometimes a part of the public. The opinion of the Court is given on another page.

THE GENERAL ELECTRIC COMPANY.

While the announcement which we print in another column in regard to the concentration of the General Electric Company's manufacturing business at Schenectady may be far from agreeable to the New England interests and an unfortunate event for Lynn, yet it cannot be denied but that it is a move in the right direction. The action is similar to that adopted by the Westinghouse Company when it encountered its reverses, and the sequel proved that it was an eminently wise one in that case. Even had the General Electric Company continued on its former prosperous course it is quite probable that sooner or later its manufacturing departments would have been consolidated.

LIGHT WITHOUT HEAT.

The article by Lieut. Patten on "Light Without Heat" will be found very suggestive, not only as a review of the principles through which light may be produced with a minimum or entire absence of heat but also from the description of an electrical method by means of which such a desideratum may actually be closely approached. While Tesla and Patten have thus shown the manner in which high frequency currents may be produced, we are not aware if the vital question, cost of production, has yet received definite attention. Prof. Kennedy, in a lecture last year before the Royal Institution of London, made the statement that the engine which ordinarily furnishes power to run all of the lights in that large building was taxed to its utmost when generating the high frequency currents necessary for Tesla to perform his experiments, although the light produced was an exceedingly small quantity. This may or may not be significant, as the apparatus employed was not only merely experimental, but, on account of the entire lack of knowledge of the requirements for efficiency in this new branch, may have even been the worst form as regards that point. It will be remembered in this connection that an early form of dynamo, the Lontin, actually required more power on open circuit than when loaded, and that for many decades, and until their principles became understood, the efficiency of motors rarely exceeded 10 or 20 per cent.

ALTERNATING CURRENTS.

The growing importance of alternating currents, which have already left the continuous current far behind in many of the most important applications of electricity, is such that soon the engineer or electrician who is not well up in this subject will be left entirely out of the race, notwithstanding even exceptional proficiency in everything relating to continuous currents. The new conceptions necessary for the proper understanding of alternating currents cannot be deduced from knowledge of direct currents, and to obtain the necessary ideas to build on it is necessary to start at the

beginning and even to put aside for the time those connected with direct currents. In the present issue Prof. Ryan begins a series of articles on alternating current working, in which the fundamental principles are first taken up and developed and afterward their application to alternators, transformers, multiphase machinery, etc., will be considered. Mathematics will be little used and the different theories and principles will be stated in such a manner that the reader with little or no preparation can follow the various subjects with profit. This, as far as we know, is the first attempt to treat this important branch connectedly and in such a way as to place it within reach of all, and with particular attention to the practical side of the subject. The reader is also to be congratulated that the author is Prof. Ryan, who was one of the first workers in this field, as he is now one of the few thoroughly conversant with the subject in all its details.

1883 VS. 1894--A COMPARISON.

The present number of The Electrical World is issued exactly eleven years after the change from a telegraphic journal to one whose field comprises the entire range of electrical science and its attendant industries. That during this period of magnificent electrical accomplishments The Electrical World has efficiently discharged the duties which have fallen to its lot needs no other demonstration than the fact of its great success, which has followed from the appreciation of those whom it has served. How great a success this has been is apparent both from the remarkable increase in the subscription list and also from a comparison of the quantity of its advertising, which, after all, is the soundest criterion. The Electrical World of Jan. 6, 1883, had only one full page advertisement, while in the present issue it has no less than 25. The number of advertisements in the pioneer issue was 63, occupying 430 inches of space, while in this issue the numbers are 320 and 2,549, a gain in eleven years of 500 and 590 per cent respectively. These figures speak for themselves, and mark a record of growth that is unrivalled in the field of technical journalism. This table shows the advertising in three different electrical journals in their first issues of 1883 and 1894, respectively:

	1883.	1894.	Dec.
			p. c.
"The Electrical Review," No. of advts.....	116	92	21
Inches of advts.....	844	737	12
"The Electrical Engineer," No. of advts.....	207	145	30
Inches of advts.....	1,255	855	32
THE ELECTRICAL WORLD, No. of advts....	317	320	1*
Inches of advts....	1,784	2,549	43*

Turning to the reading pages, we find these 8 and 40, respectively, or, reduced in the same measure, 8 and 20, an increase in eleven years of 250 per cent. The great growth in two directions, circulation and increase of size, is most strikingly shown by a comparison of the quantity of paper used in the first issue of 1883 and the present issue. At the beginning of the former year 5,000 copies were sufficient to meet the requirements of the subscription list. Comprising but sixteen pages—eight of reading matter and eight of advertisements—a complete copy consisted of but a single sheet of paper, so that just ten reams (of 500 sheets to the ream) were required for the edition. As the present week's issue consists of 100 pages—96 of white paper and four of cover—six sheets are necessary for the inside pages of each paper, and as 15,000 copies are printed, this requires including the cover, 200 reams of paper. We do not take this backward glance in the spirit of one satisfied with his achievements as to feel contented to rest upon them. On the contrary, we hope to make the change to a new form a marking point from which to advance to new conquests, so that in years to come we may look back and note the same steady advance that has characterized the period just passed.

* Increase.

Education of Engineers.

Our able contemporary, "Engineering News," in a recent number, gives an analysis of the record of the work of the graduates of a prominent civil engineering school, which is very suggestive in several respects. It seems to have been the endeavor of the school in question to impart a sound general knowledge of the theory and practice of engineering, and not to subordinate its teaching to the exigencies of the laboratory or to special or to detail work, apparently on the assumption that it is a mere chance that more than a small fraction of college practical instruction will fit the particular work that may fall to the lot of the graduate. The analysis of our contemporary seems to show that in most cases, while the purely technical training has been an adjunct in bringing about promotion, yet a fair inference from the record of the graduates is that it is twice as important to be fitted to become a leader and manager of men than to be fitted only with purely technical qualifications. As remarked by us before in these columns, a system of education that tends to broaden the mind and thus render it capable of dealing confidently with large questions is not only most likely to make the engineer educated under it more respected by those with whom he comes into contact in professional life, but it gives him a wider range of opportunities and a more ambitious scope to his strivings. When an employer takes into his service one just graduated he should not, and in most cases does not, expect him to be exactly fitted by a school training for the practical work he is engaged for. What he should, and in most cases does expect, however, is a thorough grounding in principles so that when the young man finally becomes fully acquainted with the details of his particular work he will be able to carry it on with every prospect of success. It is assumed, of course, that the graduate has not been educated under an impractical system by purely academic professors, but that the theory taught and the practice inculcated are based upon a proper knowledge of the requirements of actual work. Owing to the desire to start on a professional career at the earliest possible moment most technical courses are none too long for the bare purpose of teaching principles, and yet the tendency seems to be becoming greater and greater to subordinate the theoretical grounding to "practical work." Pattern shops, smith shops and even foundries are becoming features of technical schools, and testing work is carried on more with a view to teach the practical manipulations than to illustrate principles. But to return, applying the conclusions which our contemporary draws from its analysis in a general way to any branch of engineering, the inference seems to be that it is impossible for any young man to foresee with any degree of exactitude what particular knowledge will probably be most useful to him. He is extremely likely to have both technical and executive positions in various lines open before him at some time in his life, and hence what he particularly needs is a good all-around knowledge so that he will not be wholly at a loss in undertaking any duties that may fall to his lot. It implies that there is no better method than to devote the first four years of a young man's professional study to acquiring a sound general knowledge of the theory and broad practice of all the main branches of his profession instead of devoting particular attention to special and detail work. The difficulty with many of our engineering schools, it may be added, is that they attempt to combine three different courses, each of which in turn is sacrificed to the others. In Europe in some cases these are differentiated into engineering, industrial and manual training schools. Some of our technical schools partake more of the character of the French industrial schools, a graduate of which does not expect to become anything higher than a superintendent of a manufactory or plant, or an "expert" in his line of training.

Municipal Conduits.

That the usual objections urged against municipalities entering into the business of supplying water, gas or electricity do not apply to public ownership of electric conduits and subways is becoming to be recognized. Recently the Cambridge, Mass., Board of Aldermen requested the mayor to petition for such legislation as will enable cities and towns to construct and maintain conduits and manholes in their respective streets, for the purpose of carrying wires and cables for the transmission of electricity; that the companies and individuals now maintaining overhead wires and cables be required to place their wires and cables in the conduits built by the city or town, and remove their overhead construction in all streets provided with conduits, and that such companies and individuals shall pay to the city or town a rental that will insure not less than 10 per cent. upon the amount invested in the conduits. The question thus broached is aside from any advanced views in regard to the extent to which municipalities may extend their functions and rather one as to whether electric companies should be compelled to submit themselves to the mercy of a private monopoly when they are required by the public to adopt a certain method of installing their wires. It would, on the other hand, seem to be the duty of cities to provide equal and untrammelled facilities for those whom they compel to adopt this means of electrical distribution—a duty which cannot be properly discharged by an intermediary whose object is not accommodation but profit. The principle at stake is more nearly akin to that involved in the maintenance of public highways, and in its application there seems to be no reason for introducing the element of private monopoly. The conditions are not the same as those concerned in the ownership of city lighting plants for several reasons. In the latter case it is the question of the supply of a commodity, and the continuous operation of a manufacturing plant, which may result in abuses if in the hands of a municipality. Better service may be given through private ownership, and in case of inefficiency the entire public is affected and has the power to at once apply the remedy. On the other hand, a conduit is a structure, and when once laid requires little or no attention. The contract is a forced one as far as the users are concerned, while in an electric lighting monopoly the consumer can order out his lights and a combination of consumers can force reasonable treatment. In the one case the parties directly affected are only the conduit monopoly and the electrical company or companies compelled to use the conduits, with only the politicians or the uncertainties of legal technicalities to protect the latter, while in the other the entire public serves as a check against unfair treatment. In other words, there is a decided difference between a monopoly to which the public willingly submits itself and over which it retains practical control, and one which it accords to a second party to be exercised by the latter over a third party. It may be said that the rights of the users of conduits will be defined by law and may be enforced by them whether the owner is a private company or a municipality, but experience has shown that while in the former case technicalities of law and a "pull" may intervene, in the latter public opinion will tend to force equitable treatment aside from technicalities. It thus seems to be entirely to the interest of electric light and power companies to have the ownership of electrical conduits and subways vested in the public and not in a private monopoly, and it is to the interest of the public itself to retain the control of its streets, and besides earn the continuous profit that otherwise it would donate to private individuals, whose only considerable active function would not extend beyond the period of installation.

Changes in the General Electric Company.

The General Electric Company has announced that it has been definitely decided at a meeting of the Executive Committee of the Board of Directors to make the Schenectady works the main factory of the company, while the Lynn plant will be conducted as an annex for the manufacture of such small standard articles as are required in large numbers. The New York office and salesroom are to be taken to Schenectady, which will be made the general headquarters of the company. New buildings have recently been completed, and, as fast as required, the force will be increased, and the works, it is stated, soon again run on full time. The lamp works will remain at Harrison, N. J., and the Eastern District headquarters at 44 Broad street, New York, where offices will also be retained by the directors and general officers.

Thoughts on Cosmical Electricity.

BY PROF. JULIUS THOMSON.

Prof. Thomson prefaced his remarks by stating that he had attempted to apply known principles to conditions of the heavenly bodies and that he thought there was much to learn in this field.

Beginning with the consideration that as we rise from the earth's surface to different altitudes there appears to be a gradual increase of potential with respect to the ground, such that at a thousand feet, as at the top of the Eiffel tower, there may be 10,000 volts difference between the air at the top and the surface, he assumed that this difference might increase as we reach high altitudes, and that at 20 or 30 miles the potential difference might amount to a million volts more or less. This would seem to indicate the possession of a positive charge by the higher layers of the atmosphere. He stated, however, that it had not yet been proven that a pure gas could carry a charge of electricity and instanced the case of a drop of water suspended in the air and charged to a certain potential. If the air were dry and the drop evaporated the potential would rise gradually until when it was entirely evaporated the potential would be infinite. This consideration would be based on the fact, if it be a fact, that liquids in evaporating do not part with their electricity. The increased potential of the drop, however, might have other effects, such as the repulsion of its particles and its division into an extremely comminuted state.

After stating the nature of the electrical charge as dependent upon capacity and potential he showed that whenever the capacity is diminished the potential, with a given amount of electricity, rises and vice versa, but went on to state that attraction and repulsion, and other phenomena could be explained by the general tendency of all bodies to increased capacity. He adduced considerations going to show that there was a relative repulsion between charges of electricity besides the attraction between opposite charges, and that, therefore, the lines of electrostatic stress would agree with those of magnetism in their tendency to shorten and also to spread laterally.

He then took up the question as to whether a perfect vacuum is or is not a conductor of electricity, and brought forward the results of recent investigations as showing that an excellent vacuum is not a conductor, but, on the other hand, is the most perfect insulator. Taking this in connection with the fact that dense air is a good insulator, that rarefied gas is a fair conductor, and that the solid body of the earth is a conductor, he compared the earth to a huge condenser possessing a positive charge in the outer layers, while the earth itself might be less positive or negative. Using the results of Prof. Rowland's works on the movement of a charged body giving rise to magnetism and prin-

ciple of an air condenser, he put forward the idea that the earth being a huge rotating condenser with the positive charge in the upper layers of the atmosphere and the negative charge at the ground, it would necessarily follow that magnetism could be developed in the region between this upper layer and the earth by the rotation of these charges.

He then traced the actual direction of the magnetism which would be produced, finding that the direction was the proper one to accord with facts, and that the compass needle indicates the direction. He mentioned that the idea had come to him that possibly thunder storms were in a measure due to flaws in the dense air as a dielectric, and explained in detail, somewhat, his thoughts on this subject. He drew attention to the consequences which would follow the possession by a mass of nebulous gas of a charge of electricity; this, if insulated in space, would, as its volume diminished by the radiation of heat and condensation, gradually increase in potential however small the charge originally possessed. The sun might, therefore, be a charged body having a relatively high potential, which potential would undergo elevation on further condensation. He put forward, as a thought on this subject, that a possible explanation of the solar periods as due to electrical states; the sun reaching a certain potential by the repulsion of small electrified particles loses that potential by the passing of the coronal stream, and not only a part of the charge which it possessed, but also a considerable amount of the charged material which might be encountered by the earth in its movement around the sun, and so give rise to an auroral display.

He concluded the lecture by stating that it was possible, in his opinion, that temporary stars, that is, stars becoming visible and then fading away, might therefore be explained on an electrical hypothesis, viz., that charged bodies possessing a difference of electrical potential when they approach near enough might exchange electricity between themselves on the grandest scale, giving rise to a uniformity of charge on their leaving each other; that this would naturally be done in a vast display, which would only last for a moment of time.

Moonlight Tables for January, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of January under his modified form of moonlight schedule.

TABLE NO. 1. Standard Moonlight Philadelphia System.				TABLE NO. 2. Frund's New Moonlight System.			
Date	Light	Date	Lighting.	Date	Light	Date	Lighting.
1	6:30 P. M.	1	4:30 A. M.	1	6:30 P. M.	1	4:30 A. M.
2	6:30 "	2	4:30 "	2	6:30 "	2	4:30 "
3	6:30 "	3	4:30 "	3	6:30 "	3	4:30 "
4	6:30 "	4	4:30 "	4	6:30 "	4	4:30 "
5	6:30 "	5	4:30 "	5	6:30 "	5	4:30 "
6	6:30 "	6	4:30 "	6	6:30 "	6	4:30 "
7	6:30 "	7	4:30 "	7	6:30 "	7	4:30 "
8	6:30 "	8	4:30 "	8	6:30 "	8	4:30 "
9	6:30 "	9	4:30 "	9	6:30 "	9	4:30 "
10	6:30 "	10	4:30 "	10	6:30 "	10	4:30 "
11	6:30 "	11	4:30 "	11	6:30 "	11	4:30 "
12	6:30 "	12	4:30 "	12	6:30 "	12	4:30 "
13	6:30 "	13	4:30 "	13	6:30 "	13	4:30 "
14	6:30 "	14	4:30 "	14	6:30 "	14	4:30 "
15	6:30 "	15	4:30 "	15	6:30 "	15	4:30 "
16	6:30 "	16	4:30 "	16	6:30 "	16	4:30 "
17	6:30 "	17	4:30 "	17	6:30 "	17	4:30 "
18	6:30 "	18	4:30 "	18	6:30 "	18	4:30 "
19	6:30 "	19	4:30 "	19	6:30 "	19	4:30 "
20	6:30 "	20	4:30 "	20	6:30 "	20	4:30 "
21	6:30 "	21	4:30 "	21	6:30 "	21	4:30 "
22	6:30 "	22	4:30 "	22	6:30 "	22	4:30 "
23	6:30 "	23	4:30 "	23	6:30 "	23	4:30 "
24	6:30 "	24	4:30 "	24	6:30 "	24	4:30 "
25	6:30 "	25	4:30 "	25	6:30 "	25	4:30 "
26	6:30 "	26	4:30 "	26	6:30 "	26	4:30 "
27	6:30 "	27	4:30 "	27	6:30 "	27	4:30 "
28	6:30 "	28	4:30 "	28	6:30 "	28	4:30 "
29	6:30 "	29	4:30 "	29	6:30 "	29	4:30 "
30	6:30 "	30	4:30 "	30	6:30 "	30	4:30 "
31	6:30 "	31	4:30 "	31	6:30 "	31	4:30 "

*Abstract of a lecture delivered before Franklin Institute, Dec. 1, 1893.

Electricity in the Far East.

BY W. STUART-SMITH.



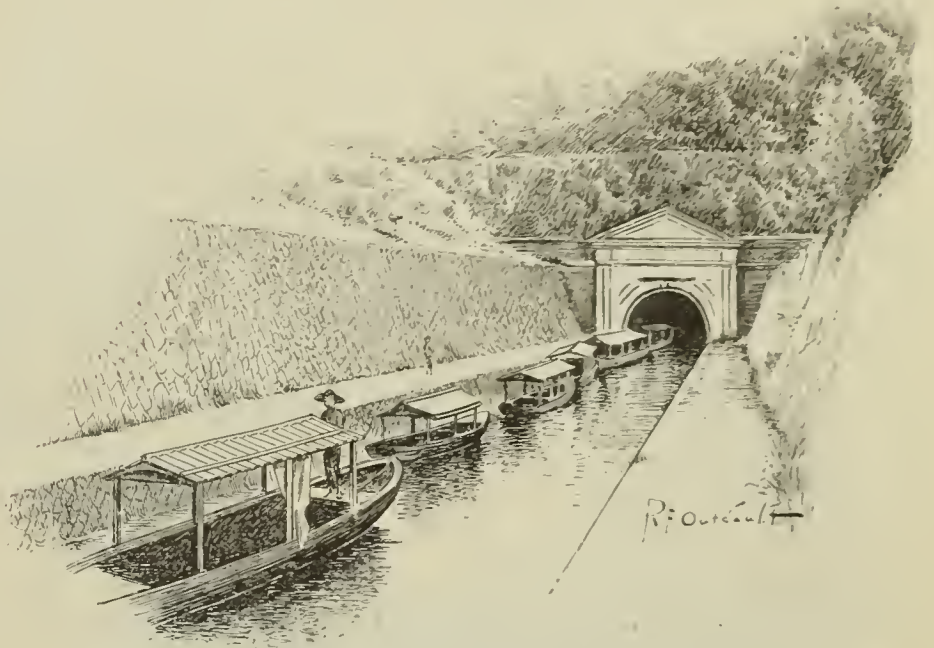
HE willingness of the Japanese to adopt, without reserve, a civilization totally different in character from that under which they had previously lived is one of their most striking characteristics. While they are very conservative in many ways, they are the most liberal people in the world in others. Twice in their history they have experienced a complete change of front, and adopted a foreign civilization. The first time was many centuries ago when Chinese civilization, with its literature, manufactures and science,

was found to be better than their own, and its adoption raised them from a state of barbarism to one of comparatively high civilization; and now, in these last few decades, the new civilization of the West has been adopted to a degree that must astonish any one who has a thorough understanding of the magnitude of the change that has taken place. To a traveler spending but a few days in the country, and in that time going into some part immediately outside of the treaty ports, it may seem that the civilization is still that of the Far East, and that it has but little in common with the West, but to one who has had the good fortune to spend a few years in the country, the extent of the movement is apparent.

In no way is this change made more evident than in the hold which electricity has taken in the past five years.

The telegraph, of course, has been in use since soon after the opening of the country and now extends to all parts of

message go along the wire, that he had watched many times since it was put up, but had never been able to see anything. The road on which this incident occurred is that leading from Utsonomiya to Nikko. At Nikko, about 400 years ago, Iyeyasu, the first shogun of the Tokugawa family, was hard pressed by his enemies, who had beaten him in battle. A mountain stream much swollen by heavy rains barred his further progress and he was in danger of being captured, when an angel appeared and assisted him and his followers across the stream. His enemies could not cross and he escaped, and soon after utterly crushed them. As a remembrance of the divine assistance given him, he determined to build the most magnificent temples in Japan upon the site of his escape, and the result of this decision was the world-renowned Nikko temples. At the place where he was as-



ENTRANCE TO NAGARAYAMA TUNNEL.

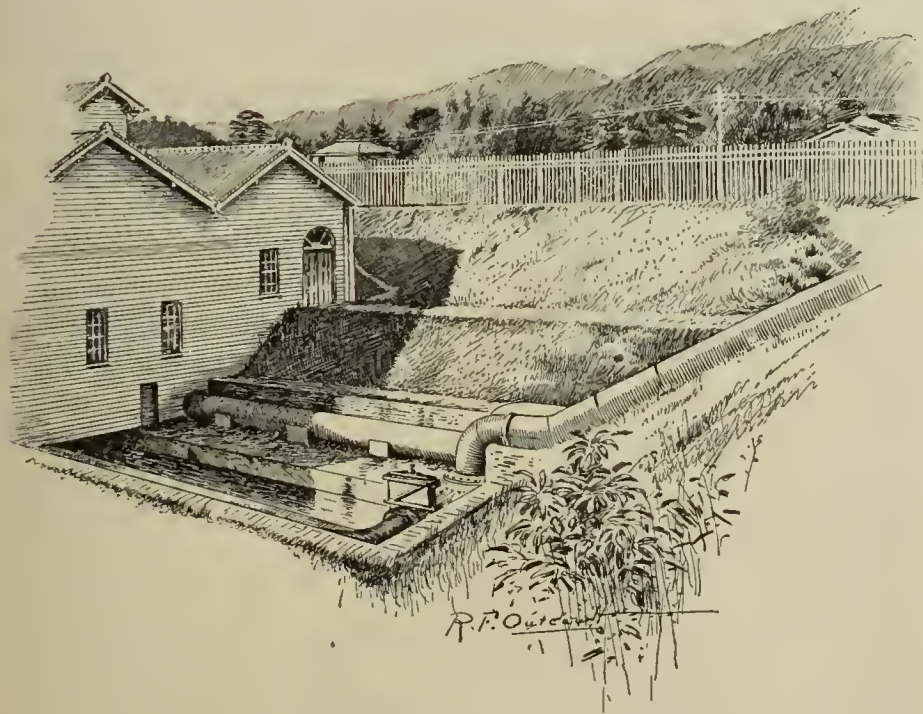
sisted across the stream a sacred bridge was built over which only the Emperor is allowed to pass, and the high priest once a year. The daimios contributed money lavishly for the temples, and when they were finished one daimio who had plenty of land and men but little money, said he had not been able to contribute toward building the temples, but would send men to build a road by which they could be reached. The result was the road twenty miles long, between Utsonomiya and Nikko. Before the march of modern progress broke in upon it it was a far finer monument than the temples themselves. These trees shown used to extend the whole distance, except where broken here and there by a village, but now the railroad has been built to Nikko and cuts the road in many places, destroying its beauty. One of the earliest telegraph lines, extending into the interior, was built along this road.

This incident was, perhaps, no more amusing than the reception of the telephone in Rio Janeiro. The writer was in that city when the exchange was being started and considerable opposition was shown, as the people supposed nothing but English could be spoken and in order to be able to use it they must learn that language.

The telephone is not in general use, but there are some good exchanges, the best being in Yokohama and Tokio. These two cities are connected by telephone, the distance being about twenty miles. All telegraph and telephone lines are owned by the government, and so far this fact has interfered with the building of electric railways, permission having been refused for any roads with rail return.

Electric lighting is exceedingly popular and several cities are supplied from central stations and there are many private plants in mills and factories.

Of all the electrical plants in Japan, by far the most interesting is the power plant of the Kyoto Canal Company, or,



LAKE BIWA POWER HOUSE.

the Empire. When it was first established there were many amusing occurrences, due to the inability of the people to understand how the message was sent over the wire. The writer's first visit to Japan was early in 1886, and one day he was, with a guide, walking over a remote mountain road along which passed a telegraph line. A countryman was met who had seated himself by the roadside and was intently watching the wire. His gaze was so fixed that the guide asked what he was doing, and he replied that he was waiting to see a

as it is called, the Sui-Ri-Jimusho. This was built by the government for the purpose of giving a new lease of life to a dying city.

For six or seven hundred years Kyoto was the residence of the Mikado or Emperor, and the name is made up of words signifying the "place of residence of the king." In the present capital, Tokyo, the same words are used and the significance is the same. From a small town Kyoto grew to be a city of perhaps 400,000 people, but when the great revolution which overthrew the power of the Tycoon or Shogun was ended and the Mikado restored to his proper power, it was thought advisable to move the capital to Yedo (Tokyo) and continue the seat of government where it had been in fact for more than three hundred years. The effect was at once seen in the decrease of the population of Kyoto. When the Japanese began to manufacture on a considerable scale it was seen that Kyoto might be kept from falling into decay if it could be converted into a manufacturing city. Lake Biwa is about six miles from the suburbs of the city and is separated from it by a range of hills called Nagarayama and a smaller range called Hino-oka-Yama. Through the city runs the waterway, Kamogawa, allowing boats to pass from Kyoto to tidewater in Osaka Bay. Lake Biwa is about 150 feet above the Kamogawa in Kyoto, and as this lake is by far the largest in Japan, being about 500 square miles area



WHAT WE MIGHT EXPECT.

and having a large contiguous agricultural territory, it has long been desired to connect it with the Kamogawa, the first record of such a proposition being dated in the twelfth century.

Lake Biwa is so named because it has the shape of a "biwa" or Japanese harp. About 300 miles from it is the highest mountain in Japan, the peerless Fujiama, 13,000 feet high and the most sacred mountain in Japan, where all volcanoes are worshiped as being the homes of dragons. Tradition has it that about the beginning of the Christian era this mountain was thrown up from the level plain in one night, and that at the same time the ground subsided over a vast extent of territory and that the depression thus formed filled with water and became Lake Biwa.

About 1882 or 1883 Mr. S. Tanabe, then a student in the Engineering College of the Imperial University, took as the subject of his graduating thesis the construction of a canal from Lake Biwa to Kyoto. He proposed that the canal should have sufficient depth and width to float the boats found on Lake Biwa and fall enough to carry sufficient water for power purposes in the suburbs of Kyoto, to furnish water by a branch canal for irrigation, and to supply the city with water under a good pressure for fire and sanitary purposes. The matter was ably presented and at an opportune time, as it was necessary that something be done for the relief of Kyoto. The result was that the pro-

ject was taken into serious consideration by the "powers that be," and it was finally decided to carry out the work as outlined by Mr. Tanabe, and as he had presented the matter in such an able manner he was appointed engineer-in-chief of the undertaking, a very responsible position for a young man just graduated. The work was carried out so successfully that Mr. Tanabe now stands in the first rank of Japanese engineers. He is at present professor of engineering in the Imperial University.

It has been stated in articles relating to this plant that Mr. Tanabe had lost his right hand and was obliged to make all plans, etc., with his left. This is happily an error, as he has only lost one finger of his right hand, though at the time he made the plans he was suffering with rheumatism and his right hand was out of commission, so he did make the drawings with his left.

The estimated cost was 1,250,000 yen, but, as usual, this estimate was exceeded, and 1,600,000 yen was expended. Of this about one-third was an imperial gift, one-fourth was a grant from the central government, and the remainder was raised by taxes of one kind or another on the city of Kyoto; these taxes were largely in the form of trade and land taxes. The work was done under the auspices of the city government, and during the construction the city assembly and governor fixed the amount to be spent for the coming year, basing their estimates on the expenditures of the past year.

Work was begun in March, 1885, and the canal was completed in April, 1890. The entire length is 6 7-8 miles, divided into two sections—the longest being 5 1-4 miles, and extending from Lake Biwa through the hills to the suburbs, and the other, 1 5-8 miles long, extending from the suburbs into the centre of the city. Between these two sections is a fall of 120 feet. The first intention was to overcome this by means of locks, but the plan was changed and an inclined plane railroad built having a total length of 1,800 feet and a grade of 1 in 15. A cable is used with a cradle car at each end and the first intention was to drive it by power obtained from a waterwheel placed at the foot.

At the time the canal was projected, electric power had not taken a prominent place, and the idea was to have mills and factories located about the foot of the incline and obtain power by means of wheels run by water piped from the canal above. Provision was made for about 2,000 h. p. on the wheels. Before the canal was completed, however, electric power transmission came strongly to the front, and in 1888 Mr. S. Tanabe and Mr. B. Takagi, one of the assistant engineers, came to America to study the question, and after considerable time spent in making observations and in consultation they returned to Japan. The result of their report was a determination to abandon the idea of locating mills, etc., around the incline. The flexibility of electric transmission, in virtue of which power can easily be sent to mills and factories located in remote parts of the city, made it possible to more fully carry out the purpose for which the work was undertaken.

Where the canal begins the lake is shallow, and the intake was formed by reclamations extending about 1,000 feet into the lake. Still water is insured by a breakwater, the material for this lake work being debris from the tunnels, etc.

The first stretch of open canal extends from the lakeside about 600 yards to the Nagarayama range and is in section 28, 10 feet wide and 5 feet deep. At the lake side a regulating lock and sluice gate are provided, by which the flow is kept constant at 300 cubic feet per second.

The first tunnel through the Nagarayama range, a view of the entrance to which is given herewith, is the longest in Japan, 2,680 yards. It is horseshoe in section, 16 feet wide by 14 feet high, with a depth of water of 6 feet. It is cut through slate, hornstone, sandstone and quartz-

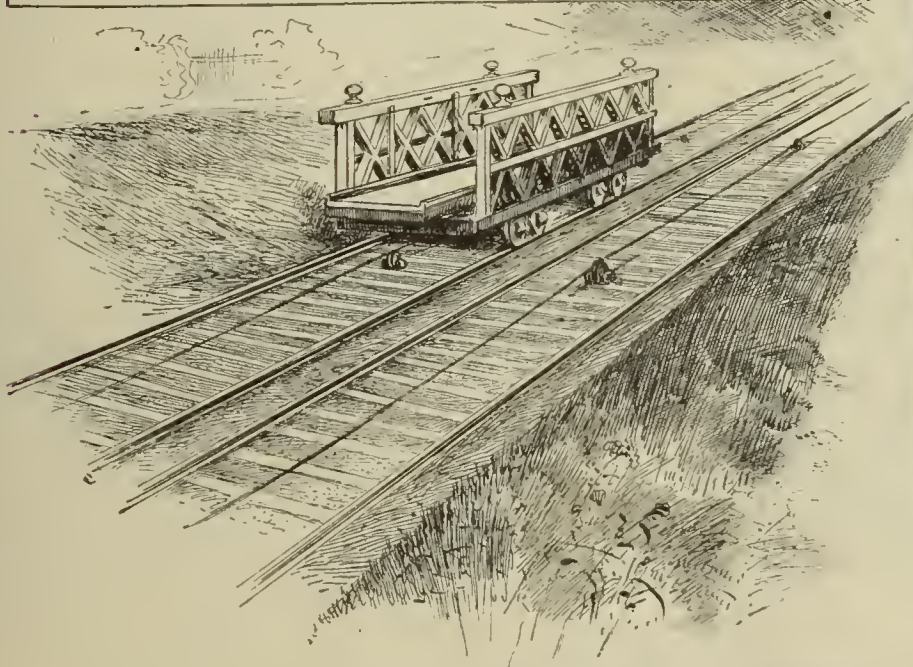
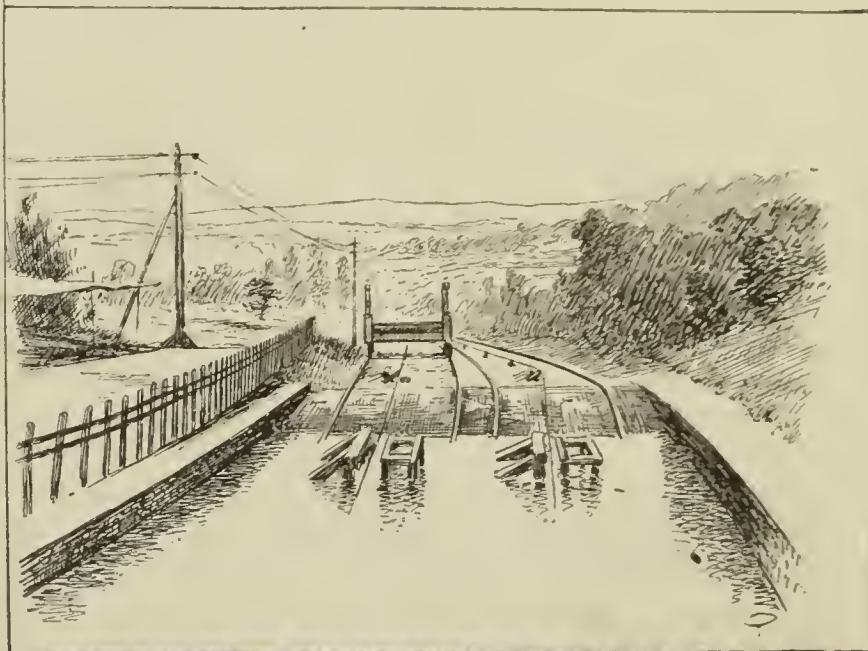
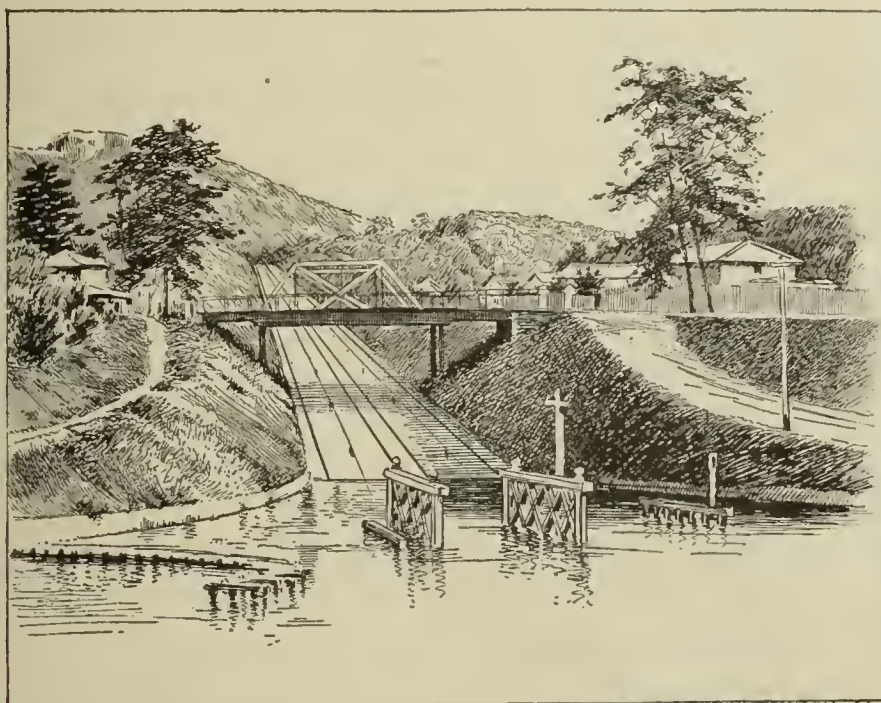
porphyry and is lined throughout with masonry and brickwork. From this first tunnel there is an open stretch of canal 4,837 yards long, partly in cutting but mostly along the hillsides, with an outer built-up bank in many places. From the end of this stretch, tunnels Nos. 2 and 3, 137 yards and 934 yards respectively, lead the canal through the Hino-oka-yama range to the incline and site of the power-house for running the cable.

At this point the canal branches, and one-sixth of the total water supply is carried northward through a small canal, a total distance of 5 1-4 miles. This part is of no interest from an electrical point of view, as the water is used solely for irrigating purposes. It winds along the hillsides, and in one place crosses the valley of the Imperial Tombs in an aqueduct of fourteen arches. This branch takes 50

motor as being easier to handle.

As it was not convenient to locate the power house at the very foot of the incline, and thus be able to utilize the entire fall, the ground was leveled about 400 feet from the foot and a deep pit was dug in which the power house is built. By this means the tail race was brought nearly to the lower canal level.

When fully completed the station is designed to hold twenty 8-foot Pelton wheels, each giving 120 h. p. under an effective head of 100 feet, after allowing for loss of head by friction, etc., but at present the station building occupies but little more than one-half the pit, the intention being to extend it as occasion demands. Two pipes, each 36 inches diameter, lead the water to the wheels from the canal above, these being sufficient to furnish power for all the wheels that



LAKE BIWA INCLINED RAILWAY AND POWER HOUSE.

cubic feet per second, leaving 250 cubic feet for power purposes.

Boats are hauled up and down the incline, being loaded on to the cradle cars at the ends of the cable. At the top of the main incline is a short reverse one of the same grade, 1 in 15, down which the car descends into the water until a boat can be floated on, while at the bottom the main incline leads far enough into the lower canal to float the boat off.

It was first proposed to locate a reversible Pelton wheel at the bottom of the incline to drive the cable drum, but when the change to electricity as a motive power was decided upon the power house was located at the head of the incline, and it is now run by a 50-h. p. Sprague automatic motor. When first started, the motor ran the same way all the time, and the drum was fitted with a reversing clutch and gear, but later carbon brushes and a reversing switch were fitted to the

can be placed in the present building. When the station is complete there will be four such pipes. From the canal to the pit one pipe is cast iron of English make, 1,307 feet in length; the other is wrought iron of Japanese manufacture, 1,511 feet in length. The remaining two will be of Japanese make. In the pit and the building both pipes are of wrought iron.

A view given shows the unoccupied portion of the pit with the tail race and main pipes, and one end of the incline and the power house for working the cable. The one above it depicts the head of the incline, showing the reverse incline and the car about to descend into the water to receive a boat. The view to the left of this shows the bottom of the main incline, while the one below it gives a view of the cradle car employed.

(To be continued.)

Alternate Current Working.

BY HARRIS J. RYAN.



DURING the past ten years there have been extensive developments in the use of the electric current for the transmission of energy for lighting and power purposes. One of the fundamental requirements for success in the wide extension of these uses of the electric current consists in the use of limited amounts of copper in the conductors. To meet this requirement it has been necessary to adopt methods that enable electric currents to be used that are transmitted at high pressures. Energy developed in the form of the alternating current is best suited for transmission over great distances because of the simplicity of the transforming apparatus, by means of which the proportions of current and pressure are arranged at any position in the working system to suit the requirements of transmission and utilization.

The fundamental phenomena of practical importance in alternate current working result from the electromotive forces produced in closed circuits in which the currents vary from instant to instant. Alternating currents cause corresponding alternating magnetizations that, in turn, cause the above electromotive forces. We also have electromotive forces produced by alternating currents in circuits possessing capacity through electrostatic processes. The pressure between the terminals of a condenser is proportional to the quantity of electricity stored in such condenser at any instant. An alternating current set up through a condenser gives rise to rates of change of the condenser charge that are proportional to the amounts of current at different instants, thus producing alternating differences of pressure, or electromotive forces. All alternate current actions are produced and regulated intelligently through a thorough understanding of the quantitative nature of these two classes of phenomena. Attention will be given to them, as they are the elements of alternate current working.

We will first study the quantitative nature of the alternating magnetizations that are necessary for the production of typical forms of alternating electromotive forces. The first of this series of electromotive forces is given in Fig. 1.

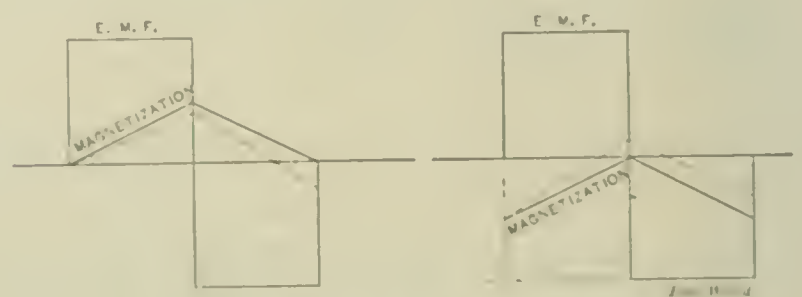


FIGS. 1 AND 2.

This is the form that is obtained in a circuit by the periodic reversal of the direction of some source of constant E. M. F. The figure illustrates the case in which these reversals of an E. M. F. of one volt occur every half second. For every second we have an application of the E. M. F. in each of two possible directions, or the production of a complete cycle or period of variation of E. M. F. This cycle of variation ends as it began, by making a change of the E. M. F. in the upward or positive direction, as indicated in the diagram. In Fig. 2 the laminated iron ring is wound with a number of turns T . This coil T is subjected to an alternating E. M. F. of the form represented in Fig. 1. The con-

ductor from which the turns on the ring are formed is comparatively large, so that the current that will produce any desired degree of magnetization in the iron ring will cause a the fall of potential in the coil equals the impressed E. M. F. ble. Under these circumstances current will be set up through the winding in such amounts at any given instant as to cause a magnetization of the ring that produces an E. M. F. counter to the actuating or impressed E. M. F. At all instants the sum of the counter E. M. F. developed and the fall of potential in the coil equals the impressed E. M. F. just as is the case in the operation of a direct current motor. The fall of potential produced by the current is small, consequently the counter E. M. F. is practically equal to that of the impressed E. M. F. at all instants. To produce this E. M. F., then, it is necessary that the rate of change of the amount of magnetism set up in the ring at each instant shall numerically be equal to the number of C. G. S. volts of E. M. F. to be developed in each turn of wire.

There are 108 units in the practical volt, hence the rate for any instant divided by this number gives the E. M. F. produced per turn in ordinary measure. In this case an E. M. F. is to be developed per turn equal in form to that illustrated in Fig. 1. One C. G. S. volt exists for one-half second in one direction, and during that time we must have the magnetization in the iron ring changing at the rate of one line per second. Since the E. M. F. to be developed is constant throughout the time of one-half second it is necessary that this rate of change of one line of magnetism per second



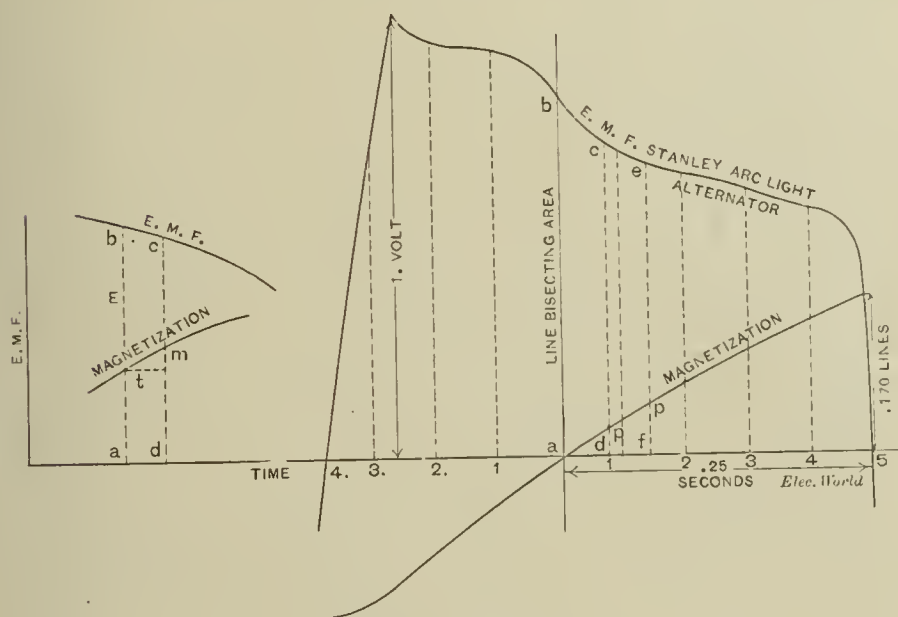
FIGS. 3 AND 4.

must also be constant throughout that time. For any particular half second this rate of change may be accomplished, as illustrated in Fig. 1, by cutting out and cutting in uniformly one-fourth line of magnetism from a negative to a positive direction. This would give a constant change of magnetism at the rate of one line per second for one-half second. Again the same rate of change during one-half second would have been accomplished by increasing the magnetism in a positive direction from zero to one-half a line uniformly throughout one-half second as indicated by Fig. 3. The same result would have ensued by diminishing the magnetization of one-half line from a negative direction as indicated in Fig. 4. For the first case, Fig. 1, the magnetism would be alternating; second case, Fig. 3, pulsating in a positive direction, and in the third case, Fig. 4, pulsating in the negative direction. The last two conditions are never even partially realized for more than a very few alternations. This is due to the fact that the resistance of no electric circuit can be made to disappear. In Fig. 3 the full line represents the change of magnetization when the fall of potential is neglected and the counter E. M. F. is, therefore, equal and opposite at all instants to the impressed E. M. F. Actually this is never completely realized. To maintain magnetization as indicated in Fig. 3 the current, and therefore the fall of potential in the primary, will be positive at all times. Then when the impressed E. M. F. is positive the counter E. M. F. will be less by an amount equal to the fall of potential caused by the current. During this time the rate of change of magnetism will be less, and is indicated by the dotted line. When the impressed E. M. F. is negative the counter E. M.

F. must be greater by the amount of the fall of potential caused by the current. During this time the rate of change of the magnetism must be greater than that indicated by the full line, and the broken line is extended to represent the further actual path of the magnetization. It is evident that the magnetic variation is rapidly changed from a pulsating to an alternating form. A similar consideration for Fig. 4 shows the same tendency, but from an opposite direction. It may then be stated positively that no matter at what point on the E. M. F. curve the circuit is closed the magnetic variation rapidly loses all pulsating characteristics and becomes alternating after the first few cycles.

It should be noted here that the alternating magnetization passes through zero at the instant when the area of the generated wave of E. M. F. is bisected. This is due to the following facts:

The positive and negative maximum values of magnetiza-



FIGS. 5 AND 6.

tion must be equal. The area developed in the E. M. F. card between any particular instants is numerically equal to the change of magnetism that took place during the interval. This is more clearly understood by reference to Fig. 5. t is a small interval of time during which the rate of change of magnetism may be considered to go on at a uniform rate, and the E. M. F., E , therefore, remains constant. During this interval the magnetization has increased by an amount m , as indicated in the diagram. $m \div t$ is the rate of increase of the magnetization, and is numerically equal to the E. M. F.

$$m \div t = E \quad m = t E$$

Consequently, this increment of magnetization is equal to the product of the E. M. F. it produces into the time during which the increment took place. This product is the area of the parallelogram $a b c d$, or the area developed by the curve of E. M. F. during the time t . It follows then that the entire area of the E. M. F. diagram from any given interval of time is equal to the sum of all the increments of magnetization that occurred to produce the E. M. F. that existed during that time. The sum of these increments is equal to the total increase of magnetization that occurred during a given interval. What is true of the increments is true of the decrements of magnetization.

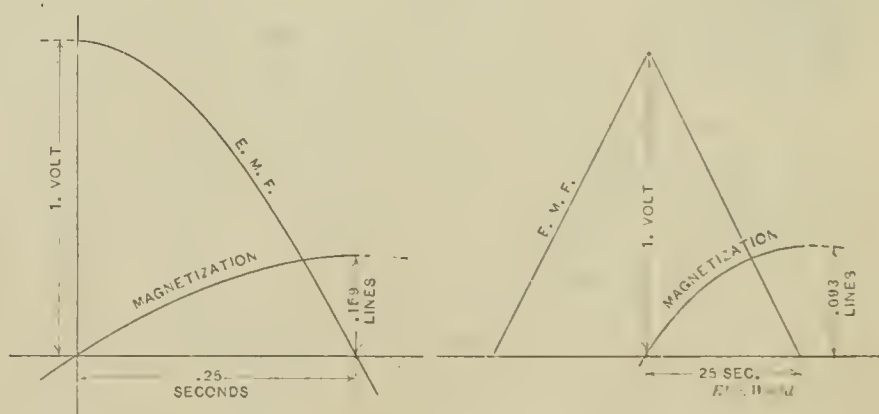
One-half of the area of the E. M. F. diagram for one alternation must, therefore, be produced by the magnetization coming to zero from its maximum value in one direction, and the other half by the increase of the magnetization to its maximum value in the other direction. What has just been said is illustrated in Fig. 6. In this figure the curve of E. M. F. is taken from a Westinghouse arc light alternator at work on a circuit of 40 arc lamps. The figure is a study of the variation of magnetism necessary to pro-

duce the E. M. F. as given. The line $a b$, bisecting the area of the E. M. F. diagram was located by means of an ordinary planimeter. Then from the point a , at which the zero of magnetization occurs, the curve of magnetization was extended by the location of points $p p'$, etc. For example, the point p was located by reading by means of the planimeter the area $a b c d$. This quantity, we have seen, is numerically equal to the value of the magnetization at p , and is, therefore, properly located in the diagram, after the selection of a suitable vertical scale. The magnetization at the point p' is equal to the area $a b e f$, etc. In this way the complete curve on each side of the zero was determined by the location of a number of points that enabled the curve to be drawn. It is to be observed that although the time occupied by an alternation is one-half second, and the maximum E. M. F. one C. G. S. volt, or the same as in Fig. 1, yet the magnetization needs to attain a maximum of but .170 line in Fig. 6, while it attains a value of .25 line in Fig. 1. This is due, of course, to the fact that in Fig. 6 the E. M. F. is less than one volt throughout the alternation, except for one instant only. The ratio between the maximum E. M. F. in an alternation of a given form per turn of conductor to the maximum of the magnetization needed to produce this form of E. M. F., is a constant of the utmost importance. This ratio for the form of E. M. F. curve in Fig. 1 is $1 \div .25 = 4$, and for that in Fig. 6 is $1 \div .170 = 5.88$. The following numerical work was done in the study of Fig. 6:

The curve of E. M. F. was plotted on Carpenter's cross-section paper. On this paper one large division has a length of one inch. Maximum height of E. M. F. card, 3.6 inches, equals 1 volt.

	Sq. in.
Total area of card by planimeter.....	10.7
Area at first point to right of bisecting line	1.35
Area at second point to right of bisecting line.....	2.48
Area at third point to right of bisecting line.....	3.58
Area at fourth point to right of bisecting line.....	4.57
Area at fifth point do. one-half total area.....	5.35
Area at first point to left of bisecting line.....	1.59
Area at second point to left of bisecting line.....	3.16
Area at third point to left of bisecting line.....	4.78
Area at fourth point do. one-half total area.....	5.35
Length of card, equals one-half second.....	Inch. 4.4
Length of complete cycle equals one second.....	8.8

A change of magnetization in a circuit at the uniform rate of one line per second will develop one C. G. S. volt per turn of conductor. With the scale adopted in the figure



FIGS. 7 AND 8.

the area developed per second by a constant E. M. F. of one volt is

$$3.6 \times 8.8 = 31.6 \text{ sq. in.}$$

By dividing each of the areas determined above by 31.6 we obtain the following magnetizations:

RIGHT OF BISECTING LINE.

Magnetization at Point 1.....	.042 line.
Magnetization at Point 2.....	.078 line.
Magnetization at Point 3.....	.114 line.
Magnetization at Point 4.....	.145 line.
Magnetization at Point 5.....	.170 line.

LEFT OF BISECTING LINE.

Magnetization at Point 1.....	.050 line.
Magnetization at Point 2.....	.100 line.
Magnetization at Point 3.....	.152 line.
Magnetization at Point 4.....	.170 line.

These values were used in plotting the magnetization curve given in Fig. 6.

Fig. 7 is a study of a sine form of E. M. F. curve to which a great amount of practice conforms approximately. The curve of magnetization was determined by means of a planimeter in precisely the same manner as in Fig. 6. Upon examination we find it to be a sine curve also, and of the same form as the E. M. F. curve that it produces. This is an especially valuable property, as will be seen through a study of the performances of alternate current motors. For this form the ratio of the maximum E. M. F. to the maximum magnetization is,

$$1 \div .159 = 6.28 = 2\pi.$$

Fig. 8 gives a study of the last of these typical forms of E. M. F. curves. The magnetization was determined as in the preceding cases. The ratio of maximum E. M. F. to maximum magnetization is,

$$1 \div .093 = 10.7$$

A glance at the various ratios just determined will be profitable. It takes approximately two and one-half times the magnetization in Fig. 8 to produce the E. M. F. in Fig. 1. Between the limits of variation found in practice this ratio of the extremes of requisite magnetizations may vary as much as 2. As the curve of E. M. F. is flattened the curve of magnetization is pointed; and as the former is pointed the latter is flattened. With the sine form common ground is met.

(To be continued.)

The Telephone Situation.

BY WILLIAM A. ROSENBAUM.



THE expiration of the fundamental telephone patent in March of last year created considerable commotion in telephone circles, although possibly the upheaval was more among the general public than in the American Bell Telephone Company. At any rate the event brought forth a large number of inquiries from financially interested parties and exhaustive and numerous articles in the various

journals touching upon the future status of makers and users of telephones as against the Bell Company, which has so effectually held its monopoly during the past seventeen years.

It has been impossible until recently to make a definite statement of the condition of the various controlling patents because of the absence of a final construction of the statutes by the Supreme Court regarding the effect of the expiration of a foreign patent upon the life of a United States patent applied for or issued subsequent to the issue of the foreign patent. Even now the condition of the Berliner patent and the basic Blake patent can only be surmised, but the circumstances bearing upon these two are such that their fate can be foretold with a reasonable degree of certainty. I believe that a brief statement setting forth the nature and scope of the fundamental patents and their present status would be of interest and value at the opening of the new year, which bids fair to be a lively one in telephone circles, and I have endeavored, in what follows, to present the matter clearly and concisely.

The patents which are generally recognized as controlling the telephone situation are the following:

1, The original Bell, dated March 7, 1876; 2, the Bell re-

ceiver, dated Jan. 30, 1877; 3, the Blake transmitter, dated Nov. 29, 1881; 4, the Hunning transmitter, dated Aug. 30, 1881; 5, the Berliner transmitter, dated Nov. 17, 1891; 6, the Edison transmitter, dated May 3, 1892.

When it is certain that all of these patents have expired by regular limitation, or otherwise become void, the field of commercial telephony is practically open to the public. That is to say, barring these patents, a serviceable transmitter and receiver may be made, sold and used. The following is a statement of the condition of each of the above patents: (1) The original Bell patent, which is the fundamental patent covering all practical methods of transmitting articulate speech by electricity, expired by statutory limitation on March 7, 1893, it having then been in force its full term of seventeen years. (2) The Bell receiver patent, which covers, in the broadest possible manner, an electro-magnet in combination with a plate (diaphragm) of iron or steel, or other material capable of inductive action, which can be thrown into vibration by the movement of the surrounding air or by magnetic attraction, will expire by statutory limitation on January 30, 1894, it having then been in force its full term of seventeen years. (3) The Blake transmitter patents are four in number, and they were issued Nov. 29, 1881. The first covers a diaphragm held against a ring seat by a spring pressing at its free end against the centre of one side of the diaphragm. The second covers an unimportant detail of construction. The third covers an arrangement of springs to hold the electrode in contact, regardless of the movements of the diaphragm, and the fourth is for a special arrangement of weight for doing the same thing. The British patent on these inventions issued January 20, 1879, prior to the dates of filing of the applications of all the above Blake patents in this country. Ordinarily, under that condition, the latter would expire with the British patent, which took place January 20, 1893. (4) The Hunning transmitter patent, which covers broadly the use of granular carbon in a loose state, as the variable resistance, would not expire regularly until Aug. 30, 1898, but fortunately for the public the same invention was patented in England in September, 1878, long before the application in this country was filed, and the United States patent therefore expired with the English on September 16, 1892. (5) The claims of the Berliner patent are broadly for the method of producing in a circuit electrical undulations, similar in form to sound waves, for the purpose of varying the pressure between electrodes in constant contact and thereby varying the resistance of the circuit. In other words, this patent covers the well known and commonly used means (a pair of electrodes in contact) for carrying out the fundamental method disclosed in the original Bell patent of 1876. The application for the Berliner patent was filed June 4, 1877, and did not become a patent until Nov. 17, 1891. On its face, therefore, this patent is a practical continuation for another seventeen years from November, 1891, of the monopoly which the Bell company has already so long enjoyed. (6) The Edison transmitter patents are three in number, and they were all issued May 3, 1892. The application for one of them was filed in April, 1877, and for the other two in July of the same year. The first is unimportant, as it covers a resistance medium consisting of a disc-like piece of plumbago in contact with the diaphragm. The other two are important, one covering a diaphragm with one or more carbon points (electrodes) in contact with it, and the other an electrode or point mounted on a spring. All three of these patents are, however, void because they were issued after the death of a foreign patent for the same invention. (Huber vs. Nelson Manufacturing Co., Supreme Court decision of March 27, 1893.)

As to the condition of the Blake patents it may be remarked that the applications upon which they are based were divisions from other applications, all disclosing the

same inventions, and the earliest of which was filed January 3, 1879, prior to the date of the British patent. It is therefore maintained by the Bell company that this early application renders Section 4,887 inoperative against the later patents and they are therefore still in force. A circuit court in the case of the Gramme Electrical Company vs. Arnoux and Hochhausen Electrical Company, held that the meaning of Section 4,887 "is that the United States patent shall expire at the same time with the foreign patent which was granted before the United States patent was granted, and not that it shall expire at the same time with the foreign patent which was granted before the application for the United State patent was made." Also, in the case of the Bate Refrigerator Company vs. Gillett, Judge Nixon said that he was "at a loss to understand what the time of filing the application has to do with the matter." This position of the Bell company would therefore appear to be untenable, and I am of the opinion that it would be safe to assume that the Blake patents are void. It is interesting to note a matter which apparently has heretofore been overlooked, to wit, the fact that the Blake application of Jan. 3, 1879, has not yet resulted in a patent. What has become of it, and is it to be a second Berliner surprise?

It seems highly improbable that the Bell company will be able to sustain the Berliner patent. A suit has been brought by the Attorney General to annul it, and the grounds set forth seem to be sufficient to accomplish that end. One is the long delay in issuing the patent, which, it is alleged, was purposely done by the company to secure an extension of its monopoly. Another is that the specifications and drawings were materially and improperly altered after the application was filed. It is also urged that a patent, issued to Berliner in 1880, covered the same apparatus, and further that Edison and not Berliner was the real inventor. The Patent Office is also charged with irregularities and errors on the part of its employes in connection with the matter. On the whole, a pretty strong case is made out against the patent, and the result will be looked for with much interest and with the reasonable expectation of its annulment.

In conclusion, it is quite safe to assert that after January 30, 1894, commercial telephony will be open to the public. It is to be understood, however, that this refers to the use of the "instruments" only, and that there are many patents under the control of the Bell company on the details of the central office apparatus which have several years to run. The fundamental principle of the switchboard, however, is open, and it would be an aspersion upon our inventors to suggest that they cannot produce a commercial switching system which will not infringe the existing patents.

Faure Accumulator Patent in Germany.

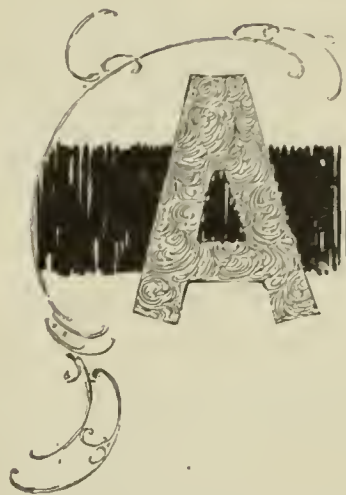
It is understood that the Imperial Court of Appeals at Leipzig has just decided that the employment of lead in the state of super-oxide, oxide, or insoluble salts as a filling material for accumulator plates comes under Faure's patent.

Dielectric Hysteresis.

Signor Riccardo Arno, through Professor Galileo Ferraris, recently communicated a paper to the Accademia Dei Lincei, of Rome, giving the result of quantitative researches on the dissipation of energy in dielectric bodies in a rotary magnetic field. Experiments were performed on numerous materials in the form of cylinders, such as glass, gutta-percha, paraffine, mica, caoutchouc, etc., and in each case it was found that the dissipation of energy varied nearly as the induction raised to the 1.6 power. The departure from this value in any case was small, but greatest for paraffine.

The Theory of Hysteresis.

BY TOWNSEND WOLCOTT.

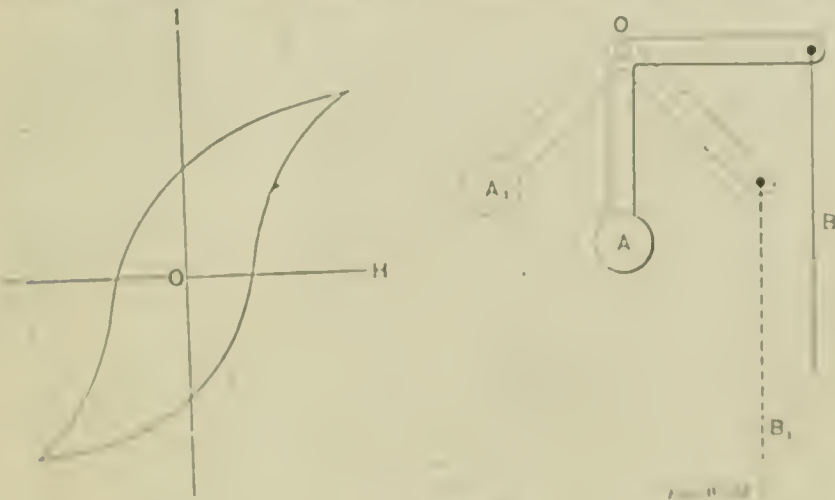


SOME of the fundamental ideas in the theory of hysteresis are very commonly misunderstood, the writer wishes to offering the following explanations and illustrations, even at the risk of saying some things which are already so well known as to be of little interest. The word hysteresis, introduced by Ewing in 1881, from the Greek *ὑστέρημα*, to lag behind, was a new name for a newly discovered fact, neither the name nor the fact received the attention they deserved for some years after. The lag to which the name hysteresis applies is the lag of phase of the magnetism of iron or other magnetic material, behind the magnetizing force applied thereto. That is to say, if we apply a magnetizing force to a given sample of iron, and measure the resulting magnetism in the iron, we find that the latter is not always the same for the same magnetizing force, but depends also upon the preceding condition of the system, that is, whether the given value of the magnetizing force is reached by increasing or diminishing its previous value. The value of the magnetism in the second case is greater than in the former. Or, to make the case more specific, take an electromagnet and send a current through its helix, gradually increasing the strength of the current from zero up to a given value, say one ampere. Then measure by any known means the total magnetism of the iron core. Now gradually increase the current again considerably above one ampere to a maximum, and then gradually decrease it again to one ampere. Again measure the magnetism of the iron, and it will be found to be greater than before. This *phase* lag is hysteresis proper, and is entirely independent of any *time* lag, that is, any tendency of the magnetism to grow or shrink with the lapse of time under a constant magnetizing force.

There is another phenomenon, which, although connected with hysteresis, and frequently confounded with it, is by no means identical with it. This is the absorption of other forms of energy, and the conversion thereof into heat, when the magnetism of the iron is changed. If we plot to any suitable scale the values of the magnetic force $\mathcal{H}$ (produced by a helix or other means) as abscissae, and the corresponding values of the induction $\mathcal{B}$ (lines per square centimetre produced in the iron) or the intensity $\mathcal{I}$ as ordinates, we obtain for a complete cycle of changes in the magnetic force a closed loop more or less like the accompanying illustration, Fig. 1, according to the specimen experimented on. It was shown by Warburg, and by Ewing himself, that the area of this loop represented work done by the magnetic force, and they both concluded that this work was in every case that which was dissipated in heat, and consequently if we could get rid of the hysteresis we would also be rid of the heat. Mr. Steinmetz, however, in his classical paper read before the American Institute of Electrical Engineers on Sept. 27, 1892, takes another view of the matter. The heat loss, he says, is due to molecular friction, and for a given specimen, between given limits of induction, the loss per cycle and per cubic centimetre is a constant quantity, and cannot be altered except by some such process as hardening or annealing, which alters the whole nature of the specimen. If the energy necessary to overcome the molecular friction is furnished by the magnetic force, then it hinders the magnetizing process and causes hysteresis. If, therefore, we could get rid of the molecular friction we would also get rid

of hysteresis and heat. On the other hand, if we supply the energy necessary to overcome the molecular friction by outside means, such as mechanical vibrations, the hysteresis disappears, but the heat remains. The area of the hysteresis loop does indeed represent energy, and the exact amount of energy furnished by the magnetic force during one cycle. Also as the energy furnished to a magnet in charging is given off again in discharging, this work for a complete cycle is zero, therefore the area of the hysteresis loop represents work done by the magnetic force outside of the magnetizing process proper. This work, however, may be equal to or greater or less than the heat dissipated by molecular friction. If it so happens that the magnetic force has to overcome the molecular friction and no other waste, then the area of the loop is what Warburg and Ewing thought it to be. If, however, there is other work to do, such as the production of eddy currents, the area will be greater than the energy dissipated by molecular friction, but as in this case the energy of the eddy currents eventually becomes heat, the area still represents the total dissipated heat. If, as before remarked, the energy necessary to overcome the molecular friction be supplied by mechanical vibrations, the loop may be entirely collapsed or even inverted so that the hysteresis becomes negative, and the magnetic force is assisted instead of being hindered. Or, to put the matter in the fewest words, Ewing says that there is dissipation of energy in heat because of hysteresis; Steinmetz says there is hysteresis because the energy of the magnetic circuit is dissipated. The immediate practical application of this is that we cannot improve the efficiency of our apparatus by "shaking out" the hysteresis, but only by improving the quality of our iron. The demonstration of Prof. Chas. A. Perkins in the last issue of *The Electrical World* (even if it be accepted as an unexceptionable demonstration, which I am afraid it will not be generally), only proves that the area of the loop equals the work done by the magnetic force per cycle, and not the energy absorbed by the iron, except as before stated when the two happen to be equal.

We may make a mechanical analogy, somewhat imperfect, but answering the purpose of illustration, thus: Assume



FIGS. 1 AND 2.

a lever bent at right angles, as in Fig. 2, pivoted at O , with a weight at A , a cord at B , in perfect balance when the weight hangs vertically below O . Now the pull on the cord B where there is no friction on the pivot O is proportional to the tangent of the angle of deflection of A from the vertical, so that it would take an infinite pull on the cord B to raise A to the horizontal. The vertical position of OA corresponds to demagnetization of the iron, the horizontal to magnetic saturation, and the pull on B to the magnetizing force. This case corresponds to iron free from molecular friction. The induction in the iron (position of OA) is related to the magnetizing force (pull on B) by a simple law, and it makes no difference in this relation whether the pull on B is increasing and A rising, or the pull decreasing and A falling. If now friction be introduced at the pivot O , we find this simple law modified.

Starting from the vertical position of OA if we pull on B with a given force, say ten pounds, A takes a certain position; now if we pull B still harder and raise A still higher and then slack off on B until the strain is ten pounds again, the deflection of OA will be greater than before, and the deflection of OA for a pull of ten pounds when there is no friction is between these two.

This represents hysteresis, phase lag (observe there is no time lag). So long as there is no way of overcoming the pivotal friction but by the extra pulling on the cord in rising and extra slacking in falling (to allow the weight to overcome it) the phase lag must remain, and a diagram of this phase lag, plotted with the pull on B as abscissae and the vertical motion of B as ordinates, we would have a closed loop as in the well known magnetic hysteresis curve, and, moreover, the area of the loop would be proportional to the work done in overcoming the friction. This loop might be collapsed by rapping on the pivot O , but to make the analogy perfect this ought to consume as much energy as before. Another common idea is that the molecular friction loss is less in slow running machines than in fast running machines of the same output, or at all events, this loss combined with the loss from eddy currents is less in the slow running machines.

The density of induction in different parts of an armature is not by any means the same and so the molecular friction loss is not the same in each cubic centimetre of the iron. However, the ratio of the densities of any two parts is constant for different densities (that is, if the density be doubled in one part, it will be also doubled in the other parts), and if the loss in the whole armature for a given density in one part be known, then if the density of this part be changed in a given ratio, the loss in the whole armature will still follow Steinmetz's law of the 1.6 power of the ratio. The eddy current loss varies with the second power of the E. M. F. which produces it, and this E. M. F. depends upon the total induction cut per second. Given a dynamo, determinate speed, E. M. F., etc., if we reduce the speed we reduce the E. M. F. in the same ratio.

To restore the E. M. F. there are three courses open: First, to increase the density of induction, and therefore the total amount in the same ratio as the speed is decreased; second, to increase the cross section of the iron and therefore the total induction with the same density; and, third, to increase the armature windings, leaving the total induction the same. In the first case, the molecular friction loss per cycle will be increased in the 1.6 power of the ratio in which the density is increased, and the number of cycle diminish in the same ratio as the speed. The eddy current loss will be unaltered. In the second case, the molecular friction loss is the same as in the high speed machine, for the cubic centimetres of iron are increased in the same ratio as the cycles are diminished. If the extra cross section is given by adding more discs, the eddy current E. M. F. in each disc varies directly as the speed, and the loss in each disc varies directly as the second power of the speed, but as there are more discs the total loss varies directly as the speed. There is, therefore, some saving in the eddy currents here. If the iron be increased by using the same number of discs of larger diameter or of smaller internal diameter, in the case of rings, the resistance of the eddy current circuit is diminished so that the loss is the same as in the high speed machine. In the third case both losses are reduced, the molecular friction loss in the same ratio as the speed, and the eddy current loss in the second power of that ratio.

I think it is a fact that the only class of slow speed machines showing a remarkably small percentage of these losses are those which, like slow speed car motors, have a much greater length of wire per volt than good high speed dynamos or motors.

SOME EVENTS OF THE PAST YEAR

1893

A BACKWARD GLANCE AT 1893

Looking backward over the year which has just been brought to a close and mentally collecting its scattered records, one is readily led to the conclusion that at least it has not been an uneventful one. It is true that the electrical world has not been startled with the disclosure of inventions of great practical and commercial importance, such as the telephone or incandescent lamp, but the electrical calendar has undergone such rapid and varied changes that it cannot be



A DAY AT THE FAIR.

complained that the chronicle of events for 1893 is uninteresting. There have been, too, some discoveries placed before the public which possess much scientific interest and possibilities of important practical developments.

The electrical lighting industry has occupied the most prominent position in the field, both on account of its own importance and the bearing which it has on kindred interests. At the close of the year 1892 the public was still in doubt as to the course the General Electric Company would pursue, and what advantage it would take of the signal victory it had recently scored in the decision of the Circuit Court of Appeals sustaining the verdict of Judge Wallace of the year before. The outside manufacturers were not to remain long in doubt, however, for it was soon evident that the policy of the General company was to close up the infringing manufacturers and secure to itself the monopoly which it believed its patent justly conferred. This policy was immediately carried out by securing restraining orders against several companies, but the first case to create much attention was that of the Beacon Vacuum Pump and Electrical Company, which came to trial at Boston on Jan. 23. The Goebel defense was then introduced for the first time and created a profound sensation in electrical circles. Nothing daunted by the adverse decision of Judge Colt in this case, the Columbia Incandescent Lamp Company renewed the fight at St. Louis, and this time it proved successful in so far that a restraining order was refused. A similar defense was brought forward in the Oconto case at Milwaukee, but in the preliminary hearing the decision was in favor of the Edison interests, while the opinion in the final hearing has not yet been handed down. Meanwhile, most of the other lamp manufacturers had been restrained, until the General Com-



FAIR TICKETS FOR TWO.

pany was left almost alone in the field. At the close of 1892 the Westinghouse Electric and Manufacturing Company had announced its intention of placing upon the market with the opening of the new year a new non-infringing stopper lamp, and early in January this lamp made its appearance. The series of important lamp suits was closed by the argument of the case of the Edison Electric Light Company et al. vs. Waring Electric Company et al. at Hartford early in December. This time the fight was along different lines, the "Novak" interests acknowledging the validity of the Edison patent and claiming non-infringement on the ground that their lamp contained an atmosphere of gas in place of the Edison vacuum. The court has as yet reached no decision in this case and lamp manufacturers and others are still looking forward to the result. While the difficulty of obtaining lamps other than those of the Edison make has resulted in considerable embarrassment, it has still been possible to secure such lamps, and the absolute monopoly of the Edison

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CELEBRITIES AT THE CONGRESS.

interest has been broken. With the prospect of the early expiration of the Edison patent it is probable that the situation during the coming year will be much more encouraging.

The Electrical World has throughout the year devoted the attention to this important question which it merited. It was the first journal, electrical or otherwise, to bring into prominence the celebrated Goebel defense, and the only one that presented anything like complete reports of the cases. To Boston, St. Louis, Milwaukee and Hartford The Electrical World sent special representatives, and to all save one its own special artist, with the result that it was enabled

in all these cases to present an exhaustive and elaborate report. From time to time in these columns the incandescent lamp situation has been fully discussed, and the opinions of



men prominently identified with these interests published.

The telephone question has been second only to that of electric lighting and has been brought to public attention by the expiration of the Bell patents and the possibility that the monopoly so long held by the Bell Company might at last pass from its hands. The Bell fundamental patent expired March 7 and in less than a month hence—Jan. 30, 1894—the patent on the metal diaphragm will have reached the end of its life.

AND STILL THEY COME!

The Edison carbon transmitter patents are admittedly void, and there is little doubt that after January 30 the Bell Company must rest its claim for a monopoly entirely upon the Berliner patents, whose validity is now being tested in the courts. Several telephones have been placed on the market during the year, but either because of suits brought by the Bell Company, or for other reasons, they have not as yet entered into active competition. The situation promises to be even more interesting during the coming year, and it is possible that the great question may finally reach a settlement.

The long distance telephone line between New York and Chicago has been extended at the one end to Boston and at the other to Milwaukee, and many other cities between these points have been given the benefit of long distance transmission of speech. Various improvements in long distance apparatus have been made and steady progress in the direction of the details essential to the success of this work. One of the sensations of the year was the paper by Prof. Silvanus P. Thompson on "Ocean Telephony" at the International Congress of Electricians.

The Electrical World has covered this question with its characteristic thoroughness and presented at frequent intervals articles discussing the situation from every point of view. No better illustration can be given of the clear and able way in which the subject has been handled than by reference to an article on the subject which appears elsewhere in this issue.



ELECTRICITY.

progress is gradually being made. Prof. Gray's telautograph may be said to be the sensation of the year in this field and on its exhibition in New York, and later at the World's Fair, was received with great interest. By far the most elaborate and scientific discussion of this apparatus appeared in the columns of The Electrical World.

The electric railway has continued to maintain its position as the most extensive of the practical applications of electricity during the past year. In many of our cities horse cars have now become objects of curiosity. Brooklyn has perhaps shown the greatest advance and has now replaced almost all its horse lines by electric cars. Baltimore has also gone into the construction of electric railways extensively during the past year, as have many important cities in the West. The Intramural railway at the World's Fair marked an important step in electric traction. This was the first practical application of electricity to the propulsion of railway trains and was an unqualified success, and its influence will undoubtedly be felt in the near future. The Chicago and St. Louis electric railroad has, unfortunately, not materialized, but its promoters still express hope of its final completion. The electric railway has recently scored another important victory in the defeat of its rival, the cable, in New York City, as the Metropolitan Traction Company has just offered a prize of \$50,000 for a satisfactory system to replace that which it has recently installed at an enormous expense. Accumulator traction continues to give promise



WORLD'S FAIR REMINISCENCES.

of more rapid development in the future, and during the past year one of the important lines in New York City has been partially equipped with accumulator cars, which have now been successfully running for some months. Accumulators have also extended their field of application in other directions, and the Edison illuminating companies of New York and Boston have important large storage battery plants as auxiliaries to their stations, and American manufacturers have given indications of their intention in the future to manufacture batteries of much larger capacity, thus following the example set by their foreign competitors.

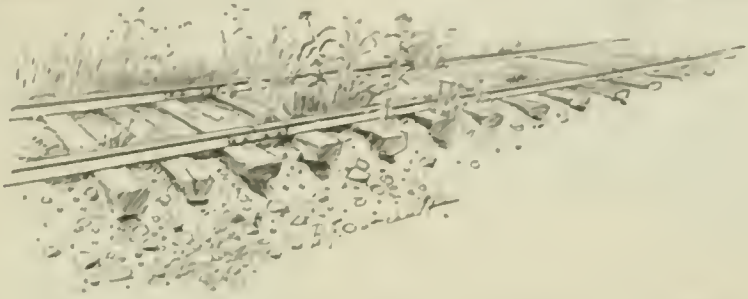
The Electrical World has given more than usual attention to the subject of electric traction, a course which is warranted by the prominent position this branch has assumed in the electrical field.

The transmission of power is a subject whose importance is shown by the protracted discussion it caused and the in-



1893 AS IT APPEARS TO THE ELECTRICAL WORLD'S ARTIST.

terest it excited at the recent International Congress of Electricians. The greatest example of power transmission is, of course, the Niagara Falls plant, and work has been rapidly progressing on this installation and within the past few months the great question of the electrical system to be adopted has been settled and the contract for the generators let. Prof. Forbes, the consulting engineer of the project.



THE CHICAGO AND ST. LOUIS AIR LINE.

has finally announced the principal details of the construction. A large three-phase plant is now being installed in California, and other transmission of power plants have been erected in this country and abroad.

The alternating current is coming more and more to the front, and each year it pushes further into the field of its old rival, the continuous current. During the present year the various questions connected with its practical application have been thoroughly discussed and the battle of the phases waged more merrily than ever. Improvements in alternating current motors, both abroad and in this country, have broadened their field of application. That this subject has been well covered a glance at the indexes to the half-yearly volumes of *The Electrical World* will show. Articles have appeared under such names as C. E. L. Brown, Behn-Eschenberg, Arnold and Emil Huber from abroad and Elihu Thomson, Patten and Kennelly in this country.

The World's Fair in itself, even if nothing else of importance in the electrical field had occurred, might well be sufficient to mark the year 1893 as an eventful one. It was early seen that the electrical features of the Fair would prove to be among the most attractive and that the Exposition would indeed serve as a monument to electrical progress. It is hardly necessary to recall here the part that electricity played in the Exposition, as that subject has recently received such full treatment in these columns. Even before the Fair opened *The Electrical World* sent a representative



of its editorial department and its special artist to Chicago, where they remained for a number of months, and the splendidly illustrated descriptions of the important electrical features and exhibits, presented often in advance of all its contemporaries, only served to substantiate its claim for enterprise and progressiveness.

The International Electrical Congress was in many respects the event of the year, and has been so fully covered in these papers that its work and its results must

now be well known. *The Electrical World* distributed at the Congress an issue of 60 pages devoted especially to the interests of the meeting and containing portraits and biographical sketches of the official delegates, and an elaborate directory to Electricity Building and other features of the Fair. It was enabled through its seven representatives at the Congress to present the most interesting and complete report of the proceedings yet published.

The year 1893 will long be remembered as one of widespread financial distress. The electrical industries have suffered in common with all the others, yet it would seem that

their chastisement has been somewhat less severe. The great majority of the electrical firms, and those more or less connected with the industry, have weathered the storm handsomely, or at least safely, and the few who have gone under were, in most cases, bubbles that were better pricked now than at some future time. In this connection it may not be inappropriate to call attention to the opinions on "How the Electrical Industries Withstood the Stress," which *The Electrical World* gathered from prominent men in every quarter of the field and presented to its readers some months ago.

The General Electric Company has been the greatest sufferer from the business depression and has been buffeted about in the stock market without mercy. In *The Electrical World* of January 7 we find its stock quoted at 111 1/8, while in the last issue of the year it is recorded at 36 3/4. Whether the company will be able to pass through this crisis without reorganization or disintegration is a question which many are asking.

The necrology of the year contains many names familiar in the electrical world, including those of Dr. Norvin Green, president of the Western Union Telegraph Company; Prof. Moses G. Farmer, Dr. Werner von Siemens, Anthony Reckenzaun, Prof. John Tyndall and Henry Goebel.

Progress during the year has been made not alone along material lines, but in the realms of thought as well. While the practical workers in the electrical field have been steadily advancing, the army of writers



has been rapidly increasing and the evidences of their industry are numerous. The year has been rich in literature and apparently this line of work has been little affected by the financial dis-

asters which have played such havoc in business circles. A brief glance at the work which has been accomplished in both book and periodical literature may prove interesting.

Electric book literature during the past year has received numerous accessions, of which the most important is J. J. Thomson's "Notes on Recent Researches in Electricity and Magnetism"—a long-promised supplement to Maxwell's great work. Another contribution in the same line is the concluding portion of Gray's work on "The Theory and Practice of Electrical Measurements." Jackson's "Electro-Magnetism and Construction of Dynamos" furnished a much needed text-book for colleges, while Kapp's "Alternating Currents of Electricity" and "Dynamos, Alternators and Transformers" bear out the reputation of this author for writing books of equal value to the student and the practical man. Cox's "Continuous Current Dynamos and Motors," Hawkins & Wallis's "The Dynamo, Its Theory and Design" and Weymouth's "Drum Armatures and Commutators" are three useful contributions on the design of electrical machinery, and Preece & Stubbs' "Telephone" and Hopkins' "Telephone Lines" are the best works yet published in English on telephony. Kennelly's "Theoretical Elements of Electro-Dynamic Machinery," Kilgour's "Electrical Distribution" and Ram's "Incandescent Lamp" are noteworthy addi-



WERNER SIEMENS.

nions to their respective subjects, as well as Benjamin's "Voltaic Cell"—an exhaustive compilation on chemical batteries. New editions were issued during the year of three standard works, Crosby & Bell's "Electric Railway," Bedell & Crehore's "Alternating Currents" and Davis "Standard Tables for Wiremen," and of Ayrton's "Practical Electricity" and Salomon's "Electric Light Installations." Two volumes of Houston's Advanced Primers completed a series of three books for the first-year electrical student and the general public, and Hering's "Electricity at the Paris Exposition" added another historical work to electrical literature.

Periodical literature has also been rich in valuable contributions to science and art. A glance through the pages of The Electrical World for the past year will give some idea of the quantity and quality of this material. In addition to the articles already referred to, the following may be mentioned as some of the more important: The completion of the concluding sections of P. Mottelay's Chronological History of Electricity, and of the series of articles on Electricity in Agriculture; Laboratory Notes, by Lieut. F. Jarvis Patten; Nomenclature, Symbols and Abbreviations, by E. Hospitalier; Conductors and Insulators, by Prof. R. A. Fessenden; Theory of the Transformer, by Drs. Bedell and Crehore; Capacity and Induction of High Potential Circuits and Electromagnetic and Electrostatic Hysteresis, by C. P. Steinmetz; The Most Economical Age of Incandescent Lamps, by Hering, Thomson, Roberts, and others; Technical Education in Europe, by F. C. Perkins; Rope Driving, by Prof. J. J. Flather; Comparison of Different Lighting Systems, by Otto Frick; The Economical Operation of Street Railway and Lighting Plants, by J. B. Cahoon; The Simplification of Alternating Current Formulae, by A. E. Kennelly; and many others of equal importance and interest.

Rural Electric Roads.

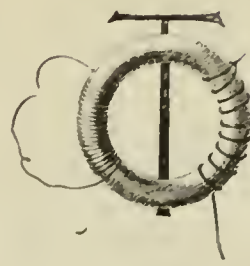
The recent report of the Ohio Road Commission to Governor McKinley pays considerable attention to the subject of electric roads for rural transportation. With the advent of the electric car, it says, has come a development along a line totally unexpected, through its extension into suburban and rural districts. There is no reason why these railways should not be carriers of freight as well as passengers, and it is not at all visionary to surmise that as the steam railway superseded horse power for long hauls, so the electric railway may supplant it for short hauls. That more electric roads will be built, that they will be almost innumerable, in fact unlimited, is evidenced by every indication, so that the problem of building the wagon road is made easier and easier by reason of the shortened distances for which horses may be profitably used for purposes of transportation. By introducing the iron rails and inanimate power for rapid transit and to take the heavier loads, the problem is solved.

A comparison of the cost will show that the average expenditure required to macadamize a road or make it hard and durable with any kind of material is fully equal to the cost required to lay down steel rails over which not only wagons and carriages propelled by horses, but cars propelled by electric power, might also go at a greatly reduced cost in transportation. Having given the cost of construction—which is the same in each kind of road—and the cost of moving the vehicle being so much less over the steel rail than any other kind of road, and knowing also that the cost of inanimate power is less than the cost of animal power, it seems clear that the substitution of steel rails for macadamized roads, and inanimate power for animal power, is destined to cheapen our transportation in the most effectual manner.

The report argues in favor of assisting the extension of electric traction by providing free tracks over country roads, thus placing it on an equality in this respect with wagon traffic.

On the Fall of Pressure in Long Distance Alternating Current Conductors.

BY A. E. KENNELLY.



THE paper on "Impedance" in vol. X., No. 5, p. 175, Transactions of the American Institute of Electrical Engineers for April, 1893, show that the fall in pressure over a line of resistance R ohms carrying a sinusoidal current of I amperes is IR volts multiplied by an impedance factor depending upon the disposition and size of the wire. It has also been pointed out that while the "drop" so computed is a minimum in regard to current wave type, being augmented by any distortion from the sinusoid, it is on the other hand a maximum in regard to the circuit, since the fall in pressure measured at load terminals cannot be greater and will usually be less than the fall of pressure as measured and computed between the far and near ends of the line, owing to the phase variation of pressure along the wire. These two opposing sources of error tend to neutralize and on short lines may be usually neglected, or when specially desired, corrections can be applied for each when sufficient data for the current lag and wave outline in the load are forthcoming.

For short aerial lines, say not more than five miles in length, the application of the electromagnetic impedance factor is therefore competent to practically determine the fall in alternating current pressure.

But when the aerial line is long, or is of even moderate length and underground, so that it possesses appreciable static capacity, and particularly if the working pressure is high, the influence of electromagnetic capacity upon the drop is no longer paramount and electrostatic influence may not be ignored, while the effect of leakage may also call for attention.

An obvious approximate method of treating the new problem is to assume that all the capacity, also all the leakage, is collected and connected at the middle point of the line, and then to consider these as derived impedance circuits. The effect of these shunts upon the main circuit can be computed by the ordinary rules of impedances. This plan while fairly successful and always useful as a check, is often unsatisfactory because it is not rigorous, and the extent of its error is left in doubt.

It is the object of this article to show how the rigorous computation for the fall of pressure in lines of known resistance, inductance, leakage and capacity, carrying sinusoidal currents can be most simply carried out.

Suppose a generating station, A , supplies a consumption point, B , at a distance of L miles or kilometres through two wires in metallic circuit, or through one wire with ground return. At B there are transformers or translating devices operated at a pressure u that it is usual to keep nearly uniform. Under this pressure at any given load a certain effective current of i amperes will traverse the apparatus at an angle of lag β . In practice the current is often so far distorted from the sinusoidal type, especially at light loads, that the angle of lag is not clearly defined, but we are compelled to sacrifice some accuracy in detail in order to arrive at determinations of reasonable facility and use. We therefore assume that the current and lag are experimentally known for the particular apparatus and load in accordance with the relation

$$u \cos \beta \times \text{efficiency} = \text{Output.}$$

Having then given u , i and β at station B , the problem is to determine the corresponding pressure, U , and current I , at A , or at any intermediate point along the line.

Let r = the resistance of the line in ohms* per mile.

Let l = the inductance of the line in henrys per mile.

Let g = the leakage conductance of the line in mhos per mile.

Let c = the capacity of the line in farads per mile.

Let ω = the frequency $\times 2\pi$.

Let $j = \sqrt{-1}$.

$$\text{Then } U = u \cosh Lz + jI \sinh Lz. \quad (1)$$

$$\text{and } I = i \cosh Lz + \frac{u}{j} \sinh Lz. \quad (2)$$

$$\text{where } z = \sqrt{(r+jl\omega)(g+jc\omega)} \text{ and } y = \sqrt{\frac{r+jl\omega}{g+jc\omega}} \quad (3)$$

As these equations involve plane vectors or the "complex quantities" of algebra, a preliminary discussion of their operations may first be admissible.

Let AB (Fig. 1), be a line of 2 units in length inclined at an angle of 40 degrees with the base AC , and let DE be a similar plane vector of length 3 units and angle 70 degrees. Then their product, $AB \times DE$, is the line or plane vector FG of length 6 and angle 110 degrees. The quotient, AB/DE , is HK of length 0.66 and angle -30 degrees, while the quotient DE/AB is LM of length 1.5 and angle 30 degrees.



FIGS. 1 AND 3.

Hence, to multiply plane vectors their lengths are multiplied and their angles added, to divide them their lengths are divided and their angles subtracted. Also to add or subtract plane vectors they are connected end to end. Thus $AB + DE = AE$ and $AB - DE = Ae$, DE being here laid off in the reversed direction.

The hyperbolic sine and cosine of any numerical quantity can be obtained directly from tables of those functions, but we have here to employ in equations (1) and (2) the hyperbolic sine and cosine of the quantity Lz , which is a plane vector. The following auxiliary formulas are requisite:

$$\sinh(a + jb) = \sinh a \cos b + j \cosh a \sin b \quad (4)$$

$$\text{and } \cosh(a + jb) = \cosh a \cos b + j \sinh a \sin b \quad (5)$$

We now proceed to the application of these formulae:

Example. — At station B transformers are supplied at a steady pressure of 10,000 volts effective and 100 periods through two No. 0 A. W. G. wires of copper in metallic circuit, suspended on high poles at an interaxial distance of two feet. The resistance of this conductor is 0.508 ohm per mile, the inductance 1.688 millihenrys per mile, the capacity 0.081 microfarads per mile, and the leakage negligible, or the leakage conductance 0 mhos per mile. To find the pressure and current at A , distant 20 miles from B , when a full load of 50 amperes is sustained with a lag of 10 degrees at B .

* Or per kilometre if L is expressed in kilometres.

This metallic circuit may be divided by the imaginary line OO , Fig. 2, into two halves, each as though inde-

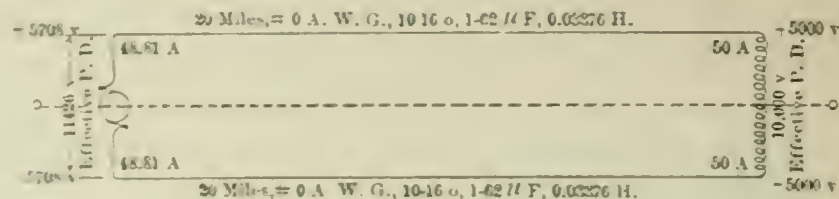


FIG. 2.

pendent of the other, and operating with ground return at 5,000 volts. We have then:

$$u = 5,000.$$

$$i = 50.$$

$$\beta = -10.$$

$$r = 0.508.$$

$$l = 1.688 \times 10^{-3}. \quad \therefore l\omega = 1.061.$$

$$c = 8.1 \times 10^{-8}. \quad \therefore c\omega = 5.09 \times 10^{-5}.$$

$$g = 628.3.$$

$$L = 20.$$

The first step is to determine the plane vector z .

The steps are indicated in Fig. 3. AB represents r , BC $l\omega$, and AC the vector sum $(r + j l \omega)$, whose angle is $64^\circ 25'$, and length 1.176. Again DE is $c\omega$, and since the horizontal component, g , is zero, the quantity $(g + j c \omega)$ remains DE simply. The product $(r + j l \omega)(g + j c \omega)$ or $BC \times DE$ is $FG = 5.987 \angle 154^\circ 25' \times 10^{-5}$, and the square root of this product is $FH = 7.7375 \times 10^{-3} / 77^\circ 12' 30''$, or the quantity z in equation (3). Lz is consequently L times the line FH or $0.15475 / 77^\circ 12' 30''$. Again the quotient of AC/DE is the line $KM = 2.311 \times 10^{-4} \angle 25^\circ 35'$, and the square root of this plane vector is $KN = 1.521 \times 10^{-2} \angle 12^\circ 47' 30''$. This gives y in equation (3).

The next step is to find the hyperbolic sine and cosine of Lz as indicated in Fig. 4. The line OP represents the plane vector Lz and its components are found to be $OQ = 0.03426$ and $PQ = 0.1509$. This length PQ represents the circular measure of an angle whose arc can be found in trigonometrical tables to be $8^\circ 38' 45''$. Taking formula (5), $RS = \cosh 0.03426 \times \cos 8^\circ 38' 45'' = 1.0006 \times 0.9887 = 0.9883$ and $ST = \sinh 0.03426 \times \sin 8^\circ 38' 45'' = 0.03426 \times 0.1503 = 0.005151$, so that RT is $\cosh Lz = 0.98835 / 0^\circ 18'$.

Similarly, with the aid of formula (4) $UV = \sinh 0.03426 \times \cos 8^\circ 38' 45'' = 0.03426 \times 0.9887 = 0.03387$ and $WX =$



FIG. 4.

$\cosh 0.03426 \times \sin 8^\circ 38' 45'' = 1.0006 \times 0.1503 = 0.1504$, so that UX is found to be $0.15417 / 77^\circ 18' 45'' = \sinh Lz$.

Substituting the above in formula (1) we find as indicated in Fig. 5.

$$U = 5000 \times 0.98835 / 0^\circ 18' + 1.521 \times 10^2 \angle 12^\circ 47' / 0^\circ 5' \times 50 \angle 10^\circ \times 0.1542 / 77^\circ 18' 45'' = 4942 / 0^\circ 18' + 1173 / 54^\circ 31' 15''.$$

$U = AB + BC = AC$ which is found by summing components to be $5708 / 9^\circ 54'$.

Also by formula (2)

$$I = 50 \sqrt{10^\circ} \times 0.98835 / 0^\circ 18' + 6.576 \times 10^{-3} / 12^\circ 47' 30'' \\ \times 5000 \times 0.1542 / 77^\circ 18' 45'' = 49.418 \sqrt{9^\circ 42'} + 5.072 / 90^\circ 6' 15'', \text{ and}$$

$I = DE + EF = DF$, which by summing components is found to be $48.81 \sqrt{3^\circ 49'}$ amperes.

The effective pressure at A being represented in Fig. 6

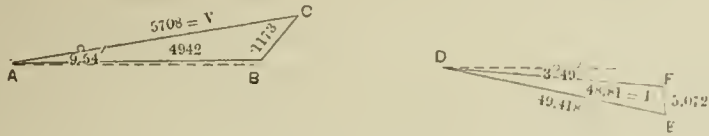


FIG. 5.

by AC and the effective current by DF , the angle between them is $13^\circ 43'$, and the energy delivered to the line is $IU \cos. 13^\circ 43' = 270.7$ kilowatts. The energy absorbed at B is $iu \cos. 10^\circ$, or 246.2 kilowatts (on each side of the circuit), and the loss in this transmission 24.5 kilowatts. This loss can only exist as $i^2 r$, the value of which must fall between $(50)^2 \times 10.16 = 25.4$, and $(48.81)^2 \times 10.16 = 24.14$ kilowatts, the mean being 24.7, confirming the above calculation.

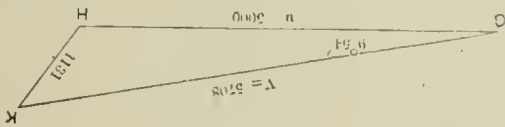


FIG. 6.

tion. The total pressure at A is thus 11,416 volts and the current 48.81 amperes.

The drop on each wire is 708 volts.

The drop due to IR on a similar continuous current circuit would be 496 volts.

The impedance factor being 2.316 for these wires, the drop in conductors would be by electro-magnetic impedance principles 1,150 volts. The actual drop between far

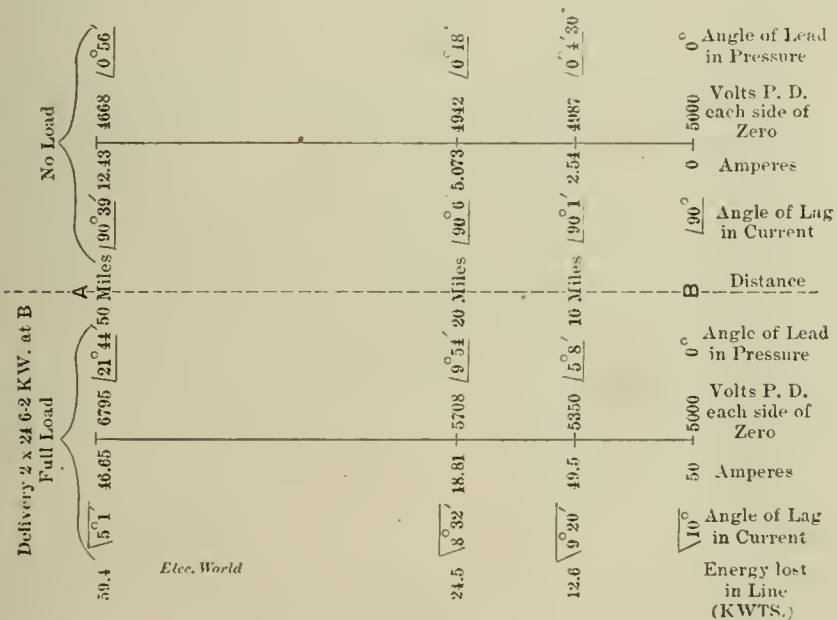


FIG. 7.

and near ends of one line is shown in Fig. 7 to be $GK = 1,131$ volts.

The influence of electrostatic capacity has reduced the drop in the line, as measured between line terminals, from 1,150 volts to 1,131.

As one more example, suppose that with 10,000 volts maintained at B the load is entirely removed. In this case the second term disappears from equation (1) and the first term from equation (2), so that we have at once

$$U = 5,000 \times \cosh Lz = 4942 / 0^\circ 18'$$

$$\text{and } I = 6.576 \times 10^{-3} \times 5000 / 12^\circ 47' 30'' \times 0.1542 / 77^\circ 18' 45'' = 5.037 / 90^\circ 6' 15''.$$

The energy absorbed at A is $UI \cos \beta$ on each wire = $4942 \times 5.037 \times \cos 90^\circ 5' 57''$, or 44 watts. The impedance of a condenser having the same capacity as the line, viz.,

1.62 microfarads at 100 periods, would be 982.3 ohms, making the line current in this case $5,000/982.3 = 5.09$ amperes, in practical accordance with the above.

Figs. 8 and 9 illustrate the effect of distance and of pressure upon the drop in the lines of the wire considered in the foregoing examples.

In Fig. 8 the current and pressure are marked off at 10, 20 and 50 miles from B at a supposed full load of $50 \sqrt{10^\circ}$ amperes and at no load, with 10,000 volts total effective de-

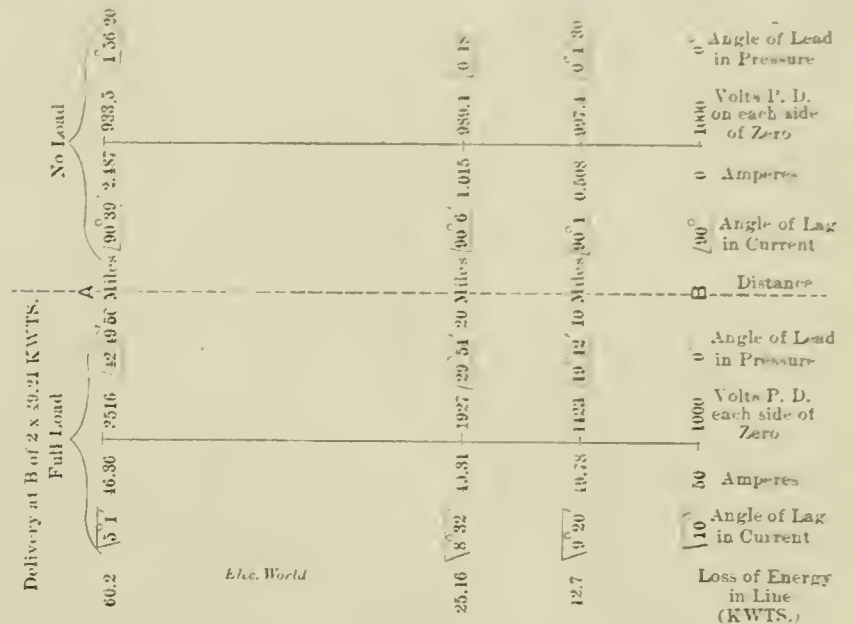


FIG. 8.

livery pressure, or 5,000 positive and negative, measured from the zero point or load center. Fig. 9 gives the corresponding figures for 2,000 volts total delivery pressure, or 1,000 volts on each side of zero. The drop is in the latter case much too great at full load for the conditions of ordinary practice, but comparison of the two series shows how much the drop may be reduced in long-distance transmission over such wires by the employment of high pressure with a given current strength; for the electromagnetic effect is practically unaltered, while the neutralizing electrostatic effect is correspondingly increased. At no load the pressure here arises along the line.

If the conductors vary in size it is still possible to follow the consequences, for if, say, at C , twenty miles from B , new sizes of wire reach thence to A , the pressure and current at C can first be determined for a given load at B , and then the computation can be repeated from C to A under the new conditions.

How far the results of such computations are practically affected by distortions in current and pressure from the sinusoidal type it would be interesting for operators of long-distance circuits to observe.

To Mr. Oliver Heaviside is due the credit for the first published solution of the differential equations upon which formulas (1) and (2) are based.

The Northwestern Electrical Association.

A special effort has been made to make the coming meeting of the Northwestern Electrical Association the most interesting yet held. Mr. Carroll Collins, the president, will open the sessions at the Pfister Hotel, Milwaukee, at 2 p. m. on January 17; an evening session will be held on that day, and morning and afternoon sessions the next day. The following papers will be read:

New Things in Electricity, by W. W. Low, Pres. Electric Appliance Co., Chicago; Essential Station Instruments, by Prof. Jackson, Madison; Economical Use of Transformers, by Forman Collins, Vice-President "Western Electrician," Chicago, and J. McFadden, of the General Electric Company, Chicago; Corliss Compound Engines, by E. L. Debell, Sheboygan; Advantages of Direct Connection, by W. N. Stewart, Siemens and Halske Electric Co., Chicago; How Shall Members Buy Supplies, by H. C. Thom, Madison; Supply of Electrical Power from Central Stations.

Light Without Heat a Possibility of the High Frequency Machine.

BY HENRY F. JARVIS, PATTER.



Of the speculative mind none of the possible future applications of electricity is more attractive and none so full of immediate interest as the possibility that seems almost within our grasp of obtaining light without heat, of making the light waves without the heat waves that have thus far always been at the same time the companion and the burden of all artificial light.

The time is ripe, and the exact science of the day seems all but ready and willing to give the analysis of two great problems, the answer to either of which would stand the crowning achievement of a century of progress in the application of nature's secrets to the requirements of daily life. One of these—the navigation of the air—seems to be a mechanical problem only, while the other—the production of light without heat—we may as confidently say is only a question of properly handling the electric current.

Nature presents us with beautiful examples of both solutions, but guards jealously the key to her method of operation, by which well-known forces are made to do the apparently impossible thing, and it is equally beyond our science to-day to explain how the bird soars aloft on motionless wing and how the glow worm emits a gleam of light without a ray of heat. But they do it, and the many imitators of the bird will soon be equaled in number by those who are chasing the firefly's secret.

What nature does with nature's forces man should and doubtless will be able to do with a full knowledge of those forces and a better comprehension of the methods by which nature applies them. Who shall say which is the more difficult accomplishment, the production of an artificial ruby or the production of an artificial light without heat? There is no certainty, indeed, that the latter will not come from the hand of the chemist first. We are only too prone to hastily write that down as the impossible which is simply not yet done and our last achievement as the most difficult of all accomplishments.

Let us not, however, forget that the chemist has striven for more than a century to make the artificial stone with commendable success, and the mechanic has striven a century to navigate the air, while the electrical engineer has wrestled but a comparatively short time with the problem of light without heat, and has already shown that the solution, far from being impossible on the lines of his attack, is, indeed, a reasonable expectation of another decade of electrical advance.

Tesla's experiments have not only shown the production of light by methods entirely new, methods entirely free from the wasteful process of chemical combustion, but he has set the scientific minds of two continents thinking upon the possibilities of high frequency phenomena and the reduction of laboratory results to a practical form.

When a theory, advanced to explain a natural phenomenon, is consistent with all its various manifestations and is contrary to no established hypothesis, we are bound to accept that explanation until some inconsistency is discovered or a better one is given.

Such a theory, thus far uncontradicted and supported by daily increasing and strengthening evidence, tells us that heat and light are merely the attendant phenomena of a high state of atomic vibration of the particles of a solid or

gaseous body, that they are distinct and may be independent phenomena of this state of molecular agitation, and so might be separately produced.

Thus, the state of a body being hot is the result of a certain state of agitation of the particles of which the body is composed, and the state of being luminous or incandescent is merely the result of another and higher state of vibration of the same particles. Artificial light, as we know it, is produced in a roundabout fashion by causing the substance to be heated and generally consumed, in which condition of chemical change or combustion the particles are thrown into a state of violent agitation producing light. In all such cases the particles or atoms of the body necessarily pass through all the lower stages of vibration before that one is reached at which the mass appears luminous or incandescent.

The higher state of agitation can be brought about in a variety of ways. A piece of cold iron may be beaten with a hammer until it is sensibly warm to the touch—more hammering will considerably increase the internal agitation until it emits a dull red light, and if the hammering is continued with sufficient vigor it will eventually become white hot and intensely luminous—thus there seems to be two entirely independent manifestations of the internal agitation of the particles—heat and light.

The heat and light derived from a burning gas jet is explained in a similar way, but not exactly the same. In this case we start with the potential energy of chemical attraction. Instead of the powerful blows delivered by the hammer we have in the latter instance an infinite number of invisible but rapid and incessant blows delivered by the oxygen atoms of the air as they rush into the flame and collide with the hydrogen and carbon atoms of the gas, being impelled to this action by the powerful force of chemical attraction. The physical effects are practically alike in both cases, though in the latter they are not so plainly apparent to ordinary observation. In the electric lamp the light of the carbon filament is merely an attendant result of the heat produced by the resistance that the filament opposes to the passage of the electric current, and the light given off we find is a mere accident of the transformation that is taking place between the forces at work—electric energy is being changed back again to heat energy in the filament. We know that light vibrations are far more rapid than heat vibrations and the interesting question is, Can we not obtain the high-rate light vibrations without first making the low-rate heat vibrations that absorb so large a proportion of the energy expended? For the light itself costs practically nothing; it is the heat we pay for in every case. There is encouraging evidence that this can be done by properly delivering the electric current, by which means we may be enabled to throw a gas or possibly a solid substance into such a high state of molecular agitation that it will shine without being necessarily hot or consumed.

Tesla has shown us how currents of high potential and high frequency may be made to cause a sort of bombardment of the atoms in certain forms of matter so vigorous as to render them luminous with little or no heat, and certainly without any combustion of the material. These remarkable phenomena are the result of a molecular agitation set up by an electric current that itself has a correspondingly high rate of alternation or frequency. This phenomenon has been produced in a rarefied gas inclosed in a glass bulb and in a piece of copper wire so agitated by the vibrating currents that luminous streams emanate from its surface and a sheet of flame is made to flow from the bare hand that neither heats nor consumes anything.

Speaking of the so-called "brush discharge," Tesla says: "We know that the phenomenon is due to the agitation of the molecules at the terminal (electrode) and we are led

to the conclusion that could we reach sufficiently high frequencies we could produce a brush which would give intense light and which would resemble in every particular an ordinary flame."

Thus the problem seems largely to rest upon the production of very high frequency currents, as the potential can generally be increased to almost any desired limit.

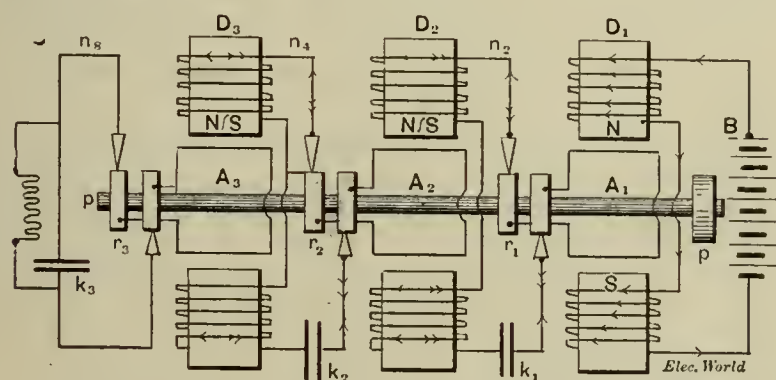
There has been, however, thus far but one known way to produce very high frequency currents, and that is by the disruptive arc discharge, with the attendant electrostatic effects. Such discharges, though possibly of very high frequency, have their own fixed rate and are practically beyond control as to the rate of vibration or alternations used, and it seems equally impossible to determine with any degree of accuracy what the frequency or rate of such a discharge really is.

It would certainly seem that all these conditions of high frequency currents must be brought under perfect control before we can hope to obtain from them the practical results that it is reasonable to suppose they are capable of giving us.

We should be able to produce any rate of alternation or frequency required in a perfectly uniform and reliable manner, to promptly place the frequency at a certain value and hold it there as long as desired, or to change it to another rate at pleasure.

Considering what has been done with an erratic and unmanageable frequency, what may we not expect from a frequency that may be fixed at any desired rate and held absolutely uniform or varied at pleasure?

Quoting again from a recent lecture of Mr. Tesla's, he says: "When we consider the enormous rapidity of light vibrations we realize the impossibility of producing such vibrations directly with any apparatus of measurable dimen-



PATTEN MULTI-FREQUENCY MACHINE.

sions, and we are driven as the only possible means of affecting the atoms of a gas to the use of electrostatic force. By varying the electrostatic force we can agitate the atoms and cause them to collide with evolution of heat and light. It is not demonstrated that we can accomplish this effect in any other way."

In the light of recent developments there seems indeed to be another and possibly much better way of obtaining electrical alternations of potential of enormously high frequency, and this by a comparatively simple electro-mechanical device—a sort of dynamo, in fact, of modest dimensions and moderate cost—but capable of giving perfectly uniform oscillations of potential at inconceivable rates, so that if these wonderful effects of luminous gases and solids without combustion only require controllable high frequency currents, then such effects can probably be obtained from comparatively simple apparatus.

I refer to an invention of my own which I have christened the "multi-frequency machine," from which electric oscillations of almost any desired rate can be had by purely mechanical means and entirely independent of disruptive arc discharges or electrostatic effects.

This machine, which was described at some length in my "Laboratory Notes—X.," * is indicated by diagram of parts

in the figure herewith, and is interesting by reason of the possibility it holds out of obtaining any frequency of alternating E. M. F. desired, and of either maintaining the frequency uniform or changing it as desired between enormously wide limits, and all this with but little change of speed.

Without going into the analysis contained in the article cited, it will suffice to say that the machine has a series of successively connected armatures all carried by the same spindle, and each armature from the first or initial one on gives a frequency just double the preceding, though all revolve in single or two-pole fields at the same speed.

Such a machine can be made with its moving armatures so small that it can be driven by a steam turbine at 500 revolutions a second; this would mean 1,000 reversals of E.M.F. a second at the first armature (assuming, of course, only a two-pole field), and the successive armatures would give frequencies respectively of 1,000, 2,000, 4,000, 8,000, 16,000 and so on up to the 10th, which would give 1,024,000 reversals a second, while the 19th would give 524,288,000, and the 20th over one billion reversals a second.

If, now, the machine speed were decreased one per cent. the first armature would no longer give 1,000 reversals a second, but 990, or one per cent. less, and all the successive armatures would give just one per cent less than the former amount, so the 10th armature would give 1,013,760, instead of 1,024,000 in a second of time, and any other change of the machine speed would give a corresponding change throughout all the values. So this simple device not only promises enormous frequencies from mechanical apparatus, but admits of an immense range of choice and of the frequency rate quite beyond the possibilities of disruptive arc discharges or the management of electrostatic effects.

If we have, then, here the possibility of producing an oscillating E. M. F. of any desired rate in a perfectly uniform and controllable way, may we not hope by its aid to set up an electrical bombardment of the atoms of a substance that will cause it to give light without heat as the result of our attack?

Defective Flywheels.

BY CHARLES H. MANNING.

The article by Mr. W. Stuart-Smith in *The Electrical World* of December 2, 1893, takes a very just view of the flywheel question. Why should men who would not dream of using cast iron in the tension member of a bridge use such an untrustworthy metal in the rim of a flywheel where it is subject, not only to much higher tension, but more sudden changes of load?

Since the bursting of the flywheel here, on October 15, 1891, we have abolished cast iron flywheels, and now have three wooden rimmed ones, the first being 30 feet in diameter, with a 110-inch face, replacing the wrecked one, and the other two but slightly smaller.

We have also built one 14 feet in diameter, with a 30-inch face, and rim 12 inches thick of plate steel, each plate being 1-2 inch thick, 30 inches broad, and extending half way around. This mass is riveted through and through, and I think it would be impossible to run it at a high enough speed to burst it. Its normal speed is 93 revolutions per minute, and it acts as a flywheel for a 1,500-h. p. tandem compound engine.

All these wheels are giving entire satisfaction, and I for one want nothing more to do with cast iron flywheels.

Amoskeag Mills, Manchester, N. H.

Honors to Helmholtz.

The Institution of Civil Engineers (London) has elected Prof. von Helmholtz an honorary member. With a total membership of 6,490, there are only 15 honorary members.

* See "Electrical World" of Nov. 18, 1893.

The Most Economical Age of Incandescent Lamps.

BY LIEUT. MANNING K. EYRE.



It is something fearful to see the lamentable ignorance displayed by the management of many large central stations and innumerable isolated plants as regards the most economical use of that small appliance which all these plants are mainly installed to operate; namely, the incandescent lamp. Knowledge concerning this useful article finds its way slowly into the mind of the central station manager, and, apparently, not at all into that of the average consumer.

The subject to be discussed in this paper, namely, the advisability of renewing lamps after a comparatively short period of their life, is so well worn that it would seem useless to attempt anything original. Mr. Carl Hering has covered the ground most thoroughly in an article entitled "The Most Economical Age of Incandescent Lamps," which appeared in the Transactions of the American Institute of Electrical Engineers, February, 1893. It is proposed to take up the subject in the first part of this article from a purely commercial standpoint and put the facts in such a shape that they will be readily understood. The latter part of the article will deal with the subject more mathematically and, perhaps, less interestingly; but, it is hoped, may prove of some value to technical readers.

The present method seems to be for a central station furnishing renewals to renew a lamp only when broken, or when it has dropped so much in candle power that the patience of the user is exhausted. How can it be proved to the average station manager that this is bad, hopelessly bad policy? He will tell you that he is using less current per lamp (although in many cases he is using more) and, as long as the customer does not growl, it is money in his pocket to run a lamp on ad infinitum. It does not take more than average intelligence to see that even from his own incorrect standpoint he loses, and loses largely. What is he competing with? What does he want? He is competing with gas and he wants more custom. If he would adopt the policy of giving his customers far better light, it would not be necessary to make a deal with the local gas company, as he would soon have all the custom he wants.

Every user of lamps, be he central station, isolated plant or ordinary customer, should break his lamp and renew it at such a time in its life that the cost per candle of light is least for the time the lamp has been used. Not the cost per lamp, but the cost per candle power. This is self-evident.

We are buying light, and we are buying it by the candle power, not by the lamp. We pay so much for 16 candles of light and so much more for 32 candles, and yet a user will start out with 32 candles of light that he has paid for, and he will keep right on paying for them when he is only getting 16 or 20 candles. To show the incorrectness of the station man's point of view, it is only necessary to glance at the curves showing the changes in current consumed, as shown in Fig. 2. As the voltage remains constant, and since (as a glance at the curves will show) the current throughout the 800 hours is practically the same as at the commencement of the lamp's life, the total energy imparted to the lamp throughout any period of 800 hours or less is practically constant. As a matter of fact, up to 500 hours, the mean energy consumed by the lamp is greater than the energy at the start. In actual figures, at 300 hours, the total energy being expended is 63.1-2 watts, as against 62 watts when the

lamp was brand new. So, that with 1 watt more energy, we are getting 4 c. p. less light.

It is very evident that the advisability of breaking and renewing lamps early in their life is greater in localities where power is more expensive and less where power is cheaper; we must take, therefore, comparatively wide limits for the cost of power in order to completely cover the ground. The less the value assumed for the cost of power, the stronger will the argument be against breaking the lamps. But, in order to leave no shadow of doubt in the mind of any user of lamps that there is some point in the life of the lamp

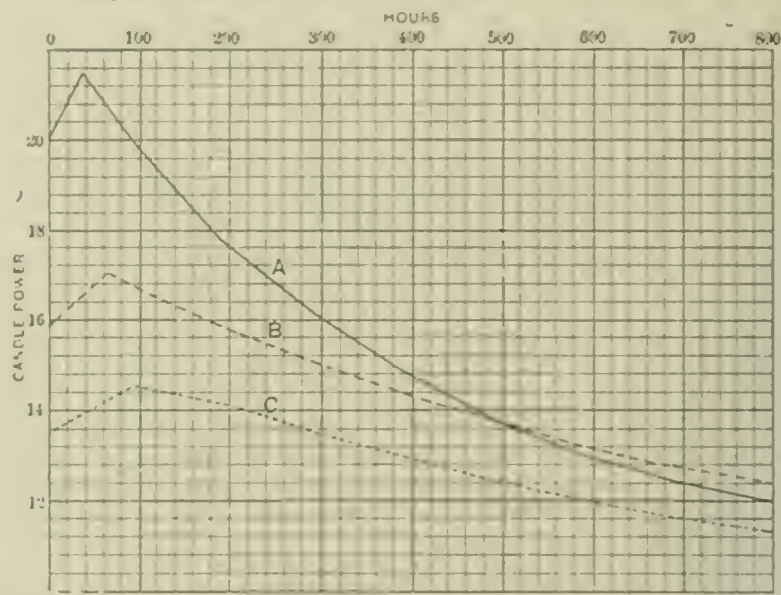


FIG. 1.—CHANGES IN CANDLE POWER WITH LENGTH OF LIFE.

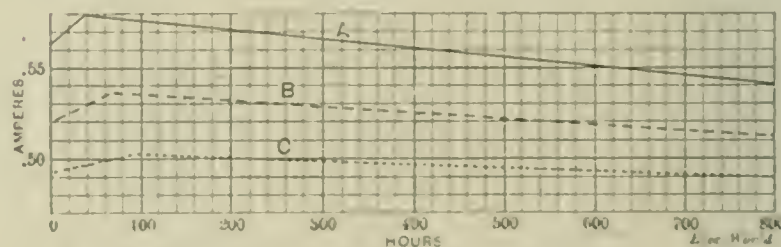


FIG. 2.—CHANGES IN CURRENT CONSUMED.

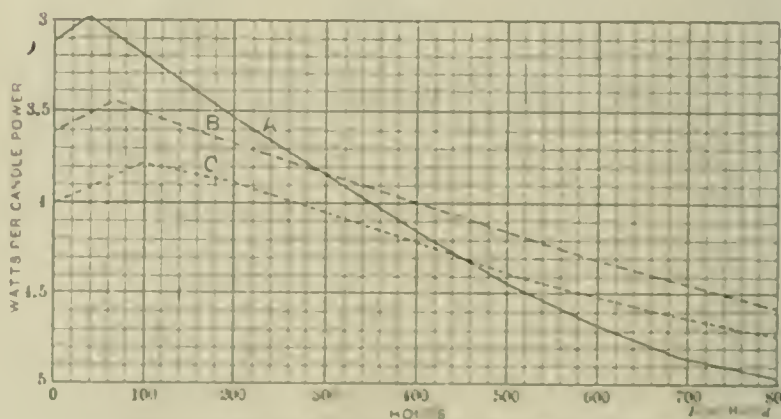


FIG. 3.—CHANGES IN EFFICIENCY.

where it is advisable to break it, and beyond which point it is actual loss to him to run it, the lowest cost of power assumed is such that it must appeal to even those who pay very little for the current they supply or receive. The assumed costs, above referred to, are 3 cents, 5 cents and 8 cents per electrical horse power hour delivered at the lamp; 3 cents is undoubtedly very low and 8 cents is not high; consequently, I have erred, if at all, on the conservative side. The cost of a lamp will be taken as constant throughout the calculations—35 cents.

The data used in the following table are the mean of a large number of careful experiments made by Prof. B. F. Thomas, and the results of which were published in the Transactions of the American Institute for May and June, 1892. The average candle power and efficiency are calculated from the data in the last column of Table V. of that paper. It must be remembered that all these results are the average of thirteen different makes of lamps, bought in the open market and carefully tested. It is presumable, therefore, that results based on these experiments will be commercially true.

The following table is an extract from the experiments re

ferred to, on which all the calculations made in the construction of Table II. are based:

TABLE I.

Life.	Percentage of Candle Power.	Watts Per Candle or Efficiency.
0 hours	100	4.2
100 hours	95.6	4.5
200 hours	90	4.8
300 hours	84	5.0
400 hours	78.4	5.3
500 hours	73	5.6
600 hours	68.6	5.9
700 hours	64.7	6.3
800 hours	62	6.6
900 hours	57.4	6.8
1000 hours	1.05	11.6
		.77 1.22 1.90

From the above table it is at once seen that the curve expressing the relation between watts per candle, or efficiency and the life of the lamp, is nearly a straight line, or, in simpler language, the efficiency decreases very nearly .3 watt for every 100 hours of the life of the lamp; consequently, the mean efficiency throughout any part of the lamp's life can be readily found.

I have taken a period of 3,000 hours, and calculated in the following manner how much it would cost the user of light per candle for that time if he broke his lamps at 300 hours, 400 hours or 500 hours, etc. Lamp cost, as stated above, 35 cents.

CASE I.—If renewed at 300 hours.

Mean efficiency during 300 hours (see Table D.) equals 4.6 w.
Mean candle power during 300 hours equals 14.9 c. p.

Since lamp is renewed 10 times in 3,000 hours:

Lamp, cost for 1 light, 10x35, equals.....\$3.50
Cost of power for 3,000 hours, for 1 lamp at 3c. per
3x3000x4.6x14.9

E. H. P. hr. ————— equals..... 8.10
746

Total cost of lamp for 3,000 hours.....\$11.60
11.60

Cost per C. P. of light, 3,000 hours ————— equals..... .77
14.9

The above process is simply repeated for 400, 500, 600, etc., hours, and the result tabulated in column 4 of Table II.. Columns 5 and 6 of Table II. are like results for costs of power of 5 cents and 8 cents:

TABLE II.

Lamp Smashed at	Total Cost.	Mean C. P. for 3000 Hrs.	Cost of 1 Candle of Light for 3000 Hrs. When El. H. P.		
			3c.	5c.	8c.
200 hours	\$5.25	15.2	\$0.88	\$1.25	\$1.79
300 hours	3.50	15.	.77	1.14	1.69
400 hours	2.62	14.4	.75	1.13	1.69
500 hours	2.10	13.9	.75	1.13	1.71
600 hours	1.75	13.4	.75	1.14	1.73
700 hours	1.50	12.9	.745	1.15	1.76
800 hours	1.32	12.5	.745	1.17	1.81
900 hours	1.17	12.	.76	1.19	1.85
1000 hours	11.6	11.6	.77	1.22	1.90

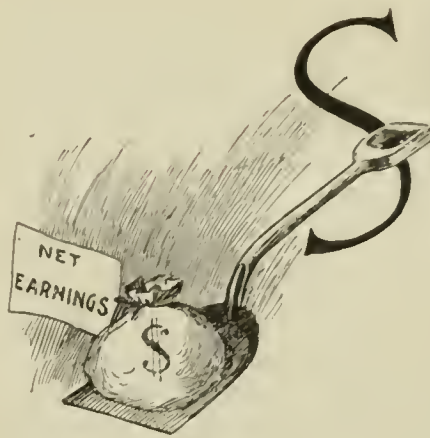
(To be continued.)

The Niagara Power Plant.

In referring to Prof. Forbes' paper on Electrical Transmission of Power from Niagara Falls, "The London Electrician" says: "The paper should never have been presented to an engineering society, and would have been premature even for a popular audience. The subject, as a practical problem, was clearly quite unripe for discussion. Many of the details were unanimously condemned by practical engineers. Mr. Ferranti's incisive and fearless speech was received with unusual applause, and while we echo his candid statement that no blame can be attached to Prof. Forbes, the important subjects on which he dwelt cannot be allowed to remain where they were left when the meeting rose. The less said about Prof. Forbes' reply the better. To say that the various criticisms have refuted each other is a very old device, and was quite inapplicable to this discussion."

False Economy.

BY J. B. CAHOON.



OME time ago in an article on "The Economy of Small Central Stations" illustration was given of the failure of the plant to pay dividends through lack of economy in its operations, and it was there shown that by the rehabilitation of the plant under the intelligent supervision of a good electrical engineer these non-paying plants could be converted

into good dividend payers. I thought at that time that the lighting plant spoken of was in a pretty bad shape, and so it was; but since that time I have run across a street railway plant which is in a much more chaotic and run-down condition than ever the lighting plant dreamed of being.

The history of the street railway plant was something as follows: In 1890 the road was in operation as a horse railroad with, approximately, 75 cars. In the following winter it was decided to equip a part of the road electrically, and 20 motor car equipments were contracted for and placed on the old horse cars. A power house was constructed and equipped with two 80-kw. Rae generators, belted direct to two 100-h. p. non-condensing Westinghouse engines, steam being supplied by a battery of four 125-h. p. boilers, fitted with mechanical stokers. This change over was made under the direct supervision of the president of the road, who, although he did not claim to be either an electrical or mechanical engineer, or even a steam engineer, did not think it necessary to secure the services of anything more than an ordinary dynamo tender to look after his plant and road equipment, nor did he consult any engineer as to his equipment; but simply bought the material and had it installed by his own force, with the exception of the overhead line, which was put up by an expert from one of the electrical companies. This was in the spring of 1891. Let us now follow this road in its operation and expansion through the following two years.

We find at the end of this time that the equipment of motor cars is doubled, i. e., that the road is now running 40 motor cars where before it ran 20. Let us see what the president, acting as his own engineer, has accomplished in this interval. As the demand of his road became greater he put in various new apparatus in his power house, as follows: First, he added a Cooper-Corliss, tandem, compound-condensing engine of 380 h. p., and concluded to put in a line shaft and belt from that to his generators, and also put in an independent Cooper condenser. From time to time were added two 350-h. p. tandem, compound-condensing Buckeye engines, one 1,000-h. p. Worthington independent jet condenser, one 1,000-h. p. Hall's live-steam purifier, a battery of three horizontal boilers of 100 h. p. each, and two 250-h. p. Manning upright boilers. The pumps for feeding the boilers were one Epping boiler feed pump, one Blake duplex boiler feed pump, one Worthington duplex pump, one Hancock inspirator and one Metropolitan inspirator.

It will be remembered that we started with two Rae generators of 80 kw. each, next were added two Edison generators of 150 kw. each, then one Westinghouse generator of 300 kw. capacity, and finally he decided it would be a good plan to put in lights for his power station, car barns, etc., and, therefore, got a 1,000-light alternator and a 50-light

2,000-c. p. machine, the last two of the T-H. type. His ammeters were of the same three kinds as his generators, while the circuit breakers were all of the Westinghouse make and the lightning arresters of the Keystone pattern. At various times the president of the road secured men for the position of chief engineer for this plant, but as he persisted in running the power house himself even to the minutest detail, he has never succeeded in retaining an engineer for a longer period than a few months at a time.

I was indirectly interested in this road, inasmuch as I was asked to recommend a chief engineer for it, and knowing something of the conditions I recommended a most excellent man, who was not only a good steam engineer, but was also exceedingly well posted electrically, and who had had quite a number of years' practical experience in the handling of both steam engines and electrical apparatus. In talking the matter over with this gentleman, I outlined to him the characteristics of the president, and told him just what to expect, and said he must be prepared to meet the eccentric behavior of the president and get along with it as best he could, but he should endeavor all the time to bring up the condition of the plant to something like an economical one, in spite of the president—in other words, to reduce chaos to something like order.

It will appeal at once to the electrical engineer if he stops to consider with what this man had to contend. There were three different makes and sizes of generators to be run in multiple or any one to be run in multiple with any other one, and these were to be driven by three different types and sizes of engines, with different systems of cut-outs and regulators, and, incidentally, steam was furnished by three different batteries of boilers of totally different makes, though this latter did not matter so materially. It is a well-known fact that it is exceedingly difficult to run generators of different makes in parallel, not only because of the different systems of windings, but of the different magnetic properties of the iron, which makes one generator respond more quickly to changes of load than the other, so that when a sudden load is thrown on to the power house the generator whose magnetic qualities permit it to pick up the quickest is the one to take the brunt of the overload, and, possibly, before the other generator can pick up and take its share of the load the first has taken so much as to literally work itself to pieces.

So, too, with steam engines of different makes, one responds quickly to the overload, having, as it does, a very quick responding and sensitive governor, while the other, with a totally different governing device, and with a different system of cutoff throughout, may take an appreciable interval before it will respond to the violent fluctuations in load, such as are often seen in the power house of a street railway.

Going back to our plant again, it will be seen by summing up that the total horse power of the engines is 1,280, the boiler power amounts to 1,300 and the generator power, roughly speaking, to 840 kw., including the lighting plant. The actual average daily output required for running the 40 cars is 400 amperes, or at the rate of 10 amperes per car, which is about right for this number of cars in operation where the track is practically level. Of course the fluctuations are considerably more than this, and may even be doubled for brief intervals of time and under special conditions.

To obtain this output of 400 amperes they are at the present burning 14 tons of good quality steaming coal per day of 18 hours, and are using on an average 268 h. p. for the railway circuit and 48 h. p. for lighting power for one-third of the time, or an average horse power per day of 284. This gives a coal consumption per horse power hour of 5.47 pounds. As a Cooper-Corliss, or any good condensing

engine, should give an output of one h. p. per hour for each two and one-half pounds of coal burned at least, it will be seen that this plant is consuming something over double the amount of coal that it should. I believe that both of the Westinghouse engines are laid up for repairs, as is also one of the 80-kw. generators, but the balance of the equipment is in condition for use, and is arranged so as to form what might be called by courtesy a duplicate plant, the last arrangement of which I heard being as follows. The line shaft was driven by the Cooper-Corliss 380-h. p. engine; near each end of this and back 60 feet were placed the two 350-h. p. Buckeye engines, with double driving pulleys, placed in line with clutch pulleys on the line shaft. To each of these engines were belted one 150-kw. Edison generator and one 80-kw. Rae generator, the idea being that in case of a breakdown of the engines they could shift the belt along and in that way run the four generators, either from the 350 h. p. engines or to the line shaft. The 50 light arc and the A 50 alternating were placed between the right-hand Buckeye and the Corliss engines and belted to the line shaft; this latter was extended through into an annex and the 300-kw. Westinghouse generator was installed there next to the coal pile, where it had every facility for accumulating coal dust on it. This generator was driven by a fixed pulley on the end of the line shaft, the distance between centres of generator and line shaft being 28 feet, and to drive this a 36-inch belt, which was used on the Corliss engine, was worked over into a 33-inch belt, and a new belt ordered for the Corliss. The result of this arrangement is that when the railway plant shuts down the lighting plant shuts down, and they consequently have to use oil lamps and gas to clean up with. To give the numerous changes and shifts that have been made in the apparatus during the interval that it has been in the possession of this road would be sufficient to drive an engineer not only wild, but crazy, as the president of the road seemed to have certain days periodically, when, according to his notions, it was necessary to change things around, and they were accordingly changed or the engineer left; sometimes one thing happened, sometimes the other.

The boiler room was not without its trouble, as was instanced by the fireman not taking kindly to the mechanical stokers, and, therefore, they failed to work satisfactorily, and were continually out of order, although there was no reason why they should have been had they been given ordinary attention. With the arrangement of feed water and the manner of firing, the Manning boilers primed so badly, that it was impossible to use them as intended, and finally resort was had to the use of Hall's live-steam purifier as a steam drum for the Manning boilers, and in this way they succeeded in getting some service out of the boilers and fairly dry steam, although it strikes me as rather a unique use to make of a steam purifier. The president of this road would persist, in spite of the protestations of every engineer he had there, in employing the cheapest grade of firemen that could be obtained in the city, and to this fact is probably to be attributed the necessity for frequent repairs on the boilers as well as the general inefficiency of the boiler plant to furnish sufficient steam to run the station properly. This seems to be an absurd statement, but it is, nevertheless, a true one, that with 1,300 h. p. in boilers it was frequently the case that, owing to various mishaps, they could not supply sufficient steam to furnish 300 h. p. to the engines.

The original installation was faulty from an engineering point of view in that, while they knew that they must, in the course of a very short time, double if not treble their electrical equipment, no provision was made for such increase other than, perhaps, the president might have had this in mind in installing his boiler plant, which was, of course,

wildly excessive for the small output required for his first installation of generators. It is, perhaps, not well to criticise too severely the original installation, as not so much was known then about the proper proportions of a plant as at the present time, and, therefore, we might pass this by; but certainly when it came to the increase, any engineer would have advised the enlargement of the plant on the same lines as begun, i. e., with the same style engines and the same style generators, or else have recommended the sale of his first installation, and if the president wanted to buy other make apparatus, then fit his plant with this new make entirely to meet the new conditions.

Now, what will, I think, strike the reader as the only way to save this railway property from bankruptcy, is for this road to secure the services of a first-class electrical engineer and place the whole thing in his hands for entire re-organization and give him absolute charge over the entire steam and electrical part of the road, with the distinct understanding that the president is not to interfere in any way with the instructions of the chief engineer. The power house could be remodeled at a small outlay so that it could be placed on an economical basis, and if then attention is paid to the balance of the road, and a uniform equipment secured there, together with some consideration for the welfare of the public in the matter of decent cars, there should be no question but that this road could be transformed into a good dividend payer.

His Appeal Decided Against Him,

Mr. T. C. Martin has again been defeated in his contest with *The Electrical World*. When in April last the Court decided against him, he was not satisfied with the decision, and he appealed from it to the General Term of the Superior Court. This appeal came on for hearing early in December before Judges Freedman, McAdam and Gildersleeve; and after considering the appeal these three Judges concluded that the Referee's decision was right and that Mr. Martin had made out no case against this paper or Mr. Johnston. The opinion of the General Term, which was delivered on December 29 by Judge Gildersleeve, is brief, but to the point, as follows:

OPINION.

GILDERSLEEVE, J.—This is an appeal by the plaintiff from a judgment entered in favor of the defendants upon the report of a Referee dismissing the complaint. The action was brought to compel the specific performance of a written contract. The complaint contained the usual allegations of due performance of all the covenants, conditions and agreements to be kept and performed by plaintiff, and charges that the defendant Johnston failed to keep and perform the contract on his part. None of the evidence taken before the Referee appears in the record, as the case comes up on the exceptions filed to the Referee's report. The plaintiff has not appealed from the Referee's refusal to find facts in the plaintiff's favor, and plaintiff must, therefore, be held to acquiesce in the conclusions of fact reached by the Referee. Has the learned Referee upon the facts found reached a correct conclusion of law? The determination of this question seems to be the sole duty of the General Term.

In the sixteenth finding of fact the learned Referee found: "That the plaintiff failed to observe, and plainly violated the promises and agreements made by him in the said agreement." The Referee holds the plaintiff as guilty of affirmative acts in violation of the contract. This is an insurmountable obstacle in the way of the plaintiff's success on this appeal. Such a finding calls for a dismissal of the complaint. It would seem that plaintiff's proper course would have been to treat the contract as continuing, and sue for damages for the breach of Johnston.

All we now decide, however, is that upon the facts as found by the Referee, the complaint was properly dismissed.

For these reasons, and for the reasons set forth in the opinion of the learned Referee, which appears in full in the papers before us, the judgment must be affirmed with costs.

I concur, J. J. F.

I concur, D. McA. J.

As will be seen by reading this opinion, Mr. Martin did not bring to the notice of these Judges the evidence given in his case. He appealed, as Judge Gildersleeve says, on "exceptions filed to the Referee's report"—that is, on technical legal

objections. The "facts" were never satisfactory to Mr. Martin; and his whole litigation was born, nurtured and developed in the atmosphere of technicality. That, of course, not from any wish on his part, but from necessity. As the Judge also says: "The plaintiff has not appealed from the Referee's refusal to find facts in plaintiff's favor, and plaintiff must therefore be held to acquiesce in the conclusions of fact reached by the Referee." The Referee found the facts to be, quoting again from Judge Gildersleeve:

"That the plaintiff failed to observe, and plainly violated, the promises and agreements made by him in the said agreement."

And in this the Judge says Mr. Martin has acquiesced. What, then, was his appeal? As we said, something based on reasoning purely technical; and we will try to briefly explain it: We have pointed out in the report of this case, already published in *The Electrical World*, that Mr. Martin's action was founded on the fact that Mr. Johnston wrote him on June 7, 1890, that he, Mr. Johnston, wished the contract between them formally terminated at the end of the year 1890. It was, as a matter of fact, at that time already terminated and had been so for over three months, and Mr. Martin had been at that time securely installed in his present position as the editor of another journal. From what Mr. Johnston wrote, Mr. Martin wanted the Referee to decide that as against Mr. Johnston the contract employing him as editor of *The Electrical World* was in existence down to the end of 1890—and this in face of the admitted fact that Mr. Martin was out of his employment on *The Electrical World* and was actually employed as editor on another paper.

So far as fact and common sense are concerned, you might just as well ask a court of justice to decide that San Francisco is situated on the shores of the Atlantic Ocean, because some one had said something which might possibly imply that it was so, as to ask what Mr. Martin modestly requested to be decided for the purpose of helping him out of his awkward situation.

The Referee did not waste time on Mr. Martin's metaphysical conundrums. He said plainly and practically that all that "may be admitted without removing or reducing the difficulty, which, it seems to me, stands in the way of the plaintiff's recovery in this action."

Now comes Mr. Martin's technical appeal. He did not find fault with what the Referee did decide, but what he contended was that had he decided more the result to him would be less disastrous; that is, had the Referee decided that because Mr. Johnston in his letter of June 7 impliedly admitted that the contract was in existence to the end of 1890, this would or at least might in law overcome the effects of Mr. Martin's own "affirmative acts in violation of the contract." Mr. Martin was only dissatisfied with the Referee's conclusions because the Referee did not appease his desires in this respect. "Only let the Referee do as I want him to do," thought Mr. Martin, "and then see where Mr. Johnston and I will stand. It will be seen that though I may have violated my contract, Mr. Johnston admitted that I did not; and not on the facts but on Mr. Johnston's implied admission I plant myself." The Referee did not view it in this light; neither could three judges of the Superior Court. So Mr. Martin's appeal, based on this technical and narrow-minded view of the matter, did not succeed.

As suggested by Judge Gildersleeve, "The plaintiff's proper course would have been to treat the contract as continuing and to sue for damages for the breach of Johnston." This is what *The Electrical World* sought all through this controversy, to force Mr. Martin to do. But that involved the question of the rightfulness or wrongfulness of his discharge, and that question he always seemed to wish to avoid ventilating. We suppose that for the same reason he withheld from the Judges the evidence on this question, the absence of which from the record Judge Gildersleeve refers to.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED BY CARL HFRING.

ELECTRO-PHYSICS.

Distortion of Wires by Oscillating Discharges.—In an article by Mr. Kennelly, in the Lond. "Elec. Rev.," Dec. 15, he refers to Mr. Bleekrode's article abstracted in the Digest, Oct. 14, and describes interesting tests made by himself, from which we extract the following: The bends in the wire do not appear to follow any law and are not confined to any plane, nor could they be controlled by a magnetic field of 1,000 units; the bends were the largest and the most abrupt with the most powerful discharges; the medium surrounding the wire, as air, water, oil or vacuum, does not seem to influence the effects, nor were the effects destroyed by hammering the wire into thin strips; the best results were obtained with wires of platinum alloyed with 10 per cent of iridium, having a diameter of .008 centimetre; some of the bends were so abrupt that they formed an angle of more than 90 degrees; microscopic examination showed the existence of holes or craters at the bend, sometimes on the concave and sometimes on the convex side; with continuous currents the distortions were very faint unless the current was applied suddenly. These observations suggest to him that the distortions are produced by the sudden expansion released, leave the small craters which were observed and caused the mechanical distortion.

Atmospheric Electricity.—In a note in the Lond. "Elec. Rev.," Dec. 15, attention is called to observations on Ben Nevis, which confirm Prof. Smith's theory that the potential is below the normal on the edge of a dissolving mist and above the normal on the edge of a condensing mist; when the summit becomes clear a strong current comes up the telegraph cable, which is grounded at the foot of the mountain, while when involved in mist the current is reversed; during a rain or snow the current invariably passes down the cable and on the cessation of the rain or snow there is generally the opposite effect.

Balloon Experiments.—"L'Ind. Elec.," Dec. 10, reprints in an abstract an Academy paper by Mr. Andre, mentioning briefly his experiments at high altitudes made in balloons; in his conclusions he states that in good weather it is certain that the electric field does not increase with the height, but that "the electric field is the same at the same instant along the same vertical"; he makes this statement provisionally, and desires to prove it by a subsequent ascension.

Radiation in Incandescent Lamps.—The "Elec. Zeit.," Dec. 15, reprints a paper of Dr. Gruner, in which he describes the results of tests intended to determine whether the constant in Weber's law for the radiation of solid bodies is the same for all substances; from the results of five different lamps he finds that the constant is the same for both black and gray carbon filaments.

Oscillations.—Mr. Blondel's mathematical article on "Oscillations in Cylindrical Conductors," mentioned in the Digest last week, is continued in "La Lum. Elec.," Dec. 9; he discusses self-induction and impedance.

Calculations of Alternating Currents.—Mr. Guilbert, in the first part of a mathematical article in "La Lum. Elec.,"

Dec. 9, describes the Steinmetz method as given in that author's recent Congress paper.

Reflection of Electric Waves at the End of a Conductor.—"La Lum. Elec.," Dec. 9, reprints a discussion by Mr. Poincaré of the paper of Messrs. Birkland and Sarasin, mentioned in the Digest, Dec. 16.

Interference of Waves in Air.—The article mentioned in the Digest, Dec. 30, is concluded in "La Lum. Elec.," Dec. 9.

MAGNETISM.

Demagnetizing Watches.—The "Elec. Anz.," Dec. 10, reprints a paper by Mr. Bohmeyer; it is first necessary to find the position of the poles of a magnetized article, which is done by approaching the article to a small light compass needle, moving it exactly along the east and west line; if the steel is not magnetized it will not deflect the needle; a U magnet is then placed as far as possible east or west of the compass and in such a position as not to affect it; equal spaces are marked on this magnet from the poles to the neutral point; the magnetized article is then touched to these lines, beginning near the neutral point, and each time tested again until the magnetism is entirely neutralized; the object of the markings on the magnet is to obtain the effects of poles of gradually increasing intensity; each pole must be neutralized in this way. In a criticism of the paper it is stated that it would probably be better not to touch the magnet, but to bring the object to a greater or less distance from it.

Compensation for Hysteresis.—In an article in the Lond. "Elec.," Dec. 15, Mr. Vignoles refers again to this subject, intending to show that the Evershed method and that of Abdank Abakanowicz are really the same; he adds a figure showing the percentage difference of the readings of a compensated ammeter on reversals of the current, which is a nearly horizontal curve for the compensated instrument and a very rapidly rising curve for the uncompensated one.

Magnetic Field of a Current in a Cylindrical Coil.—The Lond. "Elec.," Dec. 15, abstracts a Physical Society paper by Professor Minchin.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Alternating Current Potentiometer.—A Physical Society paper by Mr. Swinburne is noticed in the Lond. "Elec.," Dec. 15; a quadrant electrometer with a double fishtail needle is employed, suspended by a torsionless fibre; the electrostatic attraction of the alternating voltage between the needle and one pair of quadrants is balanced by the force, due to the steady voltage between the needle and the other pair, the steady voltage being determined by a potentiometer and standard cell; for alternating currents a differential electro-dynamometer, having one fixed and two movable coils and no controlling spring, is used; a direct current measured by the fall of potential over a small resistance is passed through one of the fixed coils, the alternating current through the other, while the movable coil is included in both alternating and direct circuits; when the two forces balance the currents are equal.

High Resistances.—“La Nature,” Dec. 9, describes a comparatively simple and ingenious method of making high resistances, devised by Mr. Jona. A cylinder of hard rubber is coated with a paste made of unvulcanized rubber well mixed with lampblack (the proportions are not given); it is then subjected to vulcanization, which makes the paste adhere; it is then turned down in a lathe, making it as thin as is desired and leaving thick ends for the contact, to which metal binding posts are attached; for a diameter of about 5-8 of an inch a resistance of about 1 megohm may be obtained for every 4 inches; for still higher resistances the cylinder may have a screw thread cut on to it, the depth of which extends through into the rubber, thus forming a long thin spiral of the semi-conducting material; the contacts at the end may be made by embedding a coil of iron wire in the paste at the end of the rod before vulcanization.

Kruppin, a New Resistance Metal.—The “Elek. Zeit.,” Dec. 15, contains an article by Mr. Dettmar, in which he gives results of numerous experiments with the new resistance material called Kruppin, which has been lately brought out by the firm of Krupp, of Essen. It has a very high resistance coefficient and is well adapted to be worked; the resistance is given as .71 to .76 when hard, and .81 to .85 when soft (although not so stated, it appears that this is the resistance in ohms per metre per square millimetre cross-section); the temperature coefficient is .0013, the curve for this is given; numerous experiments were made to determine the best form of resistance spirals for this material, and for every diameter it was found that a certain number of windings per unit of length gave a maximum value for the heat dissipated per unit length of spiral; for 13 millimetres diameter of spiral, for instance, the best result was obtained when the distance between the spirals was double the diameter of the wire; curves and formulas are also given for the amperes which these wires of different diameters can take before they will hiss when touched with the moist finger, one of the curves being for currents lasting one minute and the other for a continuous load; the results of the observations are given in a table, which also gives the resistances and the lengths per ohm for different diameters; the nature of the metal and its composition are not given.

The Continuous Current Arc as a Standard of Light.—Mr. Blondel's Congress paper is concluded in the Lond. “Elec.,” Dec. 15. He gives the results of experiments and concludes that for homogeneous carbons the intrinsic brilliancy may be considered constant and equal to about 160 bougies decimales (candles) per square millimetre; commercial carbons, however, may exhibit appreciable differences; when the arc hisses this brilliancy is decidedly lower by about 10 or 20 per cent. at least; but such a standard does not at present fulfill the necessary conditions for an absolute standard. The paper is discussed editorially in the same issue.

Measurements at Central Stations.—In the “Elek. Zeit.,” Dec. 15, Dr. Kallmann gives the first part of a paper on measurements at central stations; in the present portion he describes what he calls the differential principle, in which voltages, for instance, are measured by galvanometers connected across between two branched circuits, like in a Wheatstone bridge; by this means it is claimed that high voltages can be measured with low voltage instruments and with a greater degree of accuracy.

Terminology.—In an article on this subject in “L'Ind. Elec.,” Dec. 10, Mr. Guillaume discusses the inconsistency of several terms used in mechanics. Regarding electrical terms he states that if there are two points on a circuit, separated by a distance R , and having respectively the potentials A and B the difference AB is indifferently called “difference of potential” and “fall of potential;” but the last term is applied also to the quantity $V \div R(AB)$; for the latter

he suggests the name “slope of potential” (*pente de potentiel*), corresponding to the German “potential genfäelle.”

Coefficient of Self-Induction.—The Lond. “Elec.,” Dec. 15, abstracts briefly a Physical Society paper by Prof. Minchin, on the calculation of the coefficient of self-induction of a circular current of given aperture and cross-section.

Commercial Condensers.—In a communication to the London journals for Dec. 15, Messrs. Swinburne & Co. claim to have solved the problem of the manufacture of condensers on a commercial scale, stating that they have been making them for the past two years.

DYNAMOS AND MOTORS.

Starting Resistances for Shunt Motors.—Mr. Baumgardt, in the “Elek. Zeit.,” Dec. 15, from a simple mathematical deduction shows that in order to make the resistance as small and as cheap as possible the starting current for the motor should be taken as large as possible; as even large motors will start in the fraction of a minute, heat radiation may be neglected, and he therefore bases his deductions only on a permissible rise in temperature; he shows that the length of the resistance wire will be smaller the shorter the time it takes the motor to start; also that the weight of the wire is smaller the shorter the time, that is, the greater the starting current.

Unipolar and Non-Polar Induction.—In a paper reprinted in the “Elek. Zeit.,” Dec. 15, Mr. Vogel describes at some length experiments with unipolar machines of a new design, which, however, were inoperative; he attempts to show by means of these experiments how the lines of force act in such machines; among other things he states that his experiments prove that the lines of force remain with the pole pieces and are not carried along in the iron of the armature.

Crompton-Branton Alternator.—The London journals of Dec. 15 give a short description of this new alternator, accompanied by a good illustration; the armature contains no iron and revolves; in general it resembles the Siemens type of 1878; among the advantages claimed are that the armature is easily accessible, as the two upper halves of the field magnets are hinged; the armature coils are easily replaced; the field is powerful and the armature reaction small; the commercial efficiency is said to exceed 91 per cent.

ARC AND INCANDESCENT LIGHTS.

Photometric Theory of Projectors.—Mr. Blondel's article, the first part of which was abstracted in the Digest, Dec. 23, is concluded in “L'Ind. Elec.,” Dec. 10; it is devoted mostly to a theoretical discussion of the optical properties of various forms of projectors, and gives a few formulas; from a considerable distance a projector is exactly like a plane incandescent surface having an intrinsic brightness at every point equal to that of the source multiplied by certain optical coefficients. He discusses various features of projectors, and in comparing the different types he concludes that theoretically the parabolic reflector is the best, while in practice the Mangin is perhaps the most perfectly made, owing to the fact that the curves are circles; so much depends on the workmanship that it would be difficult to say in general which of the two would be the better. Regarding the Schuckert searchlight at the World's Fair, he calculates its intensity, assuming that the brightness of the crater is equal to 160 candles per square millimetre (see the abstract in the present issue on the “Arc as a Standard of Light”), and that the whole surface of the projector has this same brightness multiplied by the factor .70, and finds it to be 213,000,000 candles; even assuming a factor of only .6, it gives 183,000,000, that is, the same that would be produced by the crater of an arc having an area of 1.147 square metres; the figure given by the constructor, 190,000,000, he states, is therefore not unreasonable.

Vacuum Pump.—The "Elek. Zeit," Dec. 15, reprints a paper by Prof. Neesen, describing, with the aid of an illustration, his modified pump, which was already mentioned in the Digest, Nov. 18; besides what was stated there it appears that other advantages of this pump are that its action is continuous, rapid, and requires but little mercury; that there is no suction like in the Sprengel pump, but an expulsion of the air by means of small pistons of mercury; the volume of the air carried along is larger than that of the globules of mercury, which is the chief advantage of this pump; it differs also in the means by which the mercury drops are formed.

Alternating Current Arc.—Mr. Blondel's long serial in "La Lum. Elec.," abstracted in the Digest, Oct. 14 and 28, is given in abstract in the Lond. "Elec.," Dec. 15, in which ten of the sets of curves are reproduced.

Hanson Arc Lamp.—An illustrated description of this lamp is given in the Lond. "Elec.," Dec. 15.

TRANSMISSION OF POWER.

Transmission of Power at Niagara Falls.—The discussion of Prof. Forbes' paper is continued in the Lond. "Elec. Eng.," Dec. 15. Mr. Ferranti regarded the method of exciting in series as anything but the best; he had his doubts about the feasibility of the subway, as he believes an accident might lead to a complete breakdown of the system; he did not consider the frequency of 16.2, or even 25, the best, as considerable amount of lighting would be done, and the most practical way would be by direct transformation from the high pressure mains.

Niagara Falls.—In "L'Ind. Elec.," Dec. 10, Mr. Hospitalier gives a short description of the Falls together with some data and two interesting profiles, showing the size and depth of the five large lakes and the location of the tunnel.

Transmission of Power in Mexico.—The Lond. "Elec. Rev.," Dec. 15, publishes an illustrated abstract of Mr. de Arozarena's Congress paper, describing an interesting installation in Mexico.

Transmission of Power.—Prof. Unwin's sixth lecture is continued in the Lond. "Elec. Eng.," Dec. 15.

ELECTRIC RAILWAYS.

The Future of Electric Railways.—A recent lecture by Dr. Hopkinson is reprinted in abstract in the Lond. "Elec. Eng.," Dec. 15. Regarding the City & South London line he states that from experiments it was found that the loss in the line was about 11 per cent., the efficiency of the locomotives as a whole was 70 per cent., and the electrical efficiency of the entire system 62 per cent.; the trains weighed, with a full load of 100 passengers, about 40 tons, and the average speed between stations was 13.5 miles per hour; the cost of working, including all charges, during the last half year, was 13 cents per train mile; comparing this with a steam railway, the cost of steam traction per ton mile of train was about half this, but he states that this is an unfair comparison, as steam could not possibly be used in those tunnels, and that the real basis of comparison was the cost per passenger mile, in which respect electric traction had a great advantage over steam, as the dead weight is small. Regarding traction at enormously high speeds (which he does not seem to consider favorably), he calculates that the power required to propel an ordinary train 200 feet long at 200 miles per hour against the resistance of the air alone, apart from the frictional resistance, would not be less than 1,700 h. p.; he thinks the strength of the material at present at command would set a limit to the speeds which may be obtained; if speeds over 200 miles were required, he predicts that it would be more efficiently realized by regarding it as a problem of projectiles and not of ordinary locomotion.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Two-Phase System.—In Mr. Kennedy's serial in the Lond. "Elec. Rev.," Dec. 15 (see also Digest, Nov. 18, 25, Dec. 9, 23, 30), he describes converters for converting alternating into continuous currents; he appears to have little faith in commutating or rectifying devices, stating that they only give an intermittent current, and can be used for only small currents; he describes and illustrates the devices of Apollony and Hutin & Leblanc, which he calls "reproducers," as they change both the nature of the current and the voltage, as distinguished from transformers, which simply change the voltage, and converters, which simply change alternating into continuous currents; it consists essentially of two Gramme rings, one for the primary and the other for the secondary current, the latter being connected to a commutator as in the ordinary dynamo, the brushes for which are driven by a synchronizing motor and revolve synchronously with the alternations (for an illustration of the Apollony device see The Electrical World, Dec. 10, 1892); he speaks of these as exceedingly effective and economical reproducers; he describes, with the aid of three illustrations, another device of Hutin & Leblanc, which, he says, is likely to be very successful; the primary and secondary currents are on the same ring, forming one closed magnetic circuit; there is a separate ring for each of the two primary currents, but the secondaries of both are joined to one commutator, the sections of one being coupled in series with the sections of the other, the separate coils at the same time having different numbers of turns; they are coupled so that the E. M. Fs. oppose each other at the points in contact with the brushes, so that no currents flow except in the external circuit; this he explains in detail; he considers this an "exceedingly elegant method, and one which seems very perfect;" up to 15 kw. there is no sparking at a commutator of only twelve divisions; he states that there is another method, equally good, if not better (presumably his own), which he cannot describe at present.

Rotary Field Apparatus.—Mr. Blondel's mathematical article on the elementary theory, mentioned in the Digest, Dec. 16, is continued at some length in "La Lum. Elec.," Dec. 9; he discusses the windings employed in practice, experimental methods for studying the rotating flux, and begins the section on a new method of calculations.

Polyphase Currents.—The serial in the Lond. "Elec. Eng.," mentioned in the Digest last week, is continued in the issue of Dec. 15; in it are discussed multipolar fields, the armature, the power developed, the efficiency and the coefficient of self-induction of the armature coils. It appears to contain nothing new.

Commutation of Alternating Currents.—Mr. J. H. Thomson, in the Lond. "Elec.," Dec. 15, describes a method in which the currents are commutated by the usual synchronizing commutator, but instead of connecting this directly to the mains, it is connected to them through condensers, the commutator being driven by a synchronizing motor; he calculates that each condenser must have a capacity of about 3.6 microfarads for each ampere of mean charging current, or 2.3 per ampere of maximum current; it would make little difference in the current in this method whether one cell was being charged or whether there are a hundred cells, and theoretically it would not affect the efficiency; errors in setting the brushes cannot produce violent currents; he has not yet had an opportunity of testing the method. In an editorial note there is thought to be no prospect that this method will be successful; it is stated that condensers absorb about one-fortieth part of the power represented by the product of the voltage at the terminals and the current following them.

Utilization of Town Refuse.—Mr. Tomlinson's serial is concluded in the Lond. "Elec. Rev.," Dec. 15. He states that he has shown the refuse of a town to be sufficient to supply the amount of light required by that town, even assuming the best recorded performances of destructors under sanitary conditions. Regarding the Halpin thermal storage system (see Digest, under Power Generator, Feb. 11) he states that the assumption that it makes destructors universally available is not correct, and that it is just as applicable for coal as for refuse. Taking a population of 20,000 the refuse will be about 4,000 tons per year, the evaporative power of which is 500 to 800 lbs. of water per ton of refuse, this being equal to 100 to 140 tons of coal; assuming 1.8 c. p. for 500 hours per year per capita and 10 to 20 lbs. of coal per kilowatt hour, 1,300 to 2,600 tons of coal will be required per year for the low tension continuous current system and the high tension alternating current respectively; the proportion is very small, but in many cases it may pay to utilize the power from the refuse as auxiliary; he states that thermal storage is not by any means the form of storage best adapted for town refuse, as it ties the central station down to a site in most cases unsuitable; the low temperature of the waste gases is not particularly applicable to this system of thermal storage.

Lightning Induction Discharges.—Referring to the notes on this subject in the Digest Oct. 28 and Nov. 25, describing a case in which a wooden table was set on fire by small lighting induction discharges, supposed to have taken place between the metallic threads in the trimming, Mr. Niels P. Jurgensen, sergeant of the Signal Corps stationed at Fort Snelling, Minn., writes us of a similar case which came under his observation. During a thunderstorm last summer one of their telephones refused to respond, and he found the trouble in the secondary of the transmitter induction coil, although nothing but the call bell was in circuit during the storm. At the brake the copper wire was entirely fused, and the insulation carbonized; the pasteboard between the primary and secondary was found punctured.

Alternating Currents.—In Mr. Guy's serial in the Lond. "Elec. Eng.," Dec. 15, he discusses alternate current working, explaining the difference between the two alternating amperes, the errors in measuring instruments for measuring these currents, inductive and non-inductive circuits, and the skin effect, but giving nothing new.

Tesla's Oscillator.—The "Elec. Anz.," Dec. 1, gives a short illustrated description of Tesla's oscillator for producing alternating currents by means of his new steam oscillator; the cuts include an outside view and a cross-section.

Motive Power and Gearing.—Mr. Carter's serial is continued in the Lond. "Elec.," Dec. 15; he discusses waste and useful power, load, load diagrams, load factors, prime and working costs and the economic law of design.

Cape Town.—According to the "Elek. Zeit.," Dec. 15, the central station, which has been erected by a German company, consists of an accumulator station located in the centre of consumption discharging through a five-wire system and charged from a station outside of the city, supplied with power by means of a turbine from a waterfall of over 600 feet in height, in conjunction with a direct coupled steam engine.

Saint Moritz.—"L'Ind. Elec.," Dec. 10, describes briefly the present installation in this town in the Engadine; as early as 1879 one of the hotels was lighted by Jablochkoff candles, the power being furnished by a turbine.

Edinburgh.—The proposal for that city, by Prof. Kennedy, in which both low pressure continuous currents and high pressure alternating currents are to be used, is discussed editorially in the Lond. "Elec. Rev.," Dec. 15.

Bockenheim.—"L'Ind. Elec.," Dec. 10, publishes a well illustrated description of this station described in the Digest Sept. 16, and referred to in the issues of Sept. 23 and Nov. 4.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephone Central Station in Paris.—"L'Elec.," Dec. 9, publishes at some length an illustrated description of the new station, known as the Gutenberg, for 6,000 subscribers, which forms one of the four central stations in Paris which are to replace the twelve former stations; the description is devoted chiefly to the architectural features and to the arrangement for the leading in and distribution of the wires in the building.

Pacific Cables.—The Lond. "Elec. Rev.," Dec. 15, mentions briefly the lengths and cost for four different routes from Canada to Australia, but none of which seem to include the Sandwich Islands.

ELECTRO-CHEMISTRY.

Preparation of Lithium by Electrolysis.—"L'Ind. Elec.," Dec. 10, publishes a note by Mr. Guntz in which he describes apparently successful experiments for obtaining metallic lithium by electrolysis from the fused chlorides; he finds that the amount obtained is greatest the lower the temperature; an impure salt containing chlorides of potassium and sodium gives much better results, which, he thinks, may be attributed to the consequent lowering of the fusing point; pure chloride of lithium melts at 600 degrees C., while a mixture with an equal weight of potassium chloride melts at 450 degrees, and a mixture of an equal number of molecules melts at 380 degrees; the best mixture is that made of equal weights of the two substances; the positive electrode consists of a ring of carbon and the negative electrode of a rod of iron placed inside of a glass tube about three-quarters of an inch in diameter; with 20 volts and 10 amperes at the end of 1 hour the lithium will be 1 centimetre above the liquid in the tube; the metal thus obtained is free from iron and silica, but contains one or two per cent. of potassium.

Alternating Current Electrolysis.—Messrs. Hopkinson, Wilson and Lydall, in a recent Royal Society paper, mentioned in the Lond. "Elec.," Dec. 8, conclude from experiments that about 0.1 coulomb suffices to fully polarize 150 square centimetres of platinum; this will liberate 0.00007 gramme of hydrogen, hence, 0.00000007 gramme of hydrogen serves to polarize 1 square centimetre of platinum; this quantity is probably a magnitude comparable with the distance between molecules of hydrogen when this body is compressed to a density comparable with the density of liquids.

Electric Treatment of Oils.—Mr. Levat, in an Academy paper abstracted in "L'Ind. Elec.," Dec. 10, states that when olive oils of an inferior quality are treated electrically they are clarified and the bad taste is completely removed; lubricating oils of a poor quality containing 5 per cent. of acids were also treated, and it was found that the acidity could be reduced to about one-fifth; the method is not clearly described, but it appears to consist of placing the oils around the negative electrode of a voltameter (presumably of the U type), and the action continued until "the column of water is completely electrolyzed."

Effect of a Long Rest on Accumulators.—Sir David Salomons, in the Lond. "Elec.," Dec. 15, states that he discharged some cells four years ago and set them aside, and now finds that the plates are as good as ever, only that their color is bad; there is no loss of paste or buckling, and he is assured that if the discharge has not been too rapid no harm is done by allowing them to stand for years; the plates are certain to buckle if they are not charged

in the ordinary way; a sure way to prevent this is to brush the positives with a stiff brush or slip of wood in order to remove the surface scale, after which they may be charged, but slowly at first.

Verdier Accumulator.—The Lond. "Elec.," Dec. 15, gives a short illustrated description of this accumulator; the plates are horizontal and contain active material in perforated troughs.

Purification of Sewage.—According to the Lond. "Elec. Eng.," Dec. 15, the success of the Hermite process in France has led a number of municipalities to consider the subject of its introduction.

MISCELLANEOUS.

Firedamp Detector.—"La Lum. Elec.," Dec. 9, mentions the apparatus devised by Hardy, which is based on the principle that two organ pipes tuned to the same note will "beat" when one is operated by pure air, and the other by air mixed with gases; a telephone transmits these beats to any desired locality where they are magnified 400 times in loudness by a suitable microphone.

Heliotropism Produced by Sparks and Arcs.—The Lond. "Elec.," Dec. 15, mentions a Royal Society paper by Prof. Romanes, in which he describes his researches on the effect of intermittent light on the growth of plants which exhibit heliotropism; from this it appears that the heliotropic influence of electric flashes is greater than can be produced by any other artificial or natural source of illumination.

Physiological Effects of High Frequency Currents.—The Lond. "Elec. Eng.," Dec. 15, reprints a communication by Dr. Hedley from the "Lancet," Dec. 9; it appears to contain nothing new; in concluding he states "that physiological effects are proportional not only to the quantity of electricity, but also to its modality,"—that is, to the "mode in which such current is presented."

Lighting Currents for Medical Purposes.—The Lond. "Elec. Rev.," Dec. 15, contains a short editorial on this subject; it claims that continuous currents may be used safely and conveniently when properly protected, but that in unskilled hands protective devices afford little or no protection.

Welding.—The apparatus of Howard (presumably the same as is used in the Combs-Woods process, described in the Digest, April 1) is briefly described in "L'Elec.," Dec. 9; the important feature is that the arc used for the welding is kept continually in motion over the edges to be welded.

Welding Projectiles.—"L'Ind. Elec.," Dec. 10, publishes an illustrated description of the process used in Lynn.

Electric Furnace.—A more complete description of the latest form of the Moissan furnace mentioned in the Digest, Dec. 23 and 30, is given in "L'Ind. Elec.," Dec. 10, and "L'Elec.," Dec. 9.

Prizes.—The Lond. "Elec. Rev.," Dec. 15, publishes a list of the prizes offered by a French Society for various inventions in the electrical field.

Keely and His Discoveries.—The Lond. "Elec. Rev.," Dec. 15, publishes at considerable length a review of the book having this title, by Mrs. Bloomfield Moore; the criticism is very unfavorable.

Biographical.—The London journals of Dec. 8 contain biographical notices of Prof. Tyndall. The Lond. "Elec. Eng.," Dec. 8, contains a short biographical notice of Mr. Killingworth Hedges, including a portrait, although not a good one.

The Digest for 1893.—The compiler's card index to the abstracts and references which have been published in this department from Feb. 4, 1893 (the first issue), to Dec.

30, inclusive, shows that the total number of abstracts and references is a little over 2,000. The largest number in any one department is about 300, under Central Stations, Plants, Systems and Appliances; the next largest classes are Electro-physics, Units, Measurements and Instruments, and Dynamos and Motors, with about 240 each. These abstracts and references are a summary of what was published in 836 issues of journals, of which over 550 were in a foreign language, thus averaging nearly 20 periodicals a week.

Prizes for Inventors.

Attention is directed by the Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts to the fact that it may grant, or recommend the grant of, certain medals for meritorious discoveries and inventions which contribute to the promotion of the arts and manufactures. The character and conditions of these awards are briefly stated in the following:

The Elliott Cresson medal, founded in 1848 by the gift of the late Elliott Cresson. This medal is of gold, and by the terms of the deed of trust may be granted for some discovery in the arts and sciences, or for the invention or improvement of some useful machine, or for some new process or combination of materials in manufactures, or for ingenuity, skill or perfection in workmanship.

The John Scott legacy premium and medal (\$20 and a medal of bronze), awarded by the city of Philadelphia. This medal was founded in 1816 by John Scott, a merchant of Edinburgh, Scotland, who bequeathed to the city of Philadelphia a considerable sum of money, the interest of which should be devoted to rewarding ingenious men and women who make useful inventions. The premium is not to exceed \$20, and the medal is to be of copper, and inscribed "To the most deserving."

The control of the Scott legacy premium and medal, by act of ordinance of Councils in 1809, passed to the Board of Directors of City Trusts, and has been referred by the Board to its Committee on Minor Trusts, and that committee has resolved that it will receive favorably the name of any person whom the Franklin Institute may from time to time report to the Committee on Minor Trusts as worthy to receive the Scott legacy premium and medal.

The Edward Longstreth medal of merit, founded in 1880 by Edward Longstreth, machinist, and late member of the Baldwin Locomotive Works. This medal is of silver, and may be awarded for useful invention, important discovery, and meritorious work in, or contributions to, science or the industrial arts.

Full directions as to the manner and form in which applications for the investigation of inventions and discoveries should properly be made will be sent to interested parties on application to William H. Wahl, Secretary Franklin Institute, Philadelphia, Pa., U. S. A.

The Capitol Lighting Plant.

At the last session of Congress the Committee on Rules of the Senate enlisted the services of the competent electrical engineers for the purpose of ascertaining the amount of the appropriation necessary to establish an electrical plant for the purpose of illuminating the Capitol. Several reports have been made by the electrician, and definite action is soon to be taken by the Senate. It is said to be likely that the committee will recommend the immediate establishment of an electric lighting plant of sufficient power, not only for the Capitol building, but for its annex, the Maltby house, and the Congressional library, which is to be the largest building of its kind in the world, and which, by reason of its uses, will require the best class of illumination.

To accommodate such a plant, it will be necessary to

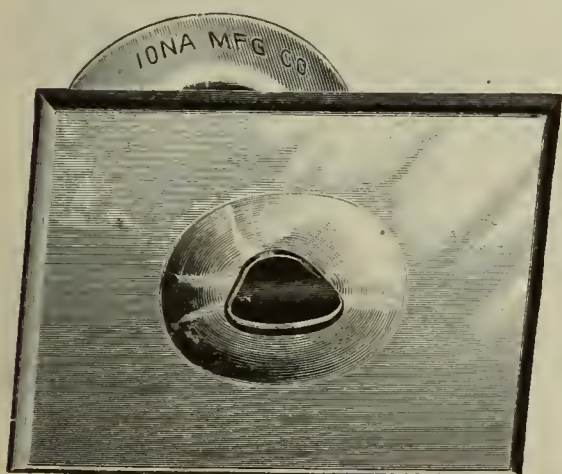
locate the engine and dynamos in a structure erected for this especial purpose. The location of the power house is now being carefully considered, and the decision will probably be reached very soon. The house will be ornamental in appearance, and will be of sufficient size to contain not only the eight dynamos necessary for the present, but also for other buildings that may be added to the group clustered around the Capitol, notably the home for the Supreme Court.

A careful estimate has placed the original cost of the building, the machinery, the wiring and the general installation of the plant at \$200,000. This will insure the work to be of the best character and the plant to be of sufficient size to furnish all the light that can be used in the buildings and the grounds. This latter is a most important item in the calculation, for at present there is an utterly inadequate illumination of the great park. It is not certain whether the grounds will be lighted by arc lamps or groups of incandescent globes. But this is a matter of detail to be settled afterward.

A rough estimate that has already been made of the cost of maintaining the new plant, which will do not only the work now done by the gas and electric plants in the Capitol building, but also the entire work of lighting the new library building and the Maltby house, shows that it will cost in the neighborhood of \$19,000.

Iona Flush Switch.

We illustrate herewith the flush switch made by the Iona Manufacturing Company, 236 Congress street, Boston, Mass., which is not only particularly convenient to wire, but makes a neat appearance when put in the wall, there being no screws in sight. The mechanism is the well-known snap and ratchet movement, which is simple and always reliable. The switch is made in single or double



FLUSH SWITCH.

pole, singly or with several switches on the same face-plate, in nickel plate or fancy colors to match interior decorations, for which purpose it is particularly applicable.

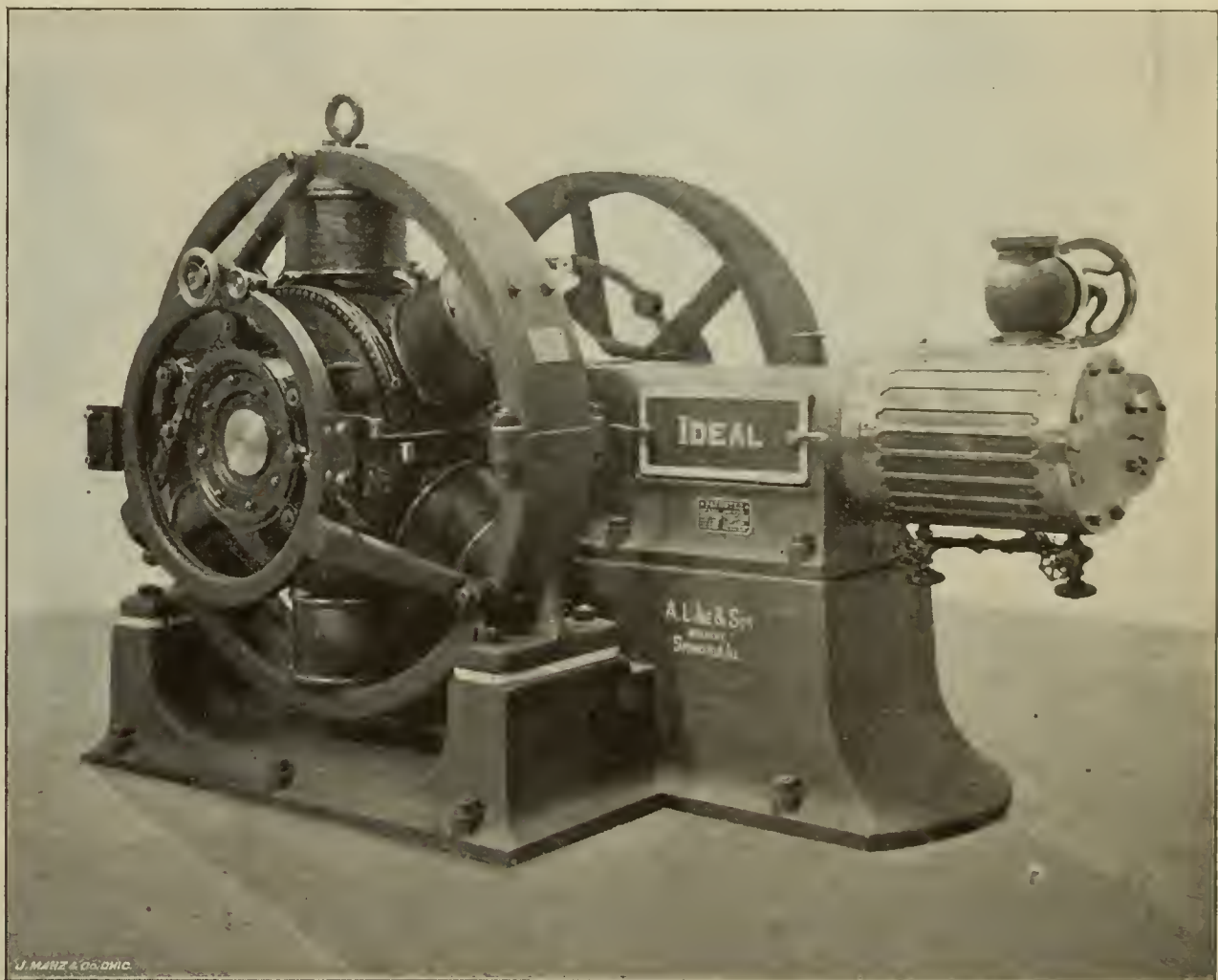
Direct Connected Engine and Dynamo.

The state of perfection at which the latest types of steam engines have arrived is shown in nothing so clearly as in the increasing demand for automatic types of engines to be directly connected to dynamos. The fluctuations in load, especially in street car service, are so great and so numerous—fluctuations of 25 to 100 per cent. of the entire load occurring almost instantaneously—that it has taxed the inventive genius of our engine builders to the utmost to produce engines that will stand the strain. In the case of belt-driven dynamos a severe short circuit will usually cause the belt to fly off and thus relieve the engine, but a direct connected en-

gine must not only be able to maintain a uniform speed under these sudden changes of load, but it must not fly to pieces if a short circuit brings the engine to a sudden standstill. That the day of the slow speed engines with deadly flywheels is past for electrical work is generally acknowledged. Where space is not very valuable, dynamos belted to high speed engines will continue to be used, but where space becomes a matter for grave consideration the future demand must be for direct connected engines as soon as engine builders can supply a suitable engine.

To meet this demand, the engine shown in the accompanying cut has been built by A. L. Ide & Son, of Springfield, Ill. The illustration is taken from one of three Ideal engines shipped by this firm for use in lighting the new Southern Hotel in St. Louis. Two of these engines had 14x14 cylinders, the third had a 13x12 cylinder. All were regulated to run at 275 revolutions. Each of these engines had a General Electric Company armature keyed on the crank shaft in place of the plain pulley. The construction of the armature and engine are such that no out-board bearing is required. The two 14x14 engines are to drive dynamos belted from the governor pulleys in addition to the direct connected armatures.

The points of superiority claimed by the builders of these engines for this form are as follows: They claim they will not vary over one per cent. in speed for a sudden change of 100 per cent. in load. They are perfectly self-contained



DIRECT CONNECTED ENGINE AND DYNAMO.

and balanced. Every engine was adjusted before leaving the works to run at its specified speed under full load and so balanced as to run without shaking with all anchor bolts removed. Excellence in workmanship and material—steel and bronze entering into its construction to an unusual extent. The engines are provided with the well-known Ideal system of self-oiling, which supplies all working parts with a constant stream of oil that is used over and over again. There is positively no oil scattered in any direction. The armatures are, therefore, entirely free from any danger that could result from a splash of oil. That these engines are peculiarly adapted to work in places where space

is valuable will be apparent from these dimensions: The 14x14 engines with armatures attached complete, as shown in the illustration, can each be placed in a box 68 inches high, 81 inches wide, 10 feet 3 inches long, and their rated horse power is 125. The 13x12 engine, 100 h. p., can be placed in a box 68 inches by 74 inches by 9 feet 11 inches.

Telephone Exchange System.

We illustrate a new exchange system now being placed upon the market by the National Telephone Manufacturing Company, 620 Atlantic avenue, Boston, Mass., which is of timely interest in view of the coming expiration of the Bell metallic diaphragm telephone patent.

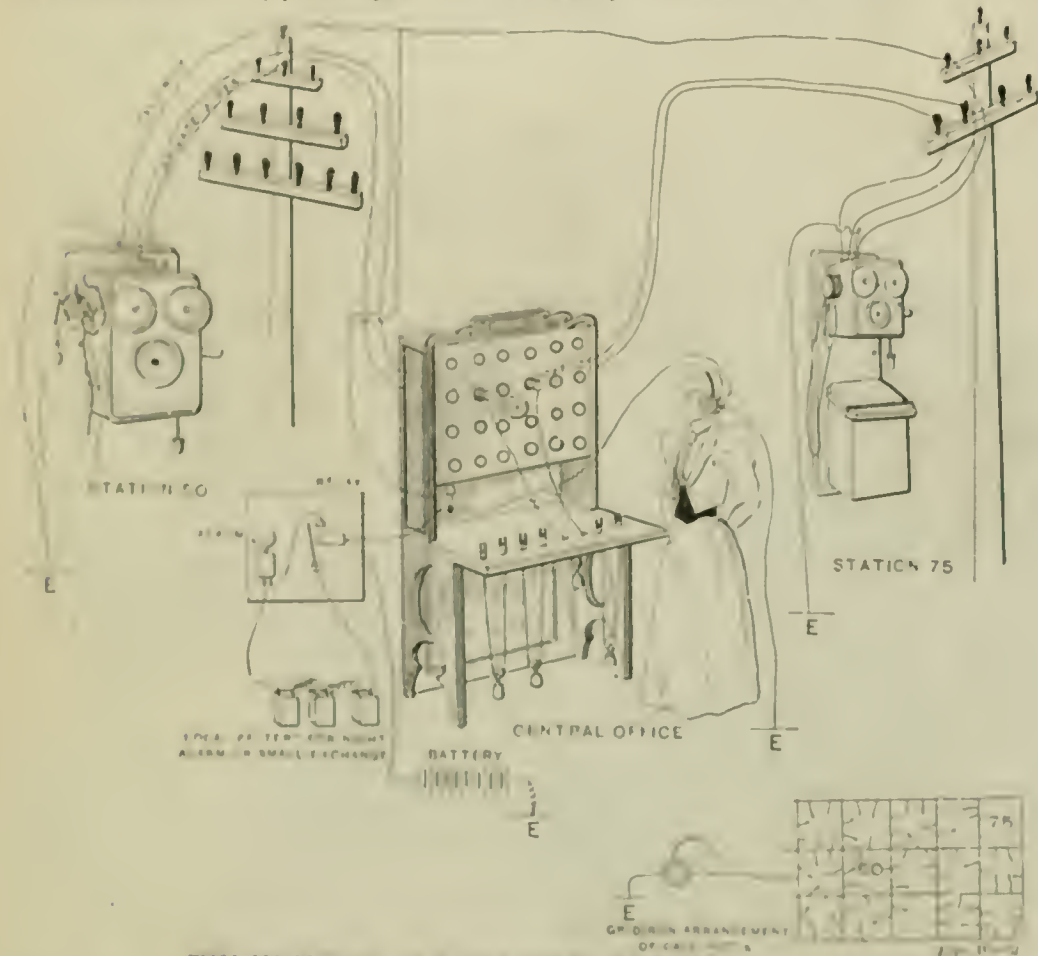
As will be seen there are two wires from the central exchange to each subscriber, and a third or call wire, which is tapped for each telephone. This latter is always in open circuit until the subscriber pulls down the cord, which puts him in connection with the exchange, which grounds his call wire, enabling him to call "central" for desired connection. For example, suppose telephone number 50 desires to talk with telephone 75. Number 50 takes the receiver from its holder, places it to his ear, and pulls down the cord at the bottom of the bell box; this connects him with the third or general signal wire running to central station, and he then calls into his transmitter "75 on 50," immediately releasing the cord

in a postoffice or store, or at any place where the continuous services of an operator are not warranted on the score of economy, a clerk or any other person may serve. The operator's instrument can be switched on to an alarm to sound a call when a subscriber desires to be connected, the subscriber pulling down his cord below the bell box and listening until his call is answered by "central," who will connect as requested.

The subscriber, when connected by "central," is enabled to do his own ringing up, as a call is not always promptly replied to. This feature alone permits the permanent operator to attend to answering calls, making connections without losing time in ringing bells and waiting for delinquents. This will also apply to a clerk or other person acting as operator; they will simply connect the wires leaving the subscriber to do his own ringing up. The subscriber is also assured of the fact that if he cannot ring up the person wanted it is by no means the fault of the central office. Metallic circuits must be used in connection with an exchange system if electric light or trolley wire poles are to be utilized.

The Lundell Motor and Interior Conduit Bushing.

The chief characteristics of the Lundell type of direct-current dynamos and motors, manufactured by the Interior



TELEPHONE EXCHANGE SYSTEM.

after calling, always giving his own number last, to enable the operator to know who he is. When the cord has been released a sharp click will be heard, which assures that the call has been received; if the click is not heard, he should again pull down the cord and call "75 on 50," releasing the cord as before. When the click is heard, he replaces the receiver in its holder and rings up 75 direct.

If, upon turning the crank of the bell, his own bell refuses to ring, it is evident that telephone 75 is busy talking with some other subscriber, and number 50 will have to call again later on, unless the operator should ring him up, having connected the line in the meantime. After conversation is completed, before replacing the receiver in its holder, number 50 should again pull down the cord from the bottom of the bell box and call into his transmitter, "disconnect number 50"; this must always be done, for, should another subscriber desire to talk with number 50, the operator would think his line still in use.

In small exchanges or central stations that may be located



THE LUNDELL MOTOR.

Conduit and Insulation Company, 44 Broad street, New York, are embodied in the novel construction of the field magnet, whereby a single coil magnetizes all the pole pieces, and a strong protecting shell for the windings of both field and armature forms the magnetic circuit is furnished.

Referring to the illustrations, it will be noted that the two field-magnet halves when bolted together form a shell which completely protects the armature, the whole of the shell being utilized in the magnetic circuit. The cross-section of the shell equals the cross-section of the base of the pole pieces, so that no choking of the lines of force can occur at any point. Cast steel is employed for all these dynamos and motors. The single energizing coil not only reduces the construction of the machine to the simplest point, but by having only two terminals it is especially adapted to be placed in the hands of inexperienced users, as it avoids any possible mistake in connecting up or any bother or delay in examination when such becomes necessary. Another feature of the design is that the pole-pieces are magnetized directly,

and, it is claimed, the resistance of the magnetic circuit thereby reduced to a minimum, thus effecting a considerable economy in the ampere turns of the energizing coil.

The armature adopted for these machines is of a modern Pacinotti form. This type of armature has in the past been subject to unfavorable criticism on account of the resultant heating of the pole-pieces, but it is now pretty well recognized that this heating was not due to the Pacinotti ring itself, but to the lack of knowledge with regard to its proper design, which is carried into practice in the Lundell machines by the employment of deep and narrow slots.

Notwithstanding the ironclad nature of the machine, the concentric position of the field-coil allows the armature to be withdrawn without disturbing either the field-coil or the pole-pieces. The openings around the armature at the ends of the field-magnets are, in the larger machines, covered with metal screens to protect the working parts, and to secure at the same time perfect ventilation. The commutator portion of the armature alone projects outside the screen, and is well protected by a strong bracket which carries the out-board bearing. The brushes are arranged diametrically around the commutator and the opposite brushes are in all four-pole machines connected together. They can be raised from the commutator when the machines are not in use.

The brushes of the two-pole type have a unique spring arrangement for pressing the carbon brushes against the commutator. The spring has its rear end placed in a curved slot at the end of the brush-holder; while its forward end in the shape of a T presses against the carbon which slides in the ways in the brush-holder. To remove the carbon, it is merely necessary to press the spring upward out of the slot, which releases it so that the T can be withdrawn, and the carbon slides out.

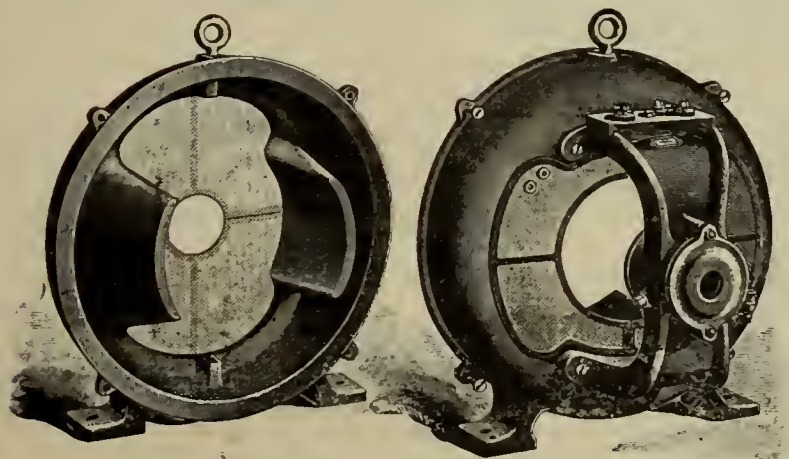
The bearings are constructed with mechanical accuracy, are self-oiling and are provided with a vision gauge. The bushings are made of the best material and are so arranged



METAL SHEATHED BUSHING.

as to be readily removed and renewed when worn out.

Recognizing also the necessity of continuous lubrication, oiling is accomplished by means of a number of rings which encircle the shaft and dip into the reservoir, thus continually feeding fresh oil to the bearing. In order that the attendant may know the exact condition of the oil, a simple oiling device has been added, consisting of an elbow with an oil-chamber, rising slightly above the normal level of the oil. The vertical arm of this elbow is so arranged that when the visual gauge is half filled the bearing is properly oiled. The glass tube is made so short that by no possible inadvertency



FRAME AND POLES OF LUNDELL MOTOR.

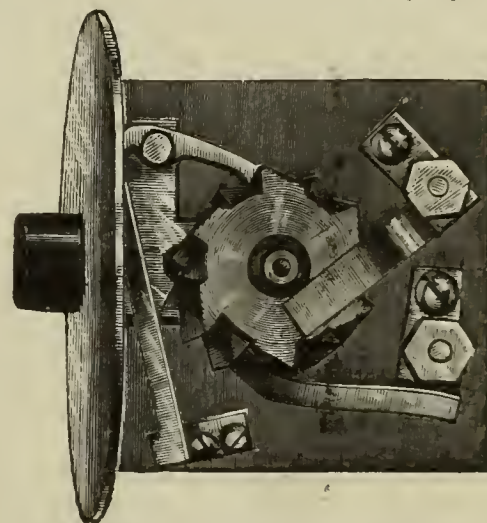
can the attendant pour in oil sufficient to flood the bearing and cause the oil to run out at the inner surface of the shaft and so go into the armature.

The insurance inspector rules of the Underwriters' Inter-

national Electric Association require that electric light and power conductors must be protected when passing through floors, or through walls, partitions, timbers, etc., in places liable to be exposed to dampness, by waterproof, non-combustible, insulating tubes, such as glass or porcelain, and when passing through walls, partitions, timbers, etc., in places not liable to be exposed to dampness, by approved insulating bushings specially made for the purpose. In order to comply with these requirements the Interior Conduit and Insulation Company, 44 Broad street, New York, has placed on the market a metal-sheathed bushing, which we illustrate. The bushing is thoroughly waterproof and non-combustible, and has superior insulating qualities. The armor gives strength and durability, which neither glass, porcelain, nor vulcanized rubber composition possesses. It is more serviceable, requiring a smaller hole in beams and joists than porcelain or glass, and for this reason alone should meet with the approval of architects.

A New Electric Light Push Switch.

The particular feature of the push switch we illustrate, as seen by reference to the cut, is that it is operated by only one button instead of two, as is the case in the ordinary construction of push switches, the advantage of this method of operation being not only in the added neatness of the switch, but in its simplicity of action. The action, which is readily apparent from the cut, is very positive, and at



IMPROVED PUSH SWITCH.

the same time the switch can be manipulated with great ease. The break is quick, and made in such a manner that the switch cannot be left half off or on, and a short circuit cannot occur. The switch is known as the Standard Single Push Flush Switch, and is intended to take the place of any 5 or 10 ampere snap or flush switch, and is made in the regular 10-ampere singlepole and 10-ampere three-way styles. A third style is now under way and will shortly be ready for the market, to be known as the Standard Commutation Switch. In general appearance it is the same as the regular switch shown in the cut, but the contacts are so arranged that a light or group of lights, by the use of the commutation switch, can be controlled from any number of points without extra wiring; that is, a light or group of lights can be turned on or off from any three or more points independently. All of the Standard switches, which are manufactured by the Electric Appliance Company, Chicago, are compact and neatly made.

New Book.

TABEAU DES STATIONS ELECTRIQUES DE FRANCE.
Paris: librairie polytechnique, Baudry et Cie, Editeurs, 15 Rue des Saint-Peres; Brochure of 32 pages, in quarto. Price, 3 francs 50 centimes.

This pamphlet gives under 27 heads details of all the central electric lighting stations of France, more than two hundred of which, it is stated, have never heretofore had data in relation to them published. Much of the data will be interesting to American electricians and central station managers.

Financial Intelligence.

The Electrical Stock Market.

New York, Jan. 2, 1894.

THE ELECTRIC STOCK MARKET is undergoing the usual holiday dullness, and with the exception of one conspicuous speculative stock there have been few transactions. Unlisted electrical stocks are particularly inactive, but suffer no decline in prices. About all of the trading is in the listed securities, which in some cases have fluctuated considerably, but to-day's closing prices differ little from those at the closing of last week's market.

GENERAL ELECTRIC STOCK was extensively traded in during the week, over \$1,000 shares being sold on Wednesday, but the buying was in a bear rush, and at the close of the day's market the stock had sustained a net loss of $3\frac{3}{4}$ points. The stock closed at a rallying figure, however, and once during the day was down to $31\frac{1}{4}$, six points below the opening. Why the cause of the slump no one in the Street seemed to know, and the officers of the company would only make one of the usual general denials. Vice-President Griffin said: "The rumors affecting the financial condition of this company are absolutely false, and the direct rot. The facts are, that we have over \$1,000,000 in the bank, and the floating debt is being chopped down at a tremendous rate. Of course, we could stand more business, as is the case with all other companies, but we are getting our share." This declaration stopped the bear landslide somewhat, but it seems as if it was only with these constant denials that the company could keep the stock from going to pieces. On Thursday the stock rallied a few points from the opening price. This rise was due to an order from Drexel, Morgan and Company to make heavy purchases of the security. On this buying there was a rush to cover by the shorts, and this brought a slight appreciation. On the same day it was reported that the Brush Electric Company had applied for a receiver for the General Electric Company at Cleveland, Ohio, owing to the General Electric Company's non-fulfilment of their obligations. This report was of course denied by the General Electric people, and the story classified as a bear trick. Nevertheless, these stories and rumors show to some extent the standing the stock has in Wall Street, and how readily all sorts of assailing yarns are put forth on the slightest provocation. There has been a heavy selling movement of the stock in Boston this week, and this, with the other rumors, has revived the story of a disruption of the trust, back to its original form in the Edison and Thomson-Houston companies. The announcement in another column of the centralization of the business offices and manufactory at Schenectady would seem to indicate the complete control of the New York faction of the company and the carrying out of their ideas. General Electric stock shows a net loss during the week of $3\frac{3}{4}$ points, it now being quoted at $33\frac{1}{2}$ bid.

WESTERN UNION TELEGRAPH lost a few points at the beginning of the week, but regained a little, so that it closed only $1\frac{1}{2}$ points below last week's figure. The decline is due to the reigning dullness, with the usual declines, and the talk of an abandonment of special wires by large houses.

ALL OTHER ELECTRICAL SECURITIES remain unchanged both in quotations and business standing, and brokers declare no trading.

ELECTRICAL STOCKS JAN. 2, 1894.

	Par	Bid.	Asked
Brush El. Co., New York	50	20	40
Detroit Electrical Works	10	2	3
Cleveland General Electric Co.	—	85	90
East River Electric Light	100	—	65
Electric Co. & Supply Co., pref.	15	15	16
Electric Co. & Supply Co., com.	15	15	17
Edison Electric Co., New York	100	96	99
Edison Electric Co., Inds.	—	103	104
Edison Electric Co., Brooklyn	100	99	102
Edison Electric Co., Boston	100	115	120
Edison Electric Co., Chicago	100	220	230
Edison Electric Co., Philadelphia	100	120	125
Edison Electric Light of Europe	—	25	5
Edison Electric Light of Europe	—	80	85
Edison Electric Light of Europe	—	5	12
Fort Wayne Electric	—	5	9
General Electric Company	10	30	31
General Electric Company	—	71	75
Interior Conduit and Ins. Co.	100	25	30
Mount Morris Electric	—	—	65
Westinghouse Consolidated	50	23	24
Westinghouse Consolidated	50	41	43
Western Union Telegraph	—	32	35

Special Correspondence.

New York Notes.

NEW YORK, Jan. 5, 1894.
OFFICE OF THE ELECTRICAL WORLD.
100 N. 10TH STREET, NEW YORK, Jan. 6, 1894.

SAMUEL ADAMS CHASE, the well-known representative of the Western Electric Company, sailed for Europe last week on official business.

STOLE A STREET.—The Union Railway Company began laying a track on One Hundred and Thirty-fifth street on Sunday, Dec. 24, thus avoiding service of an injunction.

THE METROPOLITAN TELEPHONE AND TELEGRAPH

COMPANY gave a private view of its new exchange, at 95 Broad street, on Wednesday, Jan. 3, 1894, from 2 until 5 o'clock.

JUDGE GAYNOR has enjoined the Kings County and Nassau Electric Railroad companies, restraining them from constructing their lines, on the ground that the franchise was fraudulent.

THE AMERICAN STANDARD BATTERY COMPANY, which has been located at 29 Broadway, moved its offices on the 3d inst. to 66½ Pine street, where it occupies two floors, and will engage in the manufacture of its battery.

MR. S. FRIEDBERGER, treasurer of the Wakefield Electrical Engineering Company, 731 Reading Terminal, Philadelphia, Pa., was in New York last week, and reports business in Philadelphia and vicinity on the increase.

MR. F. S. DE RONDE, of the Standard Paint Company, 2 Liberty street, New York, who has been confined to his home suffering with a severe attack of the grip, has recovered and is now in daily attendance at his office.

MR. J. McFARLAN MOORE has an interesting article in the January number of "Frank Leslie's Popular Monthly" on a cruise on the U. S. monitor "Miantonomoh" in charge of the first electrical steering gear ever installed on a ship.

MR. DAVID CHALMERS, manager for S. W. Milbank, receiver of the A. B. C. Co., 67 Cortlandt street, New York, reports having made several large sales during the past week. The remaining stock is fast being disposed of to the "knowing ones."

MR. GEO. A. HILL, manager of the Typewriter Exchange, 10 Barclay street, New York, reports the sales of machines far in excess of the corresponding time last year. This is probably due to the fact that the Typewriter Exchange sells all makes of machines at a considerable discount.

MR. W. R. BRIXEY, manufacturer of Day's Kerite, is sending to his many friends and customers a neat memento of the season in the shape of an aluminium penholder. Mr. Brixey quotes: "The pen is mightier than the sword," and then very adroitly adds, "when the sword of competition is raised against kerite let this pen do its work."

MR. E. L. BABCOCK, president of the Falls Rivet and Machine Company, of Cuyahoga Falls, Ohio, while in New York, on Dec. 27, was run over by a truck on Church street. He was fortunately not very seriously injured, and was carried at once to Chambers Street Hospital and from there removed to the New York Hospital. On the 29th he left on the train for Cuyahoga Falls.

MR. E. B. WYMAN, Manager of the railway department of the Central Electric Heating Company, 26 Cortlandt street, New York, reports that it is working to its utmost capacity filling orders for electric heaters. There are to-day in the United States over 1,000 cars using this company's heaters, Brooklyn alone having in daily use 1,000 heaters, giving a uniform and comfortable degree of heat.

MR. NEWTON HALL, who has been connected with "The Electrical World" for the past two years, where he has had charge of the compilation of "Johnston's Electrical and Street Railway Directory," has severed his connection with the W. J. Johnston Company, to accept one as assistant manager of the American Electrical Publishing Company, 135 Liberty street, New York City. This company has been organized to publish the "Electrical and Street Railway Reporter," a new paper to enter the electrical field. Mr. G. G. McDuff, for some time a member of "The Electrical World" staff, will assume the management of the new publication. Both Mr. McDuff and Mr. Hall are well qualified by their experience in the field for this work.

New England Notes.

RECEIVED OFFICE OF THE ELECTRICAL WORLD
FROM THE HADLEY BUILDING 62 ATLANTIC AVE.
BOSTON, MASS., JAN. 1, 1894.

AN ELECTRIC PLANT is to be added to the new harness factory at Holliston, Mass.

THE BERLIN-MILLS COMPANY is about to add a new 150-h. p. engine to its pulp mill at Berlin Falls.

THE BOSTON ELECTRIC LIGHT COMPANY has declared a quarterly dividend of 2 per cent payable Jan. 15.

THE W. S. HILL ELECTRIC CO. has just got out a very handsome calendar which is being mailed to its customers and friends.

THE PERKINS ELECTRIC SWITCH MANUFACTURING COMPANY, of Hartford, Conn., has opened a Boston office at 620 Atlantic avenue. Mr. F. B. Smith is in charge.

THE BROWN ELECTRIC COMPANY is presenting to its many friends a very neat calendar in the shape of a pug dog. As the supply is limited, first come will be first served.

HILLINGS & SPENCER'S plant in Hartford, Conn., has been running on full time with about two-thirds the working force. Orders are coming in more plentifully and better business is looked for soon.

THE PRATT & WHITNEY COMPANY'S extensive plant at Hartford, Conn., is running with about 800 hands, but on short time. The company believes that business will pick up and that January will show a gratifying increase.

THE NEW ENGLAND TELEPHONE COMPANY has decided to complete the work of putting its wires and cables underground in Newton, and has asked to be allowed to build the necessary conduits on Washington, Watertown, Chestnut, Hall, Greenough, Hillside, Vernon, Franklin, Jefferson, Peabody and Park streets.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD
936 Monadnock Building, CHICAGO, Jan. 2, 1894.

THE METROPOLITAN ELECTRIC COMPANY, Chicago, is meeting much success with "Mac Tape," which, it is claimed, has superior insulating qualities, is not affected by acids and is guaranteed to withstand the severest climatic changes. It sticks to the wire and not to the hands, and will not oxidize the wire. Its adhesive qualities are such that it is practically indestructible and hence will not deteriorate with age, and it is specially applicable for armature and field magnet wrapping.

A SENSATION IN INCANDESCENT LAMPS.—The Star Electric Lamp Company has now on public exhibition on Michigan avenue, Chicago, Ill., three incandescent lamps that are creating quite a sensation in electrical circles. In appearance they are ordinary 16-c. p. lamps, but it is claimed that by actual measurement one of them gave 720 effective candle power, another 184, and the other 160. The light is perfectly white and steady while the filament seems scarcely larger than in the ordinary lamp. The lamps were connected directly to the Edison mains and the instruments showed that the lamps were burned at 111 volts. The amperes averaged, it is claimed by those present, one-eighth ampere per lamp. Inventor John Kammer stated that these unusual results were obtained by introducing into the bulb a peculiar vapor which he recently discovered. The difference in illuminating power is determined by the quantity of vapor in the bulb. Mr. Kammer's efforts are now being directed to perfecting a one-watt lamp, and from the results already secured with his vapor treatment he expects to place such a lamp on the market in a very short time.

OREGON CITY, Dec. 23, 1893.

POLE TAX.—It has been proposed to place a tax of \$4 per annum upon each electric pole in Portland, Ore.

THE OAKLAND, CAL., City Council is considering an ordinance which has been introduced providing for an annual tax of \$5 upon each telegraph and telephone pole in that city.

THE PORTLAND GENERAL ELECTRIC CO.'S new street lighting circuits are now in operation in the Woodstock, Waverly and Kenilworth districts, Portland, Ore. The company has resumed work upon its new breakwater on the East Side, in Oregon City.

THE CITY COUNCIL of Oregon City, Ore., is expecting to pass an ordinance, which has been introduced, for providing for charging all street railway companies operating freight cars on the streets, a license of \$300 a year. The East Side Railway Co. is doing a profitable business in hauling freight in electric cars, discharging it at the front doors of the stores.

THE WATERLOO DITCH AND POWER CO., of Waterloo, Linn Co., Ore., has been incorporated with a capital stock of \$6,000. The incorporators are: R. R. Humphrey, O. Jennings, George Medley, J. B. Wirt, A. G. McKee, and I. M. Knifong. Among the objects of the company are: The building and maintaining of an electric railway, telegraph and telephone lines, etc., between Waterloo and Albany, Ore. Also to operate a general electrical plant.

Canadian Notes.

OTTAWA, Dec. 30, 1893.

THREE RIVERS, QUE.—The latest phase in the electric light imbroglio is that the Royal Electric Company notified the Corporation of Three Rivers that they will shut down the lighting station on Jan. 15.

HAMILTON, ONT.—A contract has been awarded Loomer & Rose, Montreal, for steel rails for the Hamilton and Grimsby Electric Railway. The order was for 1,350 tons of rails, 1,200 tons of which are to be "T" rails and the balance girder rails. The rails were bought at less than one cent per pound.

VANCOUVER.—Notice is given that application will be made to the Legislative Assembly of British Columbia, at its next session, for an act to incorporate a company for the purpose of acquiring all property, both real and personal, tolls, rights, privileges and franchises of the Vancouver Electric Railway and Light Company, with power to purchase or lease the property and franchises of and amalgamate with any other railway or lighting companies.

English Notes.

(From our own Correspondent.)

LONDON, Dec. 20, 1893.

SECONDARY BATTERIES.—One of the many interesting points brought out in the papers read by Prof. Ayrton before the Institu-

tion of Electrical Engineers in 1890, and by Prof. H. E. Armstrong and Mr. G. H. Robertson in a paper read before the Royal Society in the following year, was the injury done to secondary batteries by leaving them for any length of time at rest. Sir David Salomons, whose book on the subject of accumulators was the first of its kind, now states that as a result of leaving some cells discharged for four years on a shelf that the plates are as good as ever, excepting that their color is bad. The charging of the plates after this long rest was done slowly and the surface scale was previously removed by a brush.

THE ELECTRIC LIGHTING OF EDINBURGH.—In his latest report to the Town Council of Edinburgh, Prof. A. E. W. Kennedy proposes a scheme which presents one or two novel points. His idea is to supply both North and South Edinburgh from one central station, but since the former is a compact business district, and the latter a particularly scattered residential area, Prof. Kennedy recommends that the three-wire system should be used in one case and the alternate current transformer system with transformers in the houses in the other case; both plants being housed under the same roof. For street lighting he recommends, since alternators will be available, at the station, the use of alternate current arcs fitted with a device now being tested by Mr. Ferranti for connecting the alternate currents.

BREAKDOWNS AT DEPTFORD.—The Deptford station was visited last week by a series of small misfortunes which by their concurrence resulted in the supply being partially interrupted for three days; the whole of the incident being typical of the danger of having a few large units. At the commencement of the week one of the two 1,750-h. p. sets was shut down in order that the machine might be altered so as to give 2,400 instead of 10,000 volts. The other 1,750-h. p. set was out of the running owing to damage to the spindle of the Corliss valve. Then one of the 750-h. p. sets was put out of action by something falling in the armature. This was followed by the governor of one of the 350-h. p. sets going wrong. Central stations, however, which have a number of small units capable of running in parallel, are not entirely exempt from breakdown. The week before last the Bankside station of the City of London Electric Lighting Co. was temporarily hors de combat. Some one accidentally broke the field circuit of a Mordey alternator, the armature of which thereupon short circuited the whole of the station with the result that every fuse went.

INSTITUTION OF ELECTRICAL ENGINEERS.—There have been periodical complaints from the telephone and submarine telegraph interests that their representation on the Council of the Institution of Electrical Engineers is totally inadequate. Some four years ago in answer to an agitation, several gentlemen, representing the telephone and submarine telegraph interests, were elected members of the Council, but as they neither attended the meetings of the Council nor offered themselves for re-election, they did not exert any appreciable influence on the affairs of the Institution and have now, like the "dodo," become extinct. A second agitation is now on foot. It is true that the telephone and submarine telegraph interests constitute a large proportion of the total members of the Institution, but as telephone and submarine telegraph men rarely, if ever, read papers, contribute to the discussion, or attend meetings of the Institution, it is scarcely right that they should be largely represented on the Council. There is some talk of forming a separate society, devoted to telephony and telegraphy. Although it is much to be desired that the Institution should embrace the whole of the electrical profession, I do not think that this threatened secession would materially affect the activity of this Institution.

News of the Week.

Electric Light and Power.

GENESEO, N. Y., has voted for electric lights.

KENTLAND, IND., is to have the electric light.

PEGGOTT, ARK., is to have an electric lighting plant.

SCOTLAND, DAK., is contemplating putting in an electric light plant.

SANDY LAKE, PA., will, it is said, soon be lighted by electricity.

BEVERLY, MASS.—A municipal lighting plant is being discussed.

SPIRIT LAKE, IOWA, will soon have an electric light plant in operation.

WINONA, MINN.—Bids are called for lighting the city, to be opened Feb. 11.

FAYETTE, MO.—The municipal plant is said to make a profit of \$60 per month.

GRAND RAPIDS, MICH.—Alderman Emmer favors a municipal lighting plant.

WADSWORTH, NEV.—Peter Evans, of Reno, proposes to put in an electric light plant.

RIPLEY, TENN.—An electric light plant will be established by the authorities at Ripley.

MILWAUKEE, WIS.—Mayor Koch favors the city owning its own electric lighting plant.

SPRINGFIELD, MASS.—The street lighting committee has reported against a municipal plant.

YATES CITY, ILL.—will issue \$5,000 bonds and put in an electric light plant with the money.

PICKENS, W. VA.—The Pickens Electric Company is in the market for an electric lighting plant.

ABERDEEN, SO. DAK.—The County Board contemplate putting electric lights into the Court House.

ALLIANCE, O. Business men are seriously considering the question of a new electric light plant.

UNION, O.—There is an active movement looking toward the formation of a new electric light company.

BEAVER, PA.—Architect Boyd, of Pittsburgh, has recommended that electric lights be placed in the Court House.

ARCHOBALD, PA.—The Crescent Electric Light Company, of Archobald, is preparing to extend the scope of its work.

KEYSER, W. VA. Messrs. Henry G. and T. B. Davis will, it is reported, put in an electric light plant in the spring.

ASTORIA, ILL.—Editor Jones and Charles Foote, from Ipava, have made a proposition to establish an electric light plant.

PLAQUEMINE, LA.—At the January meeting of the City Council the question of an electric light plant will be considered.

ARCHBALD, PA.—The Raymond Coal Company is erecting poles along Main street for the purpose of running electric light wires.

CASTLETON, N. Y.—A special election of taxpayers has been called in the matter of voting for an appropriation for electric lighting.

WINFIELD, KAN.—G. P. Tomlinson and L. F. Duggan, of the Neosho, Mo., Electric Supply Company, propose to install a lighting plant here.

OGDEN, UTAH.—A franchise has been granted to the Pioneer Electric Power Company for lighting, heating, manufacturing and other purposes.

CANANDAIGUA, N. Y.—The Canandaigua Electric Light Company has extended its poles to Shortsville, and will light up that promising village.

GALVESTON, TEX.—The city authorities will inquire into the advisability of the city owning its own waterworks and electric light plant.

EL RENO, O. T.—An electric lighting franchise has been granted to the El Reno Heat, Light and Power Company, the plant to be completed in four months.

JAMESTOWN, N. Y.—A committee has been appointed to investigate the municipal plant, run by the son of an alderman. Gross frauds are charged.

PATERSON, N. J.—Mr. John F. Noonan opposes a municipal plant and says that a 600-light plant would cost \$560,000 and deteriorate 20 per cent. a year!

CHICAGO, ILL.—Through the persistent efforts of City Electrician Barrett, the Council has passed an ordinance for the extension of the municipal electric light plant.

SHORTSVILLE, N. Y.—The Canandaigua Electric Light Company have extended their poles to Shortsville and will light up that promising little manufacturing village.

NEW WHATCOM, WASH.—A new company has applied for an electric light franchise, the intention being to utilize the water power of Whatcom Creek, which is rated at 20,000 h. p.

LITTLE FALLS, N. Y.—The Little Falls Electric Light and Power Company has bought one of the prize dynamos exhibited at the World's Fair, to be used on the commercial arc circuit.

MILFORD, MASS.—All the electric light property in Milford has been bought by the Milford Electric Light Company, and improvements and extensions will be made. Stanhope T. Nolley, of Milford, is manager.

ST. CHARLES, MO.—The City Council has been petitioned by four different companies to grant them a franchise for an electric light plant. Troy, Mo., says it would be glad to see one of the companies come up its way.

HARTFORD, CONN.—President Dunham, of the Hartford Electric Light Company, has informed the city authorities that the new incandescent arc lamp was proving very satisfactory, and that it was the intention to replace all of the street lamps with these.

MERIDEN, CONN.—The following have been appointed a committee to look into the matter of an electric lighting plant for the city and to investigate the light now being furnished by the local company: Amos Ives, T. M. Crowley, Eugene Blake and H. T. King.

BUCKSPORT, ME.—The canvas in the matter of electric lighting for Bucksport is meeting with much success, and it is almost certain that Charles Moxfield, of the Fairfield (Me.) Electric Light Company, will carry on and enlarge the business of the former local company.

NIAGARA FALLS, N. Y.—The result of the many complaints

against the Buffalo and Niagara Falls Electric Light and Power Company, has been that the Board of Public Works is authorized to ascertain the cost of an electric lighting plant, to be built and operated by the city.

PRAIRIE DU CHIEN, IOWA.—The City Council has passed an ordinance granting the Prairie City Electric Company an exclusive franchise for ten years, for constructing and maintaining an electric light and power plant in that city. The ordinance is void if the company fails to have its plant in operation six months from date.

ELK POINT, DAK.—William Dupont, by his attorney, Ira L. Nichols, appeared before the City Council at its last regular session and made the proposition that if the city would grant him the franchise and guarantee him a certain amount of patronage, he would place an electric light plant and system of waterworks in the city. The citizens look upon the proposition favorably, and work will probably be begun upon the improvements in the early spring.

BELLEFONTAINE, OHIO.—Robert Colton has proposed, in consideration of a franchise for electric lighting and a street railway, to furnish not less than eighty 2,000-c. p. arc lights, all night, for \$88 per annum. The privilege to be granted for ten years, the town to have the right to purchase the electric light plant at the end of any year, at a price to be fixed by a committee or at 10 per cent. advance on its cost.

THE KEESVILLE, N. Y., Electric Light Co. has sold its plant at Keesville to Morse Bros., formerly of the Electric Construction Co., of Greenwich, N. Y., and more lately of the Consolidated Electric Co., of Greenwich, N. Y. The Morse Bros. have considerable property in Greenwich which was given in exchange part payment of the plant. The owners of the Keesville Electric Co. have been very anxious to dispose of their property in order to invest in the electric railroad, which has been surveyed from Greenwich to Schuylerville, and a local manufacturer has been induced to construct a dam in exchange for the property mentioned above.

The Electric Railway.

ATTLEBORO, MASS.—A receiver has been appointed for the Inter-state Electric Railway system.

BERLIN, ONT., CANADA.—Incorporation is being asked for a company which proposes to build an electric road between Berlin and Preston.

DANVILLE, ME.—Ricker Brothers, of Danville, are receiving estimates for their proposed electric road from Danville Junction to Poland Spring House.

ITHACA, N. Y.—The Ithaca Street Railroad Company has filed certificate of increase of capital stock from \$175,000 to \$250,000.

LOCKPORT, N. Y.—E. M. Ashley, of the Lockport Street Railway, says that the road to Oleott, 12 miles long, will be built during the coming summer.

FALL RIVER, MASS.—The plan proposed some time ago for building an electric railroad between this city and Stone Bridge, Tiverton, is in a fair way to be realized.

PETERSBURG, PA.—A preliminary survey is now being made by Major W. J. Gordon, of Fredericksburg, Va., for the Atlantic Coast Line for a belt line around Petersburg.

POTTSTOWN, PA.—The line of the Ringing Rocks Electric Railway Company is being located. The length of the road will be 3¼ miles with a maximum grade of 5 per cent.

FROM LOWELL (MASS.) TO THE SEA.—It is proposed to construct a State highway from Lowell to Newburyport, the plan of which includes a way for an electric railroad.

HARTFORD, CONN.—President Dunham, of the Hartford Electric Light Company, informed the city authorities that a storage battery street railway service would be in operation within six weeks.

GOSHEN, N. Y.—Secretary Wightman, of the Middletown-Goshen Traction Company, states that the company is prepared to build the line as soon as franchise is granted by the Board of Trustees.

WHITINSVILLE, MASS.—The Selectmen of Northbridge, Mass., will meet in the matter of granting a franchise to the Whitin Machine Works, to build and operate a private electric line from Whitins village to Northbridge, about 1¼ miles.

MILWAUKEE, WIS.—The Peterson Electric Railway System has been on exhibition. A model car has been running back and forth over a track, an automatic reversing arrangement reversing at each end of the track.

BOONSBORO, MD.—The officers of the electric railway company have decided to erect the power house in Boonsboro, and land has been bought and laid out on North Main street. Contractor Mosher has the building contract. There is talk of extending the road to Smithsburg.

PHILADELPHIA, PA.—The decision of the Dauphin County Court has put new life into the North Eastern and Quaker City Elevated roads, and President Bucholz states that work will be pushed as soon as the temporary injunctions issued by the courts of Philadelphia can be removed.

JERSEY CITY, N. J.—The Jersey City "Journal" is responsible for the statement that the Jersey City, Hoboken and Rutherford Electric Railroad Company is to have an elevated track from the top of the Palisades to a space adjoining the property of the Hamburg Steamship Line in Hoboken, to cost at least \$750,000.

EXETER, N. H.—At a meeting of the Exeter Street Railway Company, held at the office of Hon. E. G. Eastman, at Exeter, N. H., Simon W. Hathaway, of Boston, presented an offer of a Boston syndicate, which proposes to purchase and extend the road. It was decided to lay the matter over for a few days.

FALL RIVER, MASS.—A company has been formed here to build an electrical railway from Fall River to Stone Bridge, Tiverton, and the Globe Street Railway Company is behind the scheme. The president of the new company is Daniel T. Church of Tiverton; Weaver Osborn and George W. Slade, of Fall River, are interested parties.

BATTLE CREEK, MICH.—Edward C. Hinman has been appointed receiver of the Battle Creek Electric Railway. He has not yet been put in possession of the road, but he has stated his policy, which is to put the road in running order as soon as possible. The experts who were employed to make estimates as to cost of remodelling the road, have not yet filed their report.

MIDDLETOWN, CONN.—The Middletown Electric Road Company will equip with electricity and extend its tracks next spring to Meriden and neighboring suburban villages. When the bridge to Portland is constructed the tracks will be laid across to Portland up along the river meeting the Glastonbury road. Hence another winter will see a net work of electric roads connecting Hartford, New Britain, Meriden, Middletown, Portland and Glastonbury. A summer resort will be established at Black Pond, which lies just about half way between this city and Meriden.

THE UNION RAILROAD COMPANY, of New York, has filed with the Secretary of State a statement of its proposed extensions, which contemplate a system of intercommunication in the upper part of New York City. The proposed extensions are as follows: From Third avenue to Eighth avenue; on Madison avenue from the bridge to One Hundred and Thirtieth street; on One Hundred and Thirtieth street from Madison avenue to Eighth avenue; over the bridge across the Harlem River from Third avenue to Second avenue, and along Second avenue to One Hundred and Twenty-fifth street; along Fourth avenue to One Hundred and Twentieth street to Madison avenue, and from Washington Bridge to Boscobel avenue and along that avenue to Jerome avenue; along Broadway to the city line.

Personal Notes.

MR. CHARLES A. SCHIEREN, who was elected Mayor of



Brooklyn last November by such an overwhelming majority, was installed in office with appropriate ceremonies on the first day of January. The expectations of those who cast their ballots for Mr. Schieren have been abundantly met by the excellent appointments he has thus far announced, although naturally many of them have not met with the approbation of professional politicians. With the assurance given by these appointments, that Mr. Schieren means to carry out the promises upon which he was elected, and with the admirable business qualifications which have

brought about his great success in commercial life, the citizens of Brooklyn may congratulate themselves upon the prospect of an able and upright administration, like that enjoyed under Mayor Low.

MR. WILLIAM J. HAMMER and Miss Alice Maud White, of Cleveland, Ohio, were married in that city, on Wednesday, Jan. 3. Mr. Hammer's name has long been a familiar one in electrical circles and his many friends will join us in extending to him our heartiest congratulations.

MR. HORATIO A. FOSTER was married at Chicago, on Dec. 22, to Miss Florence Louise Root, of Keokuk, Iowa. After the ceremony the happy couple left for New York, where they will make their home. Mr. Foster is well-known in the electrical field and has the congratulations and best wishes of his many friends.

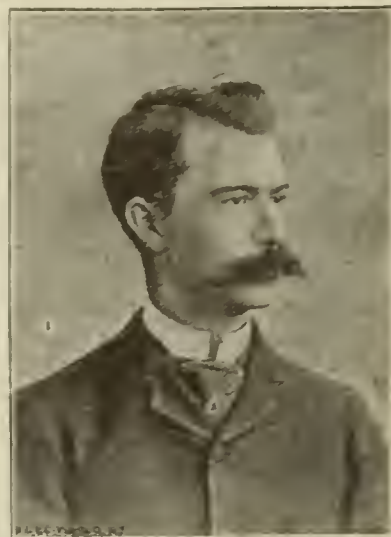
MR. GEORGE H. BABCOCK died on Dec. 16, less than three weeks after the burial of Mr. Stephen Wilcox, his partner in the world-wide known firm of Babcock & Wilcox, manufacturers of boilers. The close personal association of these gentlemen, aside from purely business matters, was well known and it seems almost more than a coincidence that they should have thus passed out of the world so closely together.

WILLIAM HERBERT PARKER died in England, December 18, after a lingering illness. Mr. Parker was educated at Bradford College and afterward took a technical electrical course at the

Hanover Square School of Electrical Engineering. He was at one time on the editorial staff of the London "Electrical Engineer."

MR. FREDERICK BATHURST, on Dec. 16, suffered a sad affliction in the death of his father in England, to whose bedside he had been called from America.

JUDGE E. A. ARMSTRONG, the popular president of the National Electric Light Association, is looking forward to a most interesting session of that organization at the next annual meeting, which is so soon to take place at Washington, D. C. The National Capital was happily chosen for the gathering of the clans, and the social features of the occasion will no doubt play a more prominent part than usual. The wide personal acquaintance of Judge Armstrong among those identified with the electric lighting interests and his well-known energy and his peculiar fitness for the position he holds render it certain that everything will be done which can contribute to the success of the convention. The electric lighting field is sure to prove an interesting one during the coming year in view of the expiration of the Edison lamp patent.



MR. WILLIAM RICHARDSON, for many years president of



the Atlantic Avenue Street Railroad, Brooklyn, died at his residence, 125 South Oxford street, Brooklyn, on Dec. 31, aged 72 years. Mr. Richardson came to America from England when 12 years old, and was engaged in the newspaper business in various capacities, from an early age up to the outbreak of the Civil War, when he was appointed a paymaster in the United States army. Four years later he became superintendent of the Dry Dock, East Broadway and Battery Railroad Company, from which position he quickly passed to director and president of the road. In 1867, Mr. Richardson

became the sole lessee and proprietor of the Brooklyn and Jamaica Railroad Company, and afterwards built up the Atlantic avenue system, with which his name was strongly identified up to about a year ago, when the various roads included in it were sold to the Brooklyn Traction syndicate. Mr. Richardson served as clerk to the New York State Assembly previous to the war, and also temporarily as Speaker, and was an Alderman in Brooklyn from 1870 to 1872. He was always prominently identified with the temperance movement, and from his devotion to the interests of the Baptist Church, was familiarly referred to as "Deacon" Richardson by newspapers, in which he at times figured largely on account of his determined fights against the elevated railroad and other interests opposed to his own.

Miscellaneous Notes.

STREET MAIL CARS.—Postmaster-General Bissell recommends the employment of electric street mail cars in cities.

AT THE DECEMBER MEETING of the directors of the Massachusetts Institute of Technology, the reports showed that the largest number of students are following the course of electrical engineering during this year. Mechanical and civil engineering and architecture follow in the order named. The total number of students is now 1,153.

THE FRANKLIN ELECTRICAL SOCIETY will, on Jan. 6, give a banquet in commemoration of Benjamin Franklin at "The Columbia," Union square, New York. The committee in charge are Messrs. A. A. Hammerschlag, Newton Harrison, Louis Wasself, Max Meyer, and Ernest V. Lallier. Mr. Wallace W. Ker will officiate as toastmaster, and the following gentlemen will respond to the toasts: Mr. Newton Harrison, "Benjamin Franklin"; Mr. E. V. Lallier, "Electrical Terms and Phrases"; Mr. Max Meyer, "The Ladies"; Mr. A. A. Hammerschlag, "The Franklin Electrical Society."

ELECTRICITY IN NAVY YARDS.—A board has been selected to inquire into the advisability of operating all electrical appliances at the New York and Norfolk Navy Yards. The Navy Department believes that this can be done, and that it will result in an economy of money and power. The board selected will meet at the Brooklyn yard at once. It consists of Commander Washburn Maynard, Lieutenant J. D. Murdoch, and Prof. O. G. Dodge. The latter is an expert electrician, who has been on duty at Chicago.

SCORING BY ELECTRICITY.—At the bicycle tournament in the Madison Square Garden, the chief electrician of the Garden,

Mr. Frank Marth, arranged a system for scoring by means of incandescent lamps. On each of a number of perpendicular poles ten incandescent lamps are suspended; when a rider makes a lap his scorer hangs a loop and the first light blazes up; so on each lap until the ten lamps are lighted, when they are extinguished by taking off the loops and the rider is credited with a mile with placards. As a check, there is another scorer recording each contestant's laps in the regular book.

THE AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION has issued a circular, which will be sent to fellows of the Association, to members of the medical profession, to electrical experts and to manufacturers of electrical appliances for medical work, containing titles of all the committees, the members serving on them with their addresses and the matter prepared for discussion and investigation by each committee. Manufacturers are asked to submit instruments for examination, and physicians, electrical experts and manufacturers are requested to co-operate in making suggestions and in relating their experience and preference for instruments, with reason and data. The circular gives full details as to points to be considered.

ELECTRIC WATER SUPPLY RECORDS.—City Engineer Jackson, of Boston, recommends the connection of the city water service pipes with the central office by electrical means, in such a way that the water department superintendent may be informed by a glance at automatic records the pressure in the mains in various parts of the city, and the state of the numerous valves, whether open or shut. By this means a break in the mains would become at once apparent, and a check would be had in regard to work on cut-out pipes. It was also recommended to show by the same means, in the central office, the height of water in the reservoirs.

THE SYRACUSE (N. Y.) STORAGE BATTERY COMPANY has a street car propelled by storage batteries running at Onondaga. The total run on one charge of the batteries was 125 miles. The car makes daily from 64 to 90 miles without a break in the service. The 125 miles run was made on a seven hour charge. There are 96 cells used in the car. The motor is a single 30-h. p. Rae type, with truck made by the McGulre Company, of Chicago. The motor and truck were purchased of the Detroit Electrical Company. The motor is wound for 190 volts. The voltage of the 96 cells at the start of the 117 mile trip was 204; at the end 192 volts, a loss of only 12 volts in a day's trip. The car is lighted from a bank of 24 cells with 48 volt incandescent lamps.

AN ELECTRICAL FOUNTAIN.—The Bubler Publishing Company, of Lynn, Mass., displays a miniature electric fountain in its show window, designed by E. T. Bubler. Incandescent lamps are arranged in a parabolic reflection situated in the bottom of a tubular receptacle of zinc which is about three feet high and some twenty inches in diameter. The lamps are incandescent and the bulbs are of six different colors, two shades of red, two of green, and one each of blue and green. Above the reflection is a screen of uncolored glass fitting into the scenic receptacle so as to be water tight, and an ingenious arrangement of valves allows the water which is projected some three feet in height to be diversified in the shape and number of the jets, while by means of the switches that control the lights, the colors can be so changed as to afford considerable variety of shade.

CANAL NAVIGATION—M. De Puy, in a letter to the New York "Tribune," says that with steam power canalboats it costs only a fraction over a quarter of a mill per ton per mile to move freight. He is sceptical of any increase of speed with the present depth of water in the Erie Canal, and says that steamers often tow canal boats so fast that they strike the bottom of the canal. Referring to the advantages of steam canalboats he says that "The present rate for towing a boat load of grain from West Troy by towing companies to New York is \$28, or \$112 for four boats, while a steam canalboat brings its three consorts down the river at one-quarter of the latter sum, making a saving of \$84 on each down trip. Still another highly important point in favor of steam power is that it is independent in the harbors of New York and Buffalo, while trolley boats must look for tugs to tow them.

THE ELECTRICAL WORKERS' UNIVERSITY EXTENSION SOCIETY has been formed under the auspices of Columbia College. A course of ten lectures has been arranged to take place in the large hall of Cooper Union, and President Seth Low, of Columbia College, has agreed to contribute \$1,000 for the expenses of the course, provided no admission fee is charged. Members of the society will be charged \$2 for the whole course and outsiders will have to pay 25 cents admission to each lecture. After the first lecture a free class will be formed, taught by W. H. Freedman, tutor of electrical engineering in Columbia College. The course is as follows: 1. Batteries, Primary, Secondary and Thermo, by C. O. Mallou; 2. Dynamos and Motors, Direct Current, by S. S. Wheeler; 3. Alternating Dynamos and Motors, by W. F. Stanley; 4. Electrical Measurements, by A. E. Kennelly; 5. Lighting, by Prof. F. B. Crocker; 6. Power, by Nikola Tesla; 7. Street Railways, by T. C. Martin; 8. Telegraphy, by William Mayer, Jr.; 9. Electrical Alarms, by William Mayer, Jr.; 10. Telephones, by J. J. Carty. The officers of the society are: M. J. O'Connor, president; William Ivory, vice-president; C. H. Hines, secretary; A. J. Kelly, treasurer, and F. E. Alexander, librarian.

A NEW TELEPHONE.—A telephone company that is to be a rival of the Bell monopoly was incorporated at Madison, Wis., with a capital stock of \$500,000, by A. B. Ferdinand, H. C. Dodge, and Edward W. Spencer, of Milwaukee. The name of the new concern is the Northwestern Telephone and Electric Company. It will not begin operations until after Jan. 30, when the last of the Bell Company's patents will expire. The company will not duplicate the Bell instrument. The incorporators say their telephone possesses great advantages over the ones now in use, and claim it gives a clearer and more distinct transmission. Among the improvements is an automatic switch arrangement which makes it possible for a half-dozen subscribers to use the same line, which, by an automatic arrangement, will prevent all the other subscribers on the line from talking or from hearing the conversation going on. It is the object of the company to manufacture telephones and establish telephone exchanges. The office, headquarters and factory of the company will be in Milwaukee. A few of the telephones are now being made, with the exception of those parts upon which the patents have not expired. They are being made up piecemeal. The company has taken no steps toward procuring a factory where the instruments and supplies will be made. The Northwestern Company is the first company in the field, besides the Bell companies, to be incorporated, though there is at present a company being organized in Chicago to operate upon much the same plan as the Northwestern Company.

Trade and Industrial Notes.

THE NATIONAL THERMOGRAPH AND ELECTRICAL COMPANY, of Chicago, is now located in Rockford, and the company expect to give employment to 500 men.

THE RAILWAY EQUIPMENT COMPANY, 81 East Front street, Cincinnati, Ohio, is presenting its friends and patrons a handsome bronze paper-weight in the form of a trolley car.

THE PETTINGELL-ANDREWS COMPANY, 192-202 Summer street, Boston, has issued a handsome and convenient calendar which it is sending out to its friends and patrons.

THE NEW CASTLE (DEL.) STREET CAR WORKS, one of the largest and best equipped plants in the United States, was almost destroyed by fire on Dec. 22. The loss is \$12,000, partially covered by insurance.

THE WHEELER CONDENSER AND ENGINEERING COMPANY, 39 and 41 Cortlandt street, New York, has recently made many new and important improvements at its works, Cartaret, N. J. Its surface and admiralty condensers are so favorably known that comment is unnecessary.

THE GENERAL ELECTRIC COMPANY'S repair shops at Atlanta, Ga., are to be closed. Mr. Fred Miles, who has been in charge of these shops, is to open a repair shop of his own in Atlanta, under the name of The Southern Electric Works, for the repair of all kinds of electric apparatus.

HUEBEL & MANGER, 289 Graham street, Brooklyn, have issued a handsome catalogue of bells, push buttons and other electrical goods manufactured by them which dealers in house goods will do well to send for. The articles are principally of standard form, but notable improvements in details have been introduced.

J. W. PENFIELD & SON, Willoughby, Ohio, have issued an 80-page catalogue of imperial friction clutches, cut-off couplings, iron and wood pulleys, and pulley and shafting fittings. Those interested will find considerable technical matter of value, as well as detailed descriptions of the well-known transmission devices of this company.

THE MECHANICS' GENERAL MANUFACTURING COMPANY of St. Paul has filed articles of incorporation. The capital stock is \$10,000,000, and the business is the manufacturing of electric motors, hardware and aluminium wares, novelties, machinery, tools, etc. The incorporators are Darwin H. Kent, Paul and A. A. Price, F. M. Johnson, P. L. Uttley and C. J. Backus of St. Paul.

QUEEN & CO., Philadelphia, have a very excellent portable tachometer by means of which the speed of engines, dynamos and motors, can be quickly and accurately determined. It is compact, convenient to handle and will indicate revolutions up to 3,000 turns per minute. They also have stationary types for permanent attachment. In the economical operation of a lighting or power plant it is highly necessary to run a dynamo very close to schedule speed, which can only be determined by an instrument such as the above.

THE BALL ENGINE COMPANY, Erie, Pa., through its late Eastern agent, F. R. Chinnock, has sold the following engines during the past few months: J. M. Iver Co., Danbury, Conn., one engine; Ridgewood Electric Light and Power Co., Ridgewood, N. J., one boiler; Brooklyn Navy Yard, one 100-h. p. heavy duty engine, for running saw mill; General Electric Co., for Hot Springs, Va., increase, two engines, one boiler; Imperial Hotel, New York City, one 150-h. p. engine; Messrs. Schwarzenbach, Huber & Co., Union Hill, N. J., one boiler, for export to Cuba, three engines; Big Four R. R. Co., Indianapolis, Ind., complete steam plant, including two engines and three boilers; John Good Rope, Cordage and Ma-

chine Co., Ravenswood, L. I., one 600-h. p. cross-compound engine.

MR. F. R. CHINNOCK, who for the past two years has been the general Eastern agent of the Ball Engine Co., of Erie, Pa., has resigned his agency of that company, and will again enter the electrical field, in which industry he was so long and successfully identified. While Mr. Chinnock has been very successful as the agent of the above company, he feels that he will be still more successful in the larger and broader field of electricity, in which line he met with such flattering success as the agent of the Edison General Electric Co., with whom his many friends will remember he was associated for eight years.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 36 Cortlandt street, this city, has increased its capital stock from \$20,000 to \$250,000. The stock of this corporation is held entirely by its officers and employees. This company has been very successful in its patented specialties, and especially with its Mesco dry battery, which is having a large sale. Over 20,000 of these dry batteries were sold during the year 1893 to telephone companies for use on long distance telephone transmitters; the batteries are holding out remarkably well for this service, and were adopted only after a long and careful test.

THE E. P. GLEASON MANUFACTURING COMPANY, 181 to 189 Mercer street, New York, is now preparing a distinct novelty in its standard reflector pendants for electric illumination. For some time it has made a number of different patterns in this line of manufacture, for from two to eight lights in a cluster, with a white porcelain stack, to reflect the light; these have been very successfully introduced and recently the new building of Brokaw Bros. was completely equipped with them. The new style is simply a difference in the porcelain reflector, which is covered with quicksilver and the under surface corrugated, so as to better diffuse the light.

THE ADAMS ELECTRIC COMPANY has been recently formed at Worcester, Mass., for the manufacture of Mr. A. D. Adams' line of improved dynamos and motors, which new machines will be of the same general type of his former ones, and embody his

well-known forged iron field magnet construction, and several other improvements. In view of the fact that armature burn-outs are due to the destructive action of heat on the cloth and paper usually employed to insulate armature cores from their windings, it has been decided to use a fireproof material for the insulation of all armature cores in the new machines. This construction is a distinct advance on the present state of the art. The line of dynamos and motors manufactured at present will cover the usual sizes from 1 to 20 kw., and shipment of any of these can be made during January. A large well-lighted shop has been fitted up at 100 Beacon street, Worcester, for the manufacture of the above machines, and the company already have several orders in hand.

THE HUBLEY MANUFACTURING COMPANY, Lancaster, Pa., has elected as president Henry Baumgardner; treasurer, D. B. Shenk, and seven directors, as follows: Henry Baumgardner, John E. Hubley, F. H. Stacy, N. M. Woods, Geo. N. Reynolds, Dr. M. L. Herr and D. B. Shenk. The capital stock was fixed at \$200,000, and the charter was directed to be applied for at once. The company will take up the patents, inventions and designs of the business carried on for the past several years by John E. Hubley and Henry Baumgardner, at Duke and Vine streets, the business having outgrown its original limits and warranting a very considerable extension. In the new plant on the Pennsylvania Railroad, on the extension of Shippen street, the new company will manufacture a large line of electric, steam and mechanical toys, indestructible malleable iron and steel toys, cast-iron toys, electric motors, electric apparatus; also, specialties in cabinet, stationer's and staple hardware, and a complete list of novelties of original designs for the toy, stationer's and hardware trade.

Business Notice.

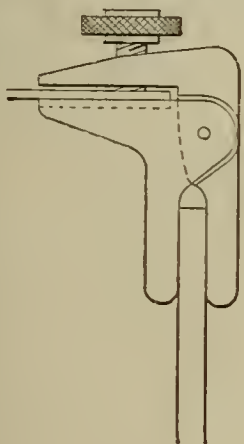
BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

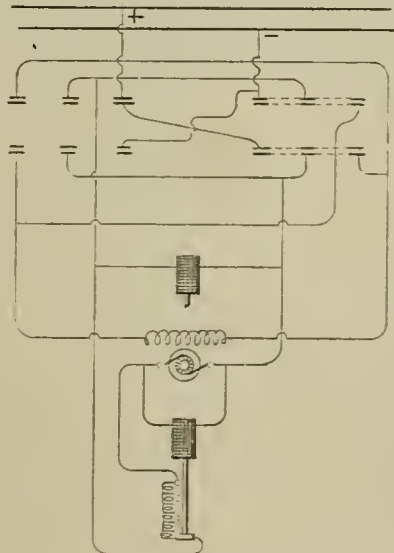
U. S. PATENTS ISSUED DEC. 19, 1893.

510,889. TEMPERATURE REGULATOR FOR ELECTRIC HEATERS; A. M. Butz, Oak Park, Ill. Application filed Dec. 24, 1892. The combination with the resistances and their circuits of the corresponding mercury cells and a compound rheostat having graduated pins adapted to dip into the cells and complete the circuits successively.

510,892. BRUSH HOLDER; J. R. Coffman, Detroit, Mich. Application filed Dec. 9, 1892. In a brush holder for dynamos and motors the combination of a support or frame, a carriage movable therein, a loose shaft mounted in the support, a coiled spring connected with the loose shaft and carriage means for rotating



NO. 510,898.—ELECTRICAL CONNECTOR.



NO. 510,932.—ELECTRIC ELEVATOR.

the loose shaft to adjust the tension of the spring and means for locking the shaft in its adjusted position.

510,898. ELECTRICAL CONNECTORS; F. G. Curtis, New York. Application filed Feb. 13, 1893. An electrical connector consisting of two jaws of conducting material, pivoted together at a point intermediate of their own length, one of the jaws carrying a binding screw at one of its ends adapted to bear against the conductor supported by the corresponding end of the other jaw, and the opposite ends of the jaws constituting a clamp. (See illustration.)

510,921. ELECTRIC PUMP; F. W. Merritt, Duluth, Minn. Application filed Dec. 2, 1892. The combination with a pump and electric motor connected therewith of a controlling device comprising a cylinder connected with the compressed air cylinder of a pump, a piston arranged to work in the cylinder, and a circuit-

maker and breaker connected with the piston and controlling the circuit between the generator and motor.

510,929. SYSTEM OF TELEGRAPHY; J. A. Parker, St. Louis, Mo. Application filed July 30, 1892. In a telegraph apparatus, a series of depression keys, a source of electrical energy composed of suitable subdivisions adapted to generate currents of variable intensity and polarity, conducting wires leading from these subdivisions and adapted to make electrical contact with each key of the series, a second series of conducting wires leading from the keys, a rotadrum adapted to conduct the respective currents from the second series of conducting wires, and a single line wire for communicating the impulses formed on the depression of the keys.

510,932. ELECTRIC ELEVATOR; F. A. Perret, Brooklyn, N. Y. Application filed Nov. 12, 1892. The combination of an electric motor and its circuit, an electric switch controlling the circuit, a locking device for the switch when in its "open" position, a rheostat in the motor circuit and an electro-responsive apparatus operating the rheostat and the locking device. (See illustration.)

510,947. ELECTRIC LOCOMOTIVE; C. F. Winkler, Troy, N. Y. Application filed March 11, 1893. An electric motor having two armatures included in a single field magnet circuit, two car axles respectively connected with the armatures and a field magnet divided into two parts, magnetically connected together, the joint being yielding and in a vertical plane. (See illustration.)

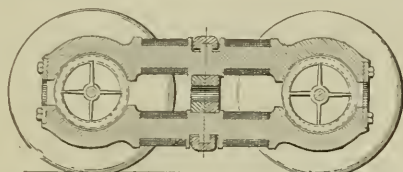
510,952. BRUSH HOLDER FOR DYNAMO-ELECTRIC MACHINE; F. E. Averill, Syracuse, N. Y. Application filed Feb. 13, 1893. In a brush holder for dynamo-electric machines, the combination of a supporting spindle, a brush holder frame loosely mounted on the spindle and having one extremity adapted to support the brush, an arm fixedly mounted on the spindle and arranged between the two extremities of the holder frame, and a spring having one end connected to the arm and the other to the opposite extremity of the holder frame.

511,005. TELEGRAPHIC RELAY; Edward Weston, Newark, N. J. Application filed June 4, 1891. The combination in an electrical apparatus of a magnet, a coil rotary on a diametral axis in the field of force of the magnet, a pivot shaft supporting the coil and two springs, both applied to the shaft near one end.

511,017. ELECTRIC RAILWAY SWITCH AND CROSSING; W. W. Hendrix, Bowling Green, Ky. Application filed Aug. 5, 1892. In a switch or crossing, a sliding block, its upper part consisting of flanges, its lower part consisting of a cylinder and its front and rear ends consisting of connecting strips.

511,018. ELECTRIC RAILWAY TROLLEY; W. W. Hendrix, Bowling Green, Ky. Application filed Aug. 5, 1892. An attachment for electric railway trolleys consisting of two jaws hinged one on each side of the trolley, the upper ends of the jaws having their front edges beveled to the rear, the upper ends adapted to overlap over the wire, suitable springs connecting the jaws above their hinged point.

- 511,019. **ELECTRIC RAILWAY TROLLEY**; W. W. Hendrix, Bowling Green, Ky. Application filed Oct. 7, 1892. An overhead trolley having its lower end pivoted in a swiveled boot, the trolley-pole bearing against its under side one end of the coiled spring, the coils of the spring passing around the pivot and the other end of the spring bearing against the bottom of the boot.
- 511,049. **ELECTRIC ARC LAMP**; A. Hormel and G. S. Junginger, New York. Application filed March 24, 1893. In an electric arc lamp, a spirally grooved carbon rack in combination with the springs having pins projecting into the grooves of the rack, and set-screws pressing upon the springs and holding the pins in the groove of the rack.
- 511,081. **TELAUTOGRAPH**; R. M. Hunter, Philadelphia, Pa. Application filed May 26, 1893. The combination of a line circuit, a source or sources of positive and negative electricity, hand-controlled devices between the sources of electric energy and the line for causing an alternating variable potential current to flow over the line circuit, electro-magnetic devices at a distant place operated by the positive and negative impulses in the line, and common marking or tracing devices moved by the electro-magnetic devices operated by the alternating variable potential current of the line, and common marking or tracing devices operated by the electro-magnetic devices.
- 511,118. **MAGNETO-TELEPHONE**; J. A. Brown, Moline, Ill. Application filed Aug. 16, 1893. In a telephone, a magnet, a coil or



NO. 510,947.—ELECTRIC LOCOMOTIVE.

- solenoid, and acute mounted for free horizontal movement in the direction of its length and having a coil and armatures at one end and a spring armature at the other end.
- 511,131. **ELECTRIC RAILWAY SIGNAL**; Jose Ortega y Espinosa, Mexico, Mexico. Application filed Oct. 26, 1891. Contact-making devices for a roadbed consisting of a set of curved longitudinal metal strips insulated from each other and provided with downward extensions and electro-magnets and armatures for connecting or separating these strips by the action of the electro-magnets.
- 511,157. **HAND REGULATORS FOR ELECTRIC MOTORS**; W. D. Packard, Warren, O. Application filed Dec. 8, 1892. In a rheostat, a frame extending across the face, a shaft mounted in the frame, a sweep-arm on the inner end of the shaft, and a spring-impelled balance wheel fast on the outer end of the shaft.
- 511,159. **PRIMARY ELECTRIC BATTERY**; E. Poppowitsch, Brooklyn, N. Y. Application filed Dec. 28, 1892. In an electric battery, a packing for separating the positive and negative plates composed of a mixture of saw-dust, sea-salt, salammoniac, bichromate of potash, mercury, granulated manganese and concentrated sulphuric acid.
- 511,163. **SIGNAL FOR CABLE RAILWAYS**; J. Sachs, New York. Application filed Aug. 4, 1893. The combination with a vehicle and a cable for moving same of signal boxes adjacent to the cable, an electric circuit connecting the signal boxes with the central station and devices that can be actuated from either end of the car for operating the signal boxes by the movement of the cable and car.
- 511,167. **LABEL HOLDER**; J. H. Shaffer and E. Horovsky, Allegheny, Pa. Application filed Dec. 21, 1892. The combination with a bolt or traveler of a tumbler engaging with the traveler and locking the same, the tumbler being formed of magnetizable material, and a magnet for withdrawing the tumbler from engagement with the traveler to release same.
- 511,172. **TELEGRAPHIC TRANSMITTER**; H. F. Stinde, Red Bud, Ill. Application filed May 4, 1893. The combination of exposed conductors, a series of fixed frames each having a yielding limit-stop near the conductors, a key rod guided in each frame, and a spring supported by the frame in the path of the key rod and with its free end adapted to impinge against the spring stop as it moves away from the exposed conductors.
- 511,173. **ELECTRICALLY OPERATED RAILWAY SWITCH**; C. A. Stone, Newton, and E. S. Webster, Boston, Mass. Application filed Aug. 30, 1892. In an electric railway system a pair of railway-switch magnets, each in an independent circuit from the main conductor, which circuits are respectively closed by a switching device which is automatically operated by a current different in intensity from that of the others, but all drawn through the trolley of a passing car.
- 511,187. **ELECTRIC REGULATING SWITCH**; E. A. Barber, Watertown, N. Y. Application filed June 26, 1893. In an electric switch operated directly by a solenoid acting on an iron core, the combination with the solenoid and the iron core of a piece of soft iron located at one end of the solenoid to act as a brake to prevent oscillation of the switch.
- 511,188. **ELECTRIC SIGNALING DEVICE FOR HOSE**; G. L. Barnard, Milwaukee, Wis. Application filed Aug. 22, 1892. The combination with a hose of electric circuit wires corrugated or

repeatedly bent and arranged spirally within the wall of the hose, extending throughout the length of the hose, and suitable means for making electrical connections with the ends of the wires.

- 511,196. **ELECTRIC MOTOR**; O. F. Conklin, Dayton, O. Application filed July 5, 1893. In an electric motor, the combination with the stationary shaft of a combined brush holder and shaft coupling consisting of a part with laterally extending sockets, and brush holders adapted to be supported in the sockets.
- 511,214. **BRUSH HOLDER FOR ELECTRIC MOTORS**; J. J. Robison and Fred. B. Perkins, Toledo, O. Application filed Feb. 6, 1893. In a brush holder for electric motors, comprising in combination a bracket having a threaded portion, a screw for receiving the brush, and slotted, an arm at right angles to the bracket and provided with flanges at each side, a lever pivoted to the end of the arm and carrying a transverse bearing-bar at its free end, pins attached to the arm and lever, and a spiral spring attached to the pins whereby the lever is pressed against the brush within the holder.
- 511,229. **ELECTRIC LAMP**; A. Zobel, Munich, Germany. Application filed Feb. 15, 1893. In an electric glow-lamp the combination with a lamp socket of a pair of conducting wires extending through the lamp socket, a third conducting wire inserted in the socket and projecting into the lamp, a filament connecting the pair of conducting wires, a second filament connecting the second wire of the pair with the third wire, and a loose contact device within the lamp and arranged to connect the third wire with the second wire.
- 511,234. **MORSE TRANSMITTER**; A. F. M. Cornand, Brussels, Belgium. Application filed May 29, 1889. The combination with a series of key levers connected to one terminal of a circuit, and each provided with a projection having insulated spaces, of a vibrating frame, a metallic brush connected therewith, a lever connected to the frame, a bar extending below the key levers and connected to the lever, and a retracting spring.
- 511,240. **ELECTRIC SWITCH**; J. L. Hinds, Syracuse, N. Y. Application filed Nov. 24, 1891. In an electric switch, the combination of a base plate, a pair of terminals, a spring having one end engaged with one terminal and the other adapted to be brought into contact with the other terminal, a cam for engaging the extremity of the spring with the other terminal, and a shoulder provided on the cam just above the spring, whereby upward movement of the spring is prevented.
- 511,245. **THERMO-ELECTRIC ELEMENT**; M. Mestern, Turin, Italy. Application filed May 4, 1891. In a relay with a circuit-closing armature acted upon by the magnet of the relay, the combination of the attracting magnet having a small self-induction, with the retarding coils having relatively large self-induction, so as to increase the attractive force of the attracting magnet at the beginning of signals and to hasten the reversal of polarity of the attracting magnet, at the end of the signals.
- 511,245. **THERMO-ELECTRIC ELEMENT**; M. Mestern, Turin, Italy. Application filed April 9, 1889. The combination of a block of iron in contact with a block or surface of an alloy of zinc and antimony and a body of nickeline or nickel compound entering into the alloy of antimony and zinc, and forming a conductor conveying the electricity generated.
- 511,254. **CLOSED CONDUIT ELECTRIC RAILWAY**; W. S. Smith, Berkeley, Cal. Application filed Feb. 29, 1892. In a system of electrical distribution, a sectional conductor connected together



NO. 511,254.—CLOSED CONDUIT ELECTRIC RAILWAY.

by junction boxes, the ends of the conductor provided with balls which fit in the sockets in the walls of the sockets consisting of two half-round blocks of insulating material held together by a clamping nut: (See illustration.)

- 511,259. **RHEOSTAT**; F. A. Weller, Boston, Mass. Application filed April 20, 1892. This consists of the combination with a series of radial supports, of the resistance conductor formed into close coils and held in place by clamping the supports between the coils, contacts and leads for connecting the resistance conductor therewith.
- 511,276. **TWO-STATION TELEPHONE CIRCUIT**; F. A. Pickernell, Newark, N. J. Application filed Aug. 7, 1893. The combination of a central station and two sub-stations with a metallic circuit extending from the central station and entering and terminating at the sub-stations by separate normally open metallic branches, there being interposed in each of the conductors of each branch a condenser of small capacity; each of the branches being provided in their relatively opposite conductors with an electric generator in a normally open grounded circuit and a high resistance call bell in a grounded circuit.
- 511,286. **RESISTANCE BOX**; A. O. Benecke, Newark, N. J. Application filed Sept. 10, 1892. The combination in a set of resistance coils or bridges of a series of fixed contact plates, a series of resistances respectively interposed between successive contact plates, and circuit connections and means whereby one or more of the intermediate contact plates may be electrically connected with either of the end plates of the series.

The Electrical World.

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1884	82	1891	325
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1886	138	1893	317

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ELECTRICITY IN JAPAN.

The first portion of Mr. Stuart-Smith's article on "Electricity in the Far East," of which the second installment appears in another column, deals with the very creditable work done in the electrical line in Japan. While it may be a matter of surprise to some to learn that Japan has many competent and even some unusually able electrical engineers, there is no reason why this should not be so. The Japanese have shown that they possess the mental qualifications to successfully prosecute any industry, and the engineering branch of the Tokyo Daigaku is rivalled by few engineering schools in the entire world in its facilities for, and methods of, engineering instruction. It is only recently that Japan has begun to manufacture electrical machinery, but with men to rely upon like Fujioka, Tanabe and several others whose names are known beyond Japan, the result is not doubtful. In one respect the West promises to receive a distinct benefit from the extension of electrical manufactures in the Land of the Rising Sun and the home of decorative art, and that is in the design of fixtures and fittings. With the marvellous artistic instinct and dislike of duplication of designs, characteristic of Japanese in all of their decorative work, we may look forward to creations in this line that will have an important effect on the state of the art here and in Europe, and, as far as electroliers in general are concerned, there is abundant room for improvement in Western countries.

THE NOVAK LAMP DECISION.

Judge Shipman's decision against the Novak lamp followed from the view taken by the court that the manufacturers of the Novak lamp intentionally used the principle of exhaustion to a generous degree, and therefore partially enjoyed the benefits of that part of the Edison combination against which they maintained their claim for a valid patent. The mere introduction of gases into the receiver, the court states, is not important, but, if before they are introduced, the air and residual gases are taken away, and after their introduction the receiver is again exhausted so that a practical vacuum finally remains, though perhaps not as high as thought necessary by Edison for his filament, yet rendering practically stable the filamentary carbon, then the combination of Edison has been infringed, however much the gas used may have improved it, and, notwithstanding, that the Edison lamp itself is not practical with an air exhaustion as low as that used. Waring, according to the court, took the Edison lamp of 1880, which was the first practical incandescent light, and used all of the ideas finally embodied in the Edison lamp, though carrying the idea of exhaustion to a more limited extent than the original inventor thought necessary; nevertheless, without this exhaustion of air and gases his lamp would be a failure. The decision maintains that an inventor of an improvement on a previously patented combination cannot use one of its patented elements in a dwarfed and incomplete way and thereby receive the resultant benefit and escape the charge of infringement by reason of low percentage of such use, and decides against the defendant's theory that its use is so far unlike that of Edison as to be radically different. Judge Shipman's opinion on the other point at issue, that in regard to what date on a British patent shall prevail, adds another authority against the first date on such a patent, and in favor of the date of

affixing the seal, the decision being also against the defendants on this point.

INCANDESCENT LAMP ECONOMY.

In another column Lieut. Eyre takes up the question of the most economical age of incandescent lamps from a purely commercial standpoint and shows very clearly the loss from continuing to use a lamp after a certain period in its life. As very truly remarked, what is wanted is light, and if the light decreases while the current consumed remains stationary or decreases at a less rate than the candle power, it is evident that the cost of a given quantity of light becomes greater as the lamp grows older, until a life is reached when the saving from retaining the old lamp becomes less than the increased cost of power. Or, to put it in another way, the extra cost of the light will finally sum up to an amount exceeding the cost of a new lamp. To continue to use a lamp longer than its most economical life, then, merely consists in saving the cost of a new lamp on the one hand and adding more than the cost of a new one to the meter bill. The curves shown are interesting, as they demonstrate the important fact that, notwithstanding the decrease in the candle power of lamps, the current remains practically the same, and may be even greater than at the start. This is probably due to a change in the character of the filament, such that its surface does not radiate the same amount of light, even if maintained at the same temperature, though the blackening of the lamp bulb has something to do with the decrease in the amount of light. While this subject is worthy, from a financial standpoint, the attention of the small user of lamps, it is doubly important to the large user. One of the factors in the question of economy is the cost of the lamp; the cheaper the lamp the sooner the "smashing" point is arrived at, and consequently the large user, who buys his lamps cheaper, will effect an additional saving by proper attention to renewals.

PROF. FORBES' NIAGARA SCHEME.

As will be seen by reference to the Digest and to the letter of our English correspondent, the paper of Prof. George Forbes on the "Electrical Transmission of Power from Niagara," read before the English Institute of Electrical Engineers, was subject to extraordinarily severe criticism. With scarcely an exception, all of the main features of Prof. Forbes' designs and methods for transmission were condemned, and by men whose opinions are ordinarily given great weight. It cannot escape notice, however, that there was an intense ill-feeling, not disguised in some cases, and apparently entirely due to the alleged methods pursued by the Cataract Construction Company in profiting by unpaid technical information; one speaker even went so far as to say that the undertaking at Niagara would be carried out upon the "unrecompensed work of the entire electrical world." It will doubtless strike the reader that if Prof. Forbes thus had the benefit of the collaboration, though unintended, of the entire electrical world, he was unusually well supplied with data upon which to base correct conclusions, leaving aside the well-known and original ability of the designer himself. The whole matter seems to be that the entire Niagara installation is designed on such radical principles as to be necessarily open to the criticism to which anything may be subjected that departs from existing practice; and that on account of the lack of definite data bearing upon many of the features decided upon, much or all of the criticism may be found without point in the crucial test of practice, while the bitter spirit from which it was evolved doubtless darkened the judgment of many of the critics. Much of the criticism seems to assume that Prof. Forbes adopted the more important features of the transmission scheme upon theoretical considerations alone, while

it is known that many were subjected to actual experiment, and none adopted until after a more exhaustive consideration of all points involved than has perhaps ever before been given to any technical undertaking. As far as the Cataract company authorities are concerned, we cannot say that we feel sorry at the rebuff they have thus received as a result of their discrimination in favor of the British electrical public as against our own. We would, however, advise them that when they wish to publish another installment of the information so jealously guarded from Americans, to choose a country in which technical men are not inclined to be so outspoken in their opinions as those of England.

RELATIVE COST OF COPPER FOR CONDUCTORS.

In another column a mathematical discussion of the relative cost of copper for distribution in different electrical systems arrives at conclusions which at first sight may appear singular in some respects. It is shown that if a basis of effective E. M. F. is taken for comparison, the three-phased alternating system requires the same amount of copper as the two-phased system, while there is a saving of 25 per cent. in each of these over the simple alternating system, which is itself in this respect on a parity with the direct current. If, however, the basis of comparison is the stress on the insulation, or, in other words, the maximum E. M. F. in each case, then the direct current requires the least amount of copper to distribute a given amount of energy at a given loss. The three-phased system comes next in economy, but requires 50 per cent. more copper than the direct current system, while simple alternating currents require 100 per cent., and two-phased currents no less than 200 per cent., more copper for conductors under the same conditions as to energy transmitted and $C^2 R$ loss. By reference to the curves in the article it will be seen that the saving noted under the first method of comparison is due to the working currents in the two and three-phased systems overlapping in one conductor thus giving a resultant current in each case, which is less than what the sum of two currents would be if there was no difference in phase. In the two-phased system the decrease in the resultant current is greater than in the three-phased system, the difference in phase being 90 degrees instead of 60 degrees, but the saving thus implied over the former is balanced by the less favorable working disposition of the E. M. F. in the latter system. If the maximum effective E. M. F. in the two-phased system were also the working E. M. F., as in the three-phased system, then the former would show the greater economy. By reference again to the curves shown, it is at once apparent why the direct current is the most favorable as regards the insulation stress or maximum E. M. F., since its effective E. M. F. is also the maximum E. M. F. while in the other three systems this is far from being the case. Here, too, the two-phased system loses in economy for the same reason as given above. That is, if the effective working E. M. F. in each case is 1,000 volts, in the three-phased system this corresponds to the curve of greatest or resultant E. M. F. whose maximum ordinate is 1,414 volts, while in the two-phased system, the corresponding E. M. F., whose maximum ordinate is also 1,414 volts, is that between the two extreme conductors, while the working E. M. F. is that corresponding to the component or primary E. M. F., in relation to which the maximum ordinate is 2,000 volts. While, therefore, by this method of comparison the direct current has the advantage over the alternating current, whether simple or multiphased, and three-phased over two-phased currents, this does not imply much until we approach the limits of insulation stress, whether in conductors or in apparatus, which, it may be added, are scarcely in sight yet. Up to recently our ideas in regard to the consequences of higher voltages were based upon experience with direct currents, in which the con-

siderations were danger to life, and difficulty with commutators, rather than with simple insulation. Owing, however, to the use of transformers with alternating currents, which enable us to almost entirely obviate danger to life from high voltages, the voltage of 10,000 used at the Frankfort-Lautten transmission was less dangerous in this respect than any arc-light currents under usual conditions. On account of the absence of commutators, the voltage of 10,000 was also produced with less practical difficulties than one-half as great a voltage would be in a direct current machine. The only factor therefore to be ordinarily considered in relation to the voltage of simple or multiphased alternating currents, is the insulation of the line and apparatus, and this factor does not become of direct importance until we approach a practical limit, which seems to be yet far removed. With direct currents, however, we have the two additional factors of danger to life on account of the necessary disposition of the generating and receiving apparatus, and difficulty with commutators, to which may be added a third factor due to electrical difficulties with high voltages at the receiving apparatus, which do not exist where alternating currents are employed with transformers as intermediaries. This is but another illustration of the variance in ideas derived from experience with direct currents and those connected with alternating currents.

Liquid Commutators.

To the Editor of The Electrical World:

Sir.—A description is given by Lieut. F. Jarvis Patten in your issue of Dec. 2 of a "Liquid Commutator" for producing the gradual reversal of electric currents by means of the rotation of a pair of metal plates in a vessel containing conducting liquid, in which two other plates are fixed. Lieut. Patten is evidently not aware that this device has been used for the last eighteen months or more in connection with my "Magnetic Curve-tracer," and is, in fact, the subject of an English patent by Mr. C. G. Lamb and myself, jointly. Commutators of the kind referred to have been described in the London "Electrician," and are made and sold by Messrs. Nalder Brothers, Red Lion street, Clerkenwell, London.

J. A. EWING.

Cambridge University, England, Dec. 27, 1893.

Prof. Forbes' Niagara Scheme.

(From Our Own English Correspondent.)

Rarely in the annals of the Institution of Electrical Engineers has any paper presented to it evoked such a storm of adverse criticism as that aroused by Prof. George Forbes' paper on "The Electrical Transmission of Power from Niagara Falls," and for scarcely veiled personalities, and scarcely suppressed anger, the second evening's debate on Thursday last was unparalleled. Among the speakers in the discussion were Professors Fleming and Silvanus Thompson, Messrs. Mordey, Kapp, Swinburne, Ferranti, Alexander Siemens, Sidney Evershed and Crompton. All these gentlemen were almost unanimous in condemning the low frequency chosen, the method of oil insulation, and the proposed conduit, and, as a minor point, the proposed use of an artificial load for switching alternators into parallel. With regard to the low-frequency, however, Prof. Fleming and Mr. Evershed were in its favor, the former being of opinion that "there was no doubt about the wisdom of selecting this low-frequency at Niagara, where the utilization of power by motors was an important matter, and there were enormous advantages to be gained by the reduction of capacity and other effects by the employment of a reduced frequency," Mr. Evershed pointing out the enormous gain in the reduction of the back electromotive force of induction.

Both Mr. Swinburne and Mr. Crompton were anxious to know just exactly what Prof. Forbes expected the difference in cost would be between generating power at Niagara and transmitting it to Buffalo, and generating it *in situ*; Mr. Crompton, moreover, emphasizing the general opinion of the meeting, that a narrow conduit containing bare conductors at a potential of 20,000 volts would scarcely be a place for human beings, but expressing the hope that Prof. Forbes did not rely upon ordinary telegraph insulators, even if supplemented by oil, for in his (Mr. Crompton's) experience oil insulators were utterly useless, and insulators which were good enough for telegraphs were not good for underground work. The speech of the debate, however, was that of Mr. Ferranti, who seldom appears at the Institution meetings, and has never before spoken. His criticisms of the technical details of Prof. Forbes' scheme was most unqualified, but he devoted no small portion of the time allotted to him to a vigorous attack upon the methods pursued by the Cataract Construction Company in obtaining its information. The undertaking at Niagara would, he said, be carried out upon the "unrecompensed work of the whole electrical world." The unusual applause which greeted his remarks expressed the feeling of English electrical engineers on this matter. It is needless to say that Prof. Forbes' reply was scarcely less vigorous than the attacks which had been made upon him, his remarks upon Mr. Mordey's speech being specially severe. The speakers on the first evening had, in Prof. Forbes' opinion, only gotten up to show their ignorance and he "felt nothing but sorrow for the position of the Institution in having such speeches made on a matter of so much importance." In spite of all adverse criticism, he felt a great deal fortified in all the conclusions he had arrived at. He denied that the International Commission was a farce, and that those who prepared the schemes had been treated unfairly.

Decision in the Novak Lamp Suit.

On Monday, Jan. 8, Judge Shipman handed down his opinion in the case of the Edison Electric Light Company et al. vs. the Waring Electric Company et al., which was argued at Hartford about a month ago. A temporary injunction was granted.

The decision first defines the Edison lamp in the words of Judge Lacombe, as the combination of carbon, filamentary or thread-like in size and properly carbonized, used as an illuminant, in an incandescent electric lamp, with a receiver made entirely of glass, and conductors passing through the glass, and from which receivers the air is exhausted to such an extent that disintegration of the carbon due to the air-washing action of surrounding gases or to any other cause is so far reduced as to leave the carbon practically stable.

The defendant's lamp, called the Novak lamp, is next defined as the Edison lamp, with the alleged exception that in the receiver a nearly perfect vacuum has not been created by exhaustion of the air, but that into the partially exhausted receiver a portion of bromine gas has been introduced. This introduction of bromine and consequent lessening of the vacuum, it is claimed, produces a marked improvement in the stability of the carbon and diminution of blackening.

After examining the specifications of the defendant's lamp, the courts say that the vague description of the "ultimate character of the vacuum and of the amount of "desired" gas which was to be admitted, furnish inadequate data by which to ascertain with precision the extent of the departure from the Edison lamp. The question naturally arises, how much gas is admitted, after the atmospheric air has been exhausted, "as nearly as possible"? The general conclusions, taken by themselves, of Prof. Appleton and also of Prof. Car-

michael, both competent analytical chemists, whose affidavits are introduced by the defendants, would far from satisfy the mind that a material departure from the exhaustion which was the result of the Edison method of manufacture, had been sought in the Waring lamp. Other experts upon each side of this controversy are, however, able to state with more mathematical accuracy the exact nature of the vacuum, and they do not essentially differ in their conclusions.

Referring to the testimony of Profs. Wright and Anthony, the opinion states that they devote themselves substantially to a statement of their opinions in regard to the improved character of the Waring lamp over that of its Edison predecessor, by reason of the introduction of bromine gas, which they think preserves the transparency of the walls of the lamp and the stability of the carbon. While the question of the extent of an alleged improvement upon an existing patented combination may become incidentally important in ascertaining the character of the departure from the peculiarities of the invention which were described in and protected by the patent, it is obvious that the first and vital question is, were all the elements of the patented combination used in the second and improved invention in the manner and to produce the result described in the antecedent patent. Without, therefore, attempting to ascertain the correctness of Prof. Anthony's conclusion that the introduction of bromine into the chamber of an incandescent lamp is a new step in the art, whose results "are of the utmost importance," the court confines itself to a consideration of the question, whether, before he took this step, he made use of the Edison entire combination, and whether the alleged improvement is an addition to and not a substitute for one of Edison's described elements.

As there is no important disagreement between the experts on either side in regard to the vacuum in the lamps of the powers tested, which vary from 1-500 to 1-600 of an atmosphere, the court states that it will confine itself to the results which flowed from those experiments and which it assumes to be true. The defendant's legal position is authoritatively stated in a case cited as follows: "Inventors of a combination cannot suppress subsequent improvements which are substantially different, whether the new improvement consists in a new combination of the same ingredients or of a substitution of some newly discovered ingredient or of some old one performing some new function not known at the date of the letters patent as a proper substitute for the ingredient withdrawn from the combination constituting their invention." Their theory is that the introduction of bromine gas into a globe only partially exhausted is the substitution of a newly discovered ingredient for the air exhaustion of the Edison patent.

What Waring puts into the receiver is not of prime importance, but the question to be solved is whether he exhausts the contents of the globe, whether air, residual gases, or newly introduced bromine gas, to such an extent that when the globe is sealed he has used that part of Edison's combination to such an extent that thereby the carbon is rendered practically stable. The mere introduction of gases into the receiver is not important, but if before they have been introduced Waring takes away the atmospheric air and the residual gases, and, after the new addition has been introduced, he takes away the contents of the globe by exhaustion, so that a practical vacuum finally remains, not as high as Edison thought necessary for the spongy and porous cotton thread which he carbonized, but a vacuum which renders practically stable a carbon, filamentary in size and of whatever hard and dense material it may be composed, then Waring has taken the combination of Edison, however much he may have improved it by the residuum of bromine gas.

To ascertain the effect of the exhaustion by the Waring method upon the stability of the carbon, the court examines

in detail the experiments of Prof. Robb, and concludes that in view of the present condition of incandescent lighting in this country, there is no doubt that an Edison lamp with the exhaustion which was given in the experiments would be considered by the users of electric light as so far inferior to the ordinary standard of an Edison lamp as to be worthless, and would be discarded by those who were accustomed to the usual stability of an incandescent lamp. But these experiments show to its mind, when read in connection with the other affidavits of the defendants, that Waring intentionally used the principle of exhaustion to a generous degree and that the vacuum ingredient of Edison was, to a large extent, employed and its benefits were partially enjoyed. Waring took the lamp which Edison gave in 1880 and which was the first practical incandescent electric light, and used all the ideas which were finally embodied in the Edison lamp, but used the idea of exhaustion to a more limited extent than the original inventor thought was necessary; nevertheless, without the large exhaustion of the atmospheric air and the gases which Waring accomplished, his lamp would be a failure. It will not be claimed that the inventor of an improvement upon a previously patented combination can use one of the patented elements in a dwarfed and incomplete way, but by its use receive the old resultant benefit, and escape the charge of infringement by reason of the low percentage of such use. The defendant's theory is that its use is so far unlike that of Edison that it can properly be said to be radically different. That theory is not supported in the Waring specification, and it does not seem to be supported by the facts. The statement in the specification that the atmospheric air may be at first exhausted as nearly as possible and the desired gas then admitted is significant. Profs. Appleton and Carmichael's affidavits show that the amount of gas which finally remains in the globe is small.

The defendant's claim that the Edison patent, which was dated Jan. 27, 1880, has expired by reason of the expiration of the British patent for the same invention, antedated to Nov. 10, 1879, but not sealed, and the specification of which was not enrolled until after the United States patent in suit had been issued, is dismissed, and the motion for preliminary injunction is granted.

Local Meetings of the American Society of Mechanical Engineers.

A series of what may be called local meetings of the American Society of Mechanical Engineers, was inaugurated at the headquarters of the society, 12 West 31st street, on Jan. 10. This new departure, which is of interest to members of the American Institute of Electrical Engineers, in view of the recent discussion among them on a similar subject, was determined upon several months ago when the following resolutions were adopted:

Resolved, That it is the sense of this meeting that it would be desirable and profitable that an opportunity be given for members of the American Society of Mechanical Engineers to meet at convenient times during the coming winter and spring for the discussion of subjects pertaining to mechanical engineering.

It is further resolved that a committee of five be appointed to arrange for such a series of monthly meetings during the coming winter and following spring, that it be authorized to select and appoint a chairman to preside, to fix dates for holding, and to issue calls for such meetings, select subjects for consideration and speakers to present and discuss them, arrange the order of proceedings and make all necessary rules for the conduct of such meetings, solicit subscriptions and audit and pay all bills incurred for such expenses and fill vacancies which may occur during the period named.

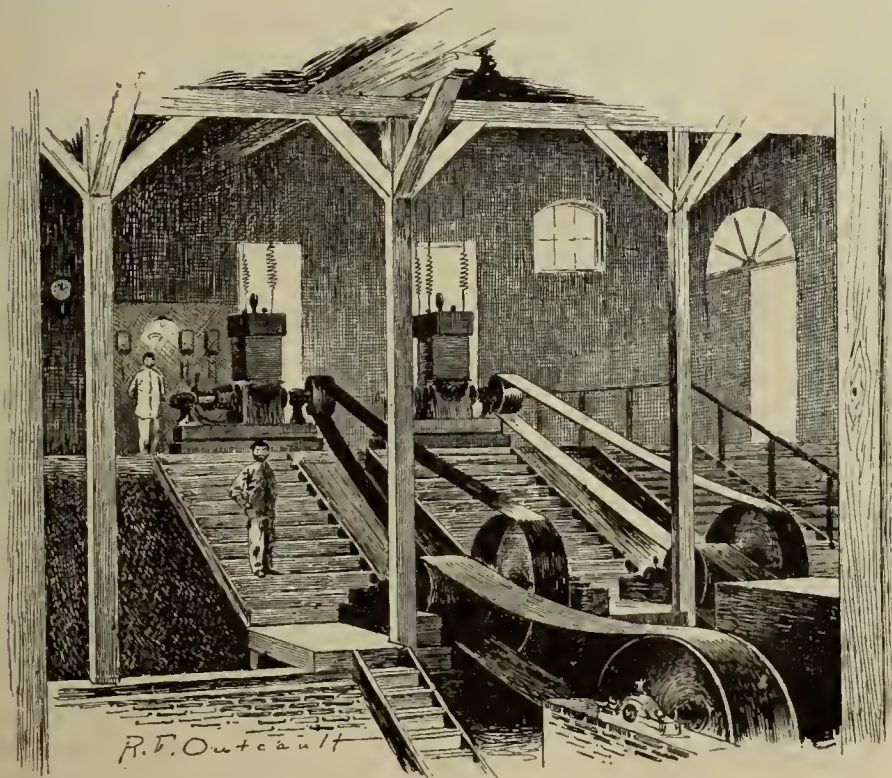
In order to avoid misapprehension the committee has deemed it best to explain that the meetings which it is proposed to hold, will not be, in any sense, meetings of the Society, but only of such members as may choose to attend them. The proceedings will form no part of the transactions of the Society, and will not be published by it.

Electricity in the Far East.—II.

BY W. STUART-SMITH.



On each side of the tail race which runs through the centre of the station is to be placed a row of Pelton wheels. As shown in the view of the interior the station is built in steps, being high on both sides and low in the centre. The dynamos are placed well up on the sides, so as to be entirely away from possible danger of getting wet. They are belted from countershafts placed on a step or landing between them and the wheels. Eight-foot Pelton wheels are used, and they are fitted with centrifugal ball governors and deflecting nozzles. At present there are set up two Edison standard 80-kw. 500-volt generators, as shown in the illustration. On the opposite side of the building there is one Thomson-Houston 1,300-light alternating dynamo and one 1,000-light, each being compounded for 15 per cent. drop. Each dynamo is belted from a wheel through a short countershaft. There is no connection between any two countershafts, and consequently each dynamo, with its wheel, is entirely independent of all the rest. The usual bad regulation found in water-power plants exists here, and when any considerable load is thrown off any dynamo it speeds up and the E. M. F. rises. One dynamo supplies at present motors distributed throughout the city, and as the work of these is comparatively steady but little trouble is experienced, but the other machine feeds the 50-h. p. Sprague motor operating the incline cable, and here the bad regulation is very apparent. This motor is not run continually, but is started when boats are to go up or down. When the car with the loaded boat is being hauled out of the water and up the short reverse incline the weight of the cars and boats at both ends of the cable has to be taken and nearly the full horse power of the motor is required; but when the descent of the main incline begins one car is balanced against the other, and only about 5 h. p. is required. This sudden drop



INTERIOR OF KYOTO CANAL POWER HOUSE.

of 45 h. p. is shown in an increased E. M. F. of the dynamo. To compensate this the chief engineer of the station has had extra rheostats made for each dynamo. They are placed in series with the rheostats furnished with the dynamos, and by means of them a very large resistance can be thrown into the field. When the 50-h. p. motor is to be started the attendants are notified by means of a call bell from the motor house

and one of them takes his stand at the rheostats and watching his voltmeter throws in or out his resistance as required.

The writer strongly advised them to arrange the short countershafts so that they could be connected together by clutches, or to use one long countershaft on each side and have the wheels and dynamos belted to clutch pulleys; then if the load of any one dynamo was suddenly varied the change of load would be divided between all the wheels and the effect on the speed would be scarcely noticeable. Ten wheels having an aggregate horse power of 1,200 would be belted to each shaft, and the change of load would have to be very considerable to have an appreciable effect.

With about 2,000 h. p. of distributed motors, which it is expected will be connected with the circuits leading from



DISTINCTLY JAPANESE.

each side of the station, the wheels will be constantly running at nearly their full power.

The two dynamos shown were set up, circuits to the city run, and everything ready for the delivery of current to factories in July, 1891. A 5-h. p. Sprague motor was installed in a clock factory almost as soon as the circuits were run. This gave perfect satisfaction, as the writer found by visiting the factory, but with the exception of the 50-h. p. incline motor no other was installed for about a year. Then a 30-h. p. Edison machine was put in a cotton mill, and in spite of exceedingly bad treatment gave such good satisfaction that during the next year quite a number were installed.

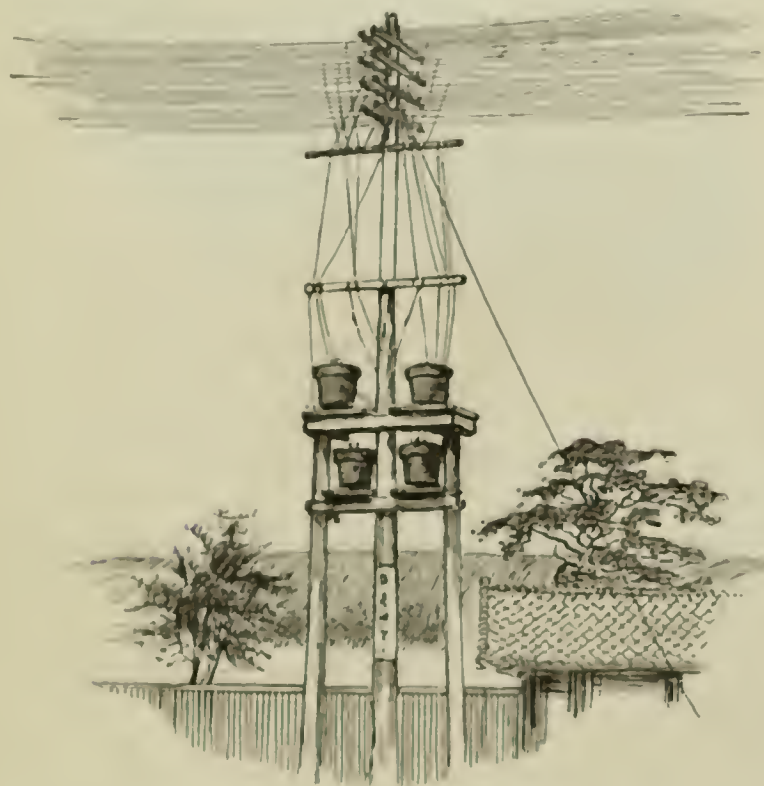
The writer at the time was in charge of the Edison electrical work in Japan, and it having been reported to him that the canal company's engineer had told the mill people not to run the motor up to its rated power, he wrote to know the reason and received a letter, of which the following is an extract: "You wrote me about the Fujii mill motor, that I told the mill people not to put more than 48 amperes on it. Why! there must be some mistake in it, as I never told such a thing to the mill people. But the people there, or rather the workmen, are very careless fellows. They sometimes caught a rat alive, with which they short-circuited and killed it, and at the same time fused the fuse wire. Sometimes they melted wire by crossing two terminals of the double pole key and at the same time melted the key. Sometimes they put on more load than they should do, and I think they do it just for fun; so I told them positively they must not put on an overload."

This motor proved to be too small for the mill, and it has since been replaced by a 45-h. p. Thomson-Houston.

In June of this year the following motors were in operation: 50-h. p. Sprague, running incline cable; 5-h. p. Sprague in clock factory; 10-h. p. Sprague in brass plate mill; 15-h. p. Sprague in Electric Light Company's station for running a Brush arc machine (this machine has a capacity for 45 1,200-c. p. lamps, but only twenty were running in June); 45-h. p. Thomson-Houston in cotton mill; 6-kw. Edison in repair shop of fabric mill; 1 1-2-h. p. Thomson-Houston in clock factory; 1-h. p. Perret in aerated water manufactory. Of all these motors the Perret was held in highest repute. The canal company has quite a number of motors in stock, and without doubt several have been installed since the writer's last visit, about the first of last June. The mills and factories in which these motors are installed are lighted by ordinary 16-c. p. lamps, placed five in series. The motor farthest from the station is the 1-h. p. Perret, about two miles distant; the 45 h. p. is about one mile.

In 1895 an industrial exhibition is to be held in Kyoto and all machinery will be run by electricity.

The Kyoto Electric Light Company was started before the canal company was ready for business, and the city authorities agreed that the canal company should devote itself to power distribution and not interfere with the lighting business. The lighting company started with four Edison dynamos on the three-wire system, and had been running some time before the canal company was ready to deliver



TRANSFORMERS IN STREETS OF TOKYO.

power. Then an agreement was entered into, in virtue of which the canal company has set up the two Thomson-Houston alternating dynamos above mentioned. These are regulated for a drop of 15 per cent., and send current to the lighting company's station, from whence it is distributed by that company. This arrangement was made in order to utilize some of the surplus power of the canal company's station, but when this power is needed for mill purposes the lighting company will go back to the use of steam engines.

In addition to the 2,400 h. p. available on the Pelton wheels in the main station, about 600 h. p. more can be obtained from the Kamogawa as it passes through the city. In five places there are locks, the extreme ones being about one mile apart, and at each of these 120 h. p. can be obtained on a low head turbine. When the main station is loaded to its capacity this extra power will be developed and added to the other. On the basis of divided power, it is expected that more than 4,000 h. p. of motors can be installed, with an average price of not less than 100 yen per h. p. per year.

Considering the magnitude of the preliminary work and the importance of the result to be obtained, and the fact that all this has been done by the Japanese, a people who twenty-five years ago had scarcely an idea of Western civilization, it must be agreed that the plant is a most interesting one.

The two 500-volt generators and several motors had been delivered to the canal company several months before they were ready to install them; finally everything was ready for work when word was received at the office of the Edison agents in Yokohama that both generators and all the motors were grounded on the fields and armatures. The writer at once proceeded to Kyoto to investigate and found that a magneto would ring through all fields and all armatures as stated. It was out of the question that the grounds existed as the Japanese engineer thought, and a little investigation showed the trouble to be due to a film of moisture over the insulation. It was very hot weather, and as the water stood in and about the station the buildings were filled with moisture and the machines sweated considerably. The engineer was considerably frightened upon starting the machines, feeling sure they would burn out, but being guaranteed against damages they were started and no further trouble experienced.

The two power generators and all the Sprague, Perret and Edison motors were supplied to the canal company by Messrs. Frazar & Co., of Yokohama (Mr. Everett Frazar, 69 Wall street, New York), who were sole agents in Japan for the Edison company from the beginning of that company until some time after the formation of the General Electric Company. They were the pioneers in establishing electric lighting in Japan, the plant in the Mikado's palace being one of the first in the country. For several years they supplied nearly all the electric machinery used in Japan, more than one hundred dynamos and motors having been introduced by them. The business which they built up grew to such dimensions that other American and European companies have established agencies there, and the Japanese have begun to manufacture, so that competition is now very keen.

The first lighting plant of importance was the Imperial palace plant, started about 1888. It was installed and for some time managed by Mr. Brenner, lately with the Edison company in Toronto, Canada. After a time it was placed under the management of the Japanese engineers, and became the first section of the Tokyo Electric Light Company. This company has grown until it now has five stations located in different parts of Tokyo, from which are running perhaps twenty thousand lamps. The lines from all the stations form a network on the three wire system. Most of the machines are from the Edison factory, though recently two or three alternating dynamos have been put in. Brush arc lamps are used for street lighting in some places. The number of lamps installed is being rapidly increased. For a long time the company was heavily in debt, but last year a dividend was declared, and now its standing is good.

The chief engineer is Mr. I. Fujioka, a man of international reputation. He is head and shoulders above all other Japanese electricians in his knowledge of electrical matters and is a lecturer in the Engineering College of the Imperial University. He is especially desirous of manufacturing steam and electrical machinery for all purposes, and is chief engineer and a large stockholder in the Mivoshi Dento Kojo (the Mivoshi Electric Manufacturing Company). This company make Armington & Sims engines and Edison 125-volt dynamos. These machines are of good quality, and many of them are running in various parts of Japan. Mr. Fujioka is also anxious to export them to other parts of the Orient, and will no doubt succeed in placing them in China and Korea. Everything connected with the Edison lighting system is manufactured, such as Howell pressure indicators, comparative indicators, ampere meters, lamp sockets, elec-

troliers and fittings of all sorts. A year ago about 1,000 lamps per week were made and the number was constantly increasing. The life is quite satisfactory, the average being over 600 hours. They retail for 50 yen each and yield a good profit. When the quality is somewhat improved and the manufacturing facilities increased the company is ambitious to send them to compete for the American market. It is certain that the sale of foreign lamps will soon become very small unless the price can be made very cheap.

The company endeavors to sell as near the price of imported dynamos and engines as possible, but in case of necessity they are able to quote a price that is far below what a foreign machine can be sold for. It is through Mr. Fujioka's high engineering abilities that the success of these machines has become assured. He is also making Brush alternators, Thomson-Houston converters, etc., and will soon be turning out 500-volt generators for power purposes, as well as mining machinery of all classes. Great difficulty will, however, be experienced with machines requiring high insulation, such as arc machines, alternators and converters, as the Japanese are not accustomed to the high grade of work required. They are, however, rapidly learning. The Miyoshi company claim to be able to make converters equal to the imported ones, but the best answer to this claim is the fact that on the lines of the Tokyo Electric Light Company Mr. Fujioka is putting up the foreign made article.

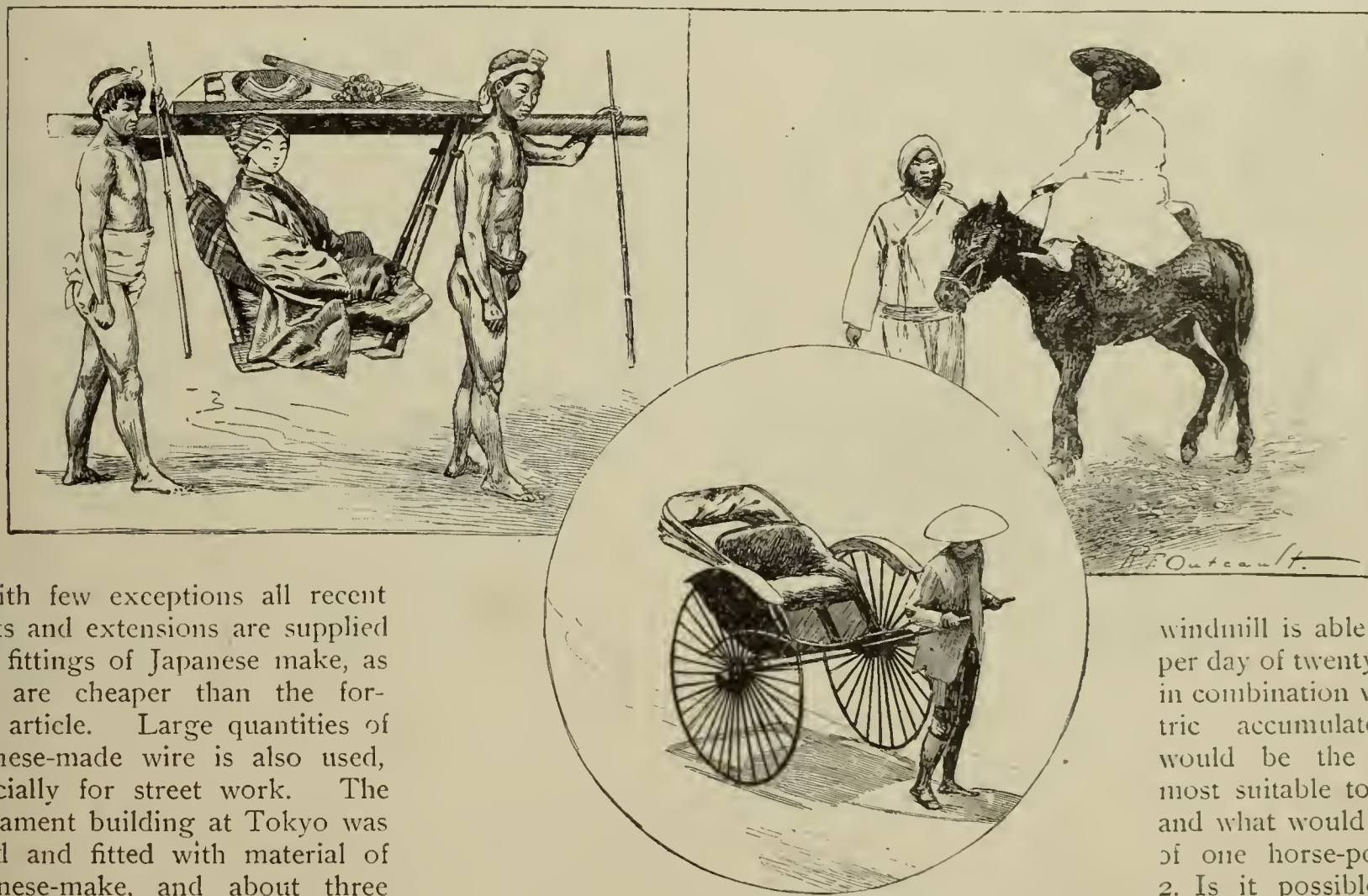
In addition to the five stations of the Tokyo Electric Light Company there is a station supplying about 1,000 lamps on the Thomson-Houston system, one supplying about the same number on the Westinghouse system and perhaps two or three thousand lamps from English dynamos.

The next largest lighting station is in Osaka, where the Thomson-Houston system is exclusively used. About ten thousand lamps are connected, all from one station. The Osaka company have been sole Thomson-Houston agents for some years, and are now sole agents for the General Electric Company. They are considerable manufacturers of sockets, electroliers and general fittings, though this work is not done under their name and they deny any connection with it, their agreement with the General Electric Company not permitting them to make any use of native-made goods. In addition to this central station there are many plants in mills and factories, most of which are Edison.

(To be continued.)

Electricity and Windmills.

The Netherlands Society for the Promotion of Industry offer a gold medal and £30 for the best paper on the production of electricity by windmills, its storage, transmission, and utilization. The following points in particular should be attended to: 1. What is the average energy a common



A FIELD FOR ELECTRICITY.

With few exceptions all recent plants and extensions are supplied with fittings of Japanese make, as they are cheaper than the foreign article. Large quantities of Japanese-made wire is also used, especially for street work. The Parliament building at Tokyo was wired and fitted with material of Japanese-make, and about three years ago it was burned, the fire being due to defective material. Since then the government has refused to allow any native-made material or fittings to be used in public buildings, and rigid inspection is made to see that everything is first class. Recently the government buildings have been fitted with Interior Conduit tubing, and this will probably be required in future work.

Two years ago Kanda, a district in Tokyo, was swept by a fire and four thousand houses destroyed, and among the others was the Kanda station of the Tokyo Electric Light Company. The fire was caused by the carelessness of a waiter in a restaurant, and as punishment for the first offense of 4,000 houses he was fined 15 yen and told not to "do so some more."

windmill is able to produce per day of twenty-four hours in combination with an electric accumulator; what would be the installation most suitable to this effect, and what would be the cost of one horse-power hour? 2. Is it possible, from an economical point of view, to apply the new aerial motors on an extensive scale for the

accumulation and the utilization of this energy? If so, what mechanical appliances would be required for this purpose? The project of a supposed application of the system, by which a factory is provided with light and power, is wanted as an illustration. Answers must be sent before July 1, 1894, with the author's name, in a closed envelope, to the general secretary of the society, F. W. Van Eeden, at Haarlem, Holland.

This problem is a most interesting one, and no doubt will be taken up by American inventors. The utilization of wind power for the generation of electricity has long been striven for, but thus far with no great commercial success.

Relative Costs of Distribution by Different Electrical Systems With the Same Effective or Maximum E. M. F.

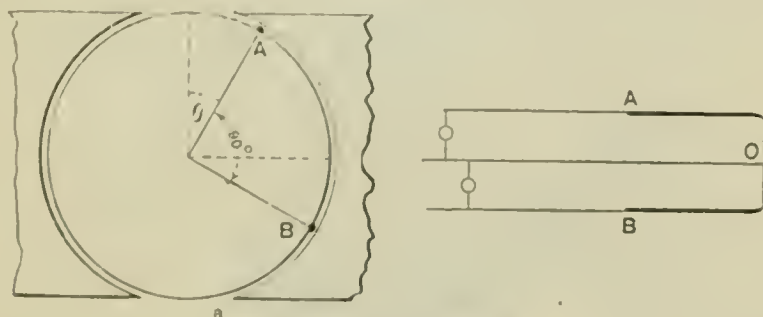
By W. D. WLAVER.



THE saving in copper over the simple alternating system in the two- and three-phased systems still being a matter of dispute, the following is offered as an attempt, starting from first principles in each case, to determine if the problem, if it so may be called, does not admit of a perfectly definite

solution. In the first part of the article, the comparisons will be made on the basis of effective E. M. F., and in the second part on the basis of insulation stress or maximum E. M. F. Mr. Gisbert Kapp, in an able paper read before the last meeting of the British Association for the Advancement of Science, brought forward, for the first time it seems, the latter method of comparison, but without giving any clue to the manner in which he arrived at the results stated.

Fig. 1 represents diagrammatically a two-phased generator, and *B* being sections of the armature wires, the other extremities of which are joined and led to a third collecting ring. Fig. 2 represents a two-phased system developed, the heavy lines designating the armature wires or the seat of the



FIGS. 1 AND 2.

E. M. F. To simplify matters, we will assume the junction of the two armature wires to be maintained at zero potential.

Then, the rate at which *A* and *B* are cutting lines of force are $\sin \theta$ and $\sin (\theta + 90^\circ)$ respectively, or the E. M. F. at any instant between *A* and *O*, *B* and *O* and *A* and *B* is $\sin \theta$, $\cos \theta$ and $(\sin \theta + \cos \theta)$ respectively, neglecting constants, while the effective E. M. Fs. are

$$\left(\frac{1}{2\pi} \int_0^{2\pi} \sin^2 \theta d\theta \right)^{1/2}, \left(\frac{1}{2\pi} \int_0^{2\pi} \cos^2 \theta d\theta \right)^{1/2} \text{ and } \left(\frac{1}{2\pi} \int_0^{2\pi} (\sin \theta + \cos \theta)^2 d\theta \right)^{1/2} \quad (1)$$

or $\frac{\sqrt{2}}{2}$, $\frac{\sqrt{2}}{2}$ and 1; that is, the E. M. F. between the extreme wires is $\sqrt{2}$ times greater than that between either leading wire and what may be called the common return.

Assuming that the entire resistance in each of the two circuits is unity, the currents flowing at the same instant in the three wires (Fig. 2) have the values $\sin \theta$, $\cos \theta$ and $(\sin \theta + \cos \theta)$ and the effective currents are, therefore, also respectively $\frac{\sqrt{2}}{2}$, $\frac{\sqrt{2}}{2}$ and 1; that is, the current in the

common wire is $\sqrt{2}$ times greater than the current in either of the other two wires.

Fig. 3 represents diagrammatically a three-phased generator with a "star" winding, *a*, *b* and *c* being sections of the armature wires, which are supposed to be joined at the other end of the armature. Assuming that the point of union is maintained at zero potential, then the rate at which each wire is cutting lines of force, and therefore the

potential at the end of each wire on open circuit, is, at $a = \sin \theta$; at $b = \sin (120^\circ + \theta) = \sin (60^\circ - \theta)$; at $c = \sin (240^\circ + \theta) = -\sin (60^\circ + \theta)$, from which it follows that the poles of a three-phased motor differ by 60° in phase. This might have been foreseen, for by drawing the lines *OM* and *ON*, it is evident that wires at *M* and *N* would cut lines of force at the same rate as the wires *c* and *b*.

Connecting the points *a*, *b* and *c* (Fig. 4), the difference of potential at any instant between *a-b*, *b-a* and *b-c* are respectively

$$A = \sin \theta + \sin (60^\circ + \theta); B = \sin (60^\circ - \theta) - \sin \theta; C = \sin (60^\circ - \theta) + \sin (60^\circ + \theta). \quad (3)$$

from which it follows that the sum of the three E. M. Fs. at any instant is zero, and that the sum of two E. M. Fs. is always equal to the third.

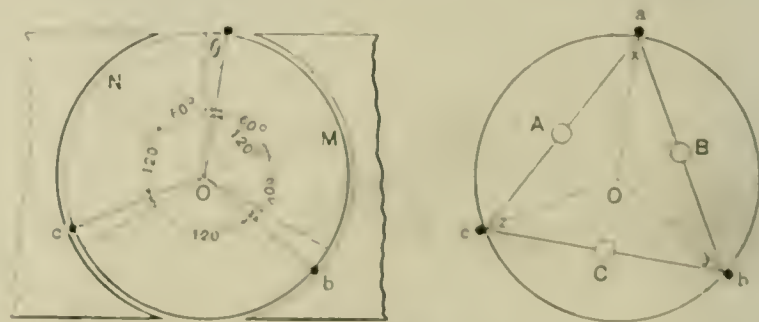
The effective E. M. F.'s are

$$A_{\text{eff}} = \left(\frac{1}{2\pi} \int_0^{2\pi} (\sin \theta + \sin (60^\circ + \theta))^2 d\theta \right)^{1/2} = \sqrt{\frac{3}{2}} \quad (4)$$

$$B_{\text{eff}} = \left(\frac{1}{2\pi} \int_0^{2\pi} (\sin (60^\circ - \theta) - \sin \theta)^2 d\theta \right)^{1/2} = \sqrt{\frac{3}{2}} \quad (5)$$

$$C_{\text{eff}} = \left(\frac{1}{2\pi} \int_0^{2\pi} (\sin (60^\circ - \theta) + \sin (60^\circ + \theta))^2 d\theta \right)^{1/2} = \sqrt{\frac{3}{2}} \quad (6)$$

As the E. M. F. generated in any one winding, as in *a*, is $\frac{1}{2\pi} \int_0^{2\pi} \sin^2 \theta d\theta = \frac{\sqrt{2}}{2}$, (7) if to the windings of a 1,000 volt alternator two similar windings are added and so arranged to develop three-phased currents, the E. M. F. will be raised $\sqrt{\frac{3}{2}} / \frac{\sqrt{2}}{2} = \sqrt{3}$ times, or to 1,732 volts, instead of 3 times or to 3,000 volts if the additional windings were superimposed on the original ones. Or, if the armatures of three 1,000-volt alternators are rigidly coupled with corresponding coils advanced with relation to each other one-third of the distance between poles, three-



FIGS. 3 AND 4.

phased currents will be generated with E. M. Fs. of 1,732 volts. It will also be seen, referring to Figs. 3 and 4, that if the point where the three wires are joined is united to a fourth collecting ring, the difference of potential between the fourth wire and any one of the other three will be $(\sin \theta - 0)$, $\sin (120^\circ + \theta - 0)$, etc., or the effective E. M. F. will be $\sqrt{\frac{1}{2}}$ instead of $\sqrt{\frac{3}{2}}$; that is a three-phased generator may have six circuits with four conductors, three with an E. M. F. of say 1,000 volts, and three with an E. M. F. of 1,732 volts in that case.

Suppose, now, that the currents flowing in the windings *a*, *b* and *c*, or, which is the same thing, in the three wires of the line, are *x*, *y* and *z*, and that the resistance in each branch, *A*, *B* and *C* (Fig. 4), is unity; then, if the currents in the branches at any instant are *A*, *B* and *C*, those in the three legs of the line will be, from (3)

$$x = A - B = 3 \sin \theta \quad (8)$$

$$y = B + C = \frac{3\sqrt{3}\cos\theta}{2} - \frac{3\sin\theta}{2} \quad (9)$$

$$z = A + C = \frac{3\sqrt{3}\cos\theta}{2} + \frac{3\sin\theta}{2} \quad (10)$$

Integrating for the effective currents, we find these to be $\frac{3}{\sqrt{2}}$ in each case. But since the resistance in the branches

is unity the currents there are $\sqrt{\frac{3}{2}}$, and, therefore, the current in each leg is $\frac{3}{\sqrt{2}} / \sqrt{\frac{3}{2}} = \sqrt{3}$ times greater.

We can now make a comparison on the basis of effective E. M. Fs. required in distribution for the same $C^2 R$ loss. Suppose the voltage to be the same in each case, that each lamp take one ampere and that the resistance of each lead is one ohm. Figs. 5, 6 and 7 represent simple alternating, two and three-phased circuits, each having six lamps of the same voltage, the currents flowing in each lead being as deduced above. The loss

in Fig. 5, is $(6)^2 \times 2 = 72$ watts;

in Fig. 6, $(3)^2 \times 1 + (3\sqrt{2})^2 \times 1 + (3)^2 \times 1 = 36$ watts;

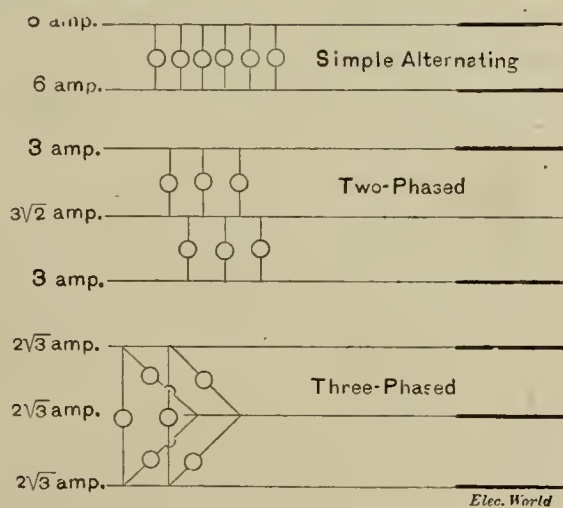
in Fig. 7, $(2\sqrt{3})^2 \times 1 + (2\sqrt{3})^2 \times 1 + (2\sqrt{3})^2 \times 1 = 36$ watts.

Now, if in Fig. 5 we were to add another wire of one ohm resistance to each side, the $C^2 R$ loss would be halved, or become 36, the same as in the other cases, and we have the following comparison:

	Work.	C R loss.	Wires.	Saving.
Simple alternating.....	6 lamps	36 watts.	4	
Two-phased.....	6 "	36 "	3	25 per cent.
Three-phased.....	6 "	36 "	3	25 per cent.

or, on a basis of effective E. M. Fs., with the two and three-phased systems there is a saving in copper for conductors of 25 per cent. over the simple alternating system in each case, but no saving in the three-phased system over the two-phased.

With alternating systems, however, the stress to which insulation is subjected is not a function of the effective, but of the maximum E. M. F.



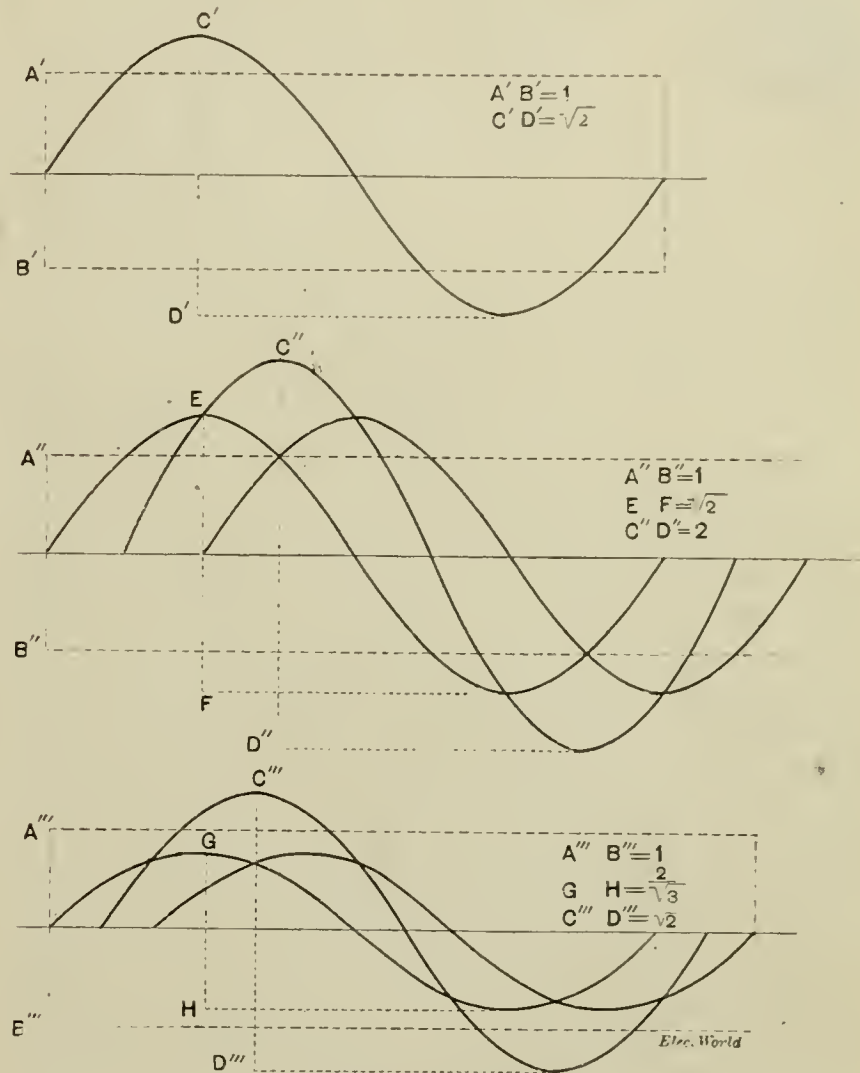
FIGS. 5, 6 AND 7.

From (7) we see that in the simple alternating system, if the maximum E. M. F. is unity, the effective E. M. F. is $\frac{\sqrt{2}}{2}$, from which it follows conversely that if the effective E. M. F. is unity the maximum is $\sqrt{2}$.

Similarly, in a two-phased system what may be called the working maximum E. M. F. is also $\sqrt{2}$ when the effective E. M. F. is unity, but from (1) we see that the difference of potential between the two outside leads is $1 / \frac{\sqrt{2}}{2} = \sqrt{2}$ times this, or the maximum stress in this system for an effective E. M. F. equal to unity is $\sqrt{2} \times \sqrt{2} = 2$.

In the preceding calculations for the three-phased system, we assumed the maximum E. M. F. in any one of the

armature wires to be unity, but as the E. M. F. between the working leads was shown to be $\sqrt{3}$ times this, the maximum E. M. F. of the system is $\sqrt{3}$, which corresponds to the effective E. M. F. of $\sqrt{\frac{3}{2}}$ calculated; therefore, reduced



FIGS. 8, 9 AND 10.

to an effective E. M. F. of unity the maximum E. M. F. is $\sqrt{3} / \sqrt{\frac{3}{2}} = \sqrt{2}$. In Figs. 8, 9 and 10 curves are plotted

showing the relation between the various E. M. Fs., in which $A B$ in each case represents the effective E. M. F., or that of the direct current used for comparison.

For an effective voltage, therefore, of unity in the simple alternating, two and three-phased systems, the stresses on insulation are as $\sqrt{2}$, 2 and $\sqrt{2}$ respectively, or that much greater than for a direct current of the same voltage, and it follows that if the stress is to be the same as with the direct current, the effective voltage must be reduced in proportion to $\frac{1}{\sqrt{2}}$, $\frac{1}{2}$ and $\frac{1}{\sqrt{2}}$ respectively. If, now, the ma-

chines are to do the same work, the currents will have to be increased in the same proportion as the voltages are reduced, and consequently the $C^2 R$ losses will become $(1)^2$, $(\sqrt{2})^2$, $(2)^2$ and $(\sqrt{2})^2$ for the direct, simple alternating, two- and three-phased systems respectively, or as 1 : 2 : 4 : 2. But we have shown that for an equal output there is an intrinsic saving of copper of 25 per cent. in the two and three-phased systems over the simple alternating system, and, therefore, also over the direct current system, so that the ratio become 1 : 2 : 3 : 1.5, or as 100 : 200 : 300 : 150.

That is, for the same stress on the insulation, and for the same output in watts, for each 100 pounds of copper required for distribution with direct currents, 200 pounds will be required with simple alternating currents, 300 pounds with two-phased currents and 150 pounds with three-phased currents. These numbers are the same as those given by Kapp, except that for the two-phased system, which in his paper is 290 instead of 300, as here deduced.

Problems for Inventors in Incandescent Lighting.

BY DR. L. K. BOHM.



NOTWITHSTANDING the fact that numerous improvements in incandescent lighting have been patented since the invention of the commercial lamp in 1879, yet there is a vast field for inventors in this line. Quite recently experimenters have taken up the subject again with renewed vigor, since Edison's fundamental patent of Jan. 27, 1880, was sustained by the Circuit Court of Appeals on Oct. 4, 1892. As a consequence of this decision, a number of lamp manufacturing companies closed their factories by order of the Court, and as they possessed the facilities for the manufacture of lamps they were certainly very anxious to adopt new lamps which would at least stand a fair fighting chance in the courts, if they were not entirely independent. Inventors saw a rich harvest before them, because it might not be saying too much, to express the opinion that the rights of the proprietors of the Edison patent will finally be enforced in all the States. Of late even a competitive company, the Waring Electric Company, has conceded that the Edison patent is valid. There is no doubt that the majority of inventors are rejoicing when patents are sustained by the courts, because inventions will then prove of greater value and capitalists will have confidence in inventions and money be procured easily by deserving inventors. It is no more than a logical fact that patents be sustained, because the patent laws of this country have been the chief factors for developing the resources of the country and have built up new and profitable industries. A patent, if sustained, is a contract between the government and a private individual, and there is no earthly reason why such a contract should not hold in the courts just as well as a contract between two private individuals. However, in patent law suits, opinions may differ regarding the scope or range of an invention and how claims are to be interpreted, that is, how far reaching or limited they shall be.

Experimenters in incandescent lighting may at the present moment be divided into two classes. Some try to improve upon the Edison lamp and others desire to invent lamps which do not infringe on any patent. The first mentioned may invent better filaments or they may look for lamps which can be manufactured cheaper.

The second class of inventors in this line must look for separable lamps, which consist of two or more parts, because the Edison patent covers in plain words an all glass closed chamber united by the fusion of the glass. Lamps which have two parts, made of other material than glass, for instance, of metals, alloys, cement, etc., are independent, according to the above; if they consist, however, entirely of glass they must be separable and not united by fusion of the glass.

The greatest chance for improvement is and will be in the future in the filaments. Inventions in this line will be of great value even after the Edison patent has expired. It is a well-known fact that the higher the voltage the larger will be the number of lamps which a lighting plant can carry with the same amount of copper in the ground. An installation with 220 volt lamps would carry theoretically twice the number of lamps that it carries at present with 110-volt lamps, and these lamps would not involve a change in the central station wherever the three wire system is in use. Filaments of more than 120 volts can be made of carbon by simply increasing their length, and this has been done by some concerns; for instance, the de Khotinsky company in Germany made filaments of 150 volts. Several disadvantages were experienced in shipping and operating these lamps: too long filaments break off easily when shipped where they are

cemented to the platinum wires. In practical operation these lamps sometimes show illuminated gases upon the cement, and when the volume of the gas increases it may happen that some of the current is passing from one little bulb of cement through the illuminated gases to the other little bulb of cement, thus causing the fusion of the platinum wires. Before the platinum fuses and while there is a short circuit between the little bulbs of cement, the filament is heated up but certainly not to full candle power. This phenomenon may easily be explained. The high-voltage carbon has a correspondingly high resistance, and the resistance between the little bulbs of cement is decreasing when more gases emanate from the cement. As soon as the resistance has been reduced enough the current will pass through both the filament and this space in accordance with their respective resistances. To remedy these defects high resistance filaments should never be fastened to the ends of the platinum wires by putting cement on; they should be fastened by electrolytically depositing carbon on there, because carbon deposited this way is very hard and does not give much gas. The two legs of a high resistance filament should be as far apart as practically possible for inserting it into the lamps and the vacuum should be as high as possible.

To avoid the exceptionally large breakage in shipping high resistance filaments should not be longer than 110-volt filaments. This may be accomplished by introducing into the filament mass substances of higher resistance than carbon or any known conductor of electricity. Such masses may be made of metal powder and metal oxides or of carbon mixed with metal oxides or suitable elementary substances. Magnesium and calcium oxides in carbon filaments have been patented. (U. S. Patent to L. K. Bohm, Dec. 8, 1891.) Other filaments were treated in atmospheres containing gaseous compounds; for instance, of silicium, chromium, phosphorus and iron. (U. S. Patents to Heller & Erlewein, 1891.) These filaments had a mineral coating on the surface of the carbon. However, for one reason or another, these lamps have never replaced the carbon filament lamp. There is still in this direction a great field for inventors. Some experimenter may discover a composition which is a sufficient conductor of electricity and allows the manufacture of high-resistance filaments for incandescent lamps, which do not volatilize so much as carbon and maintain their candle power for a longer time than the present lamps, even when burned at a higher economy.

If such compositions for filaments are discovered which will give incandescents of greater durability, then they certainly can be made of higher efficiency, say of at least 2 1-2 watts per candle. The advantages of economical lamps were fully described by me in *The Electrical World* of Feb. 4, 1893, and need not be repeated here.

The shape of the filament may also be greatly improved. It is rather remarkable that nothing has been done in this direction with a view to improve the effect of the light. The original horseshoe form is still used to the greatest extent, and the coiled filament, as made first by Swan, was made in this shape for the purpose of shortening the filament, and up to the present day only 110-volt filaments are made in this form. The 50-volt filaments are in horseshoe form. Those using incandescent lamps needing the light close to their work often complain that the light shows a peculiar line on the table or paper resembling the form of the horseshoe. This is disturbing, especially for writing, reading, jewelry work, watchmaking and the like. In large rooms and halls where many lamps are burning and where they are high up these lines are not observed. Experiments should be made with various shapes of filaments in order to find out what shape will remedy this deficiency.

(To be continued)

A New Method of Preventing Heat Radiation.

BY R. A. FESSENDEN.



THE use of electricity for heating has lagged somewhat behind its application for lighting and power. In spite of the fact that its use has met with most signal success in some special processes, such as electrical welding and forging, its employment in this way is very restricted.

One reason of this is the application of electricity to produce heat in ways for which it is not fitted. The use of electricity is economical only when the heat is to be localized and guarded from losses, and where temperature rather than quantity of heat is sought for.

The use of electrical resistance for heating street cars can, for instance, hardly be conceived of as economical under any circumstances, for if a company has power in excess of that required to run street cars, it would certainly make money by using coal in the cars and selling the extra power at as low a price as two cents per kilowatt hour, at which rate it could hardly fail to obtain customers.

A second reason is the difficulty in checking radiation from the body heated. According to the results obtained by Macfarlane, the amount of energy radiated from a box of metal raised to a temperature of 200 degrees C. above the air is equal to about 40 h. p. The writer's experiments make it about a third of this, or about 15 h. p. (The probable cause of the difference is given below.)

If we take the price of one kilowatt hour as fifteen cents, it is seen that the energy spent in merely maintaining the temperature of the box will cost about \$2.25.

If the box is surrounded with a covering of asbestos one inch thick, the loss from radiation will only be reduced one-half, and the expense of keeping up the temperature of the box will be about \$1.12, still much too high to be economical, except in extreme cases.

If, however, we confine our applications of electricity for heating to cases where temperature is required rather than quantity of heat, and if we can succeed in keeping down the radiation and convection losses, there are a very great number of cases where we may use electricity with economy and advantage.

One of these is, of course, electrical cooking. At present, owing to the inefficient means of checking radiation, the expense is too great for its practical use, except in special cases. As an instance it may be mentioned that a small oven on exhibition at the World's Fair this summer (and which was nicely blackened outside so as to radiate the greatest amount of energy possible), consumed no less than 3.83 h. p., which figure would probably rise to 4 h. p. in colder weather; the cubic contents of the oven being only 2.6 feet and the surface exposed to radiation only 11.5 square feet. At the rate of 11 cents per horse power hour this would mean an expense of 44 cents per hour.

The calculated loss from radiation in this case is about 3 h. p., and is probably something over that. The advantage to be gained in reducing the radiation is very evident.

Another typical case is the manufacture of varnishes. In 1890 the writer, while working at this subject from the chemical side, was led to the conclusion that the reason why varnishes could not be made colorless except by using the more expensive kinds of gum was because the melting point of the gum was so near the decomposition point of some of its constituents that the two actions always went on together, the result being a blackened varnish. It immediately suggested itself that this must always occur when char-

coal or other fuel is used to melt the gum, as the sides of the copper kettle must always be hotter than the gum in the centre, otherwise there would be no flux of heat, and that unless an inordinate time be taken, this heat gradient must always be so steep that the gum at the sides of the kettle must be decomposed before the gum in the centre is melted.

An obvious solution was to perform the work by electricity, and a number of experiments were carried out, with the most complete success, varnish being made from inferior and cheap gums which surpassed that made from the most expensive kinds in the market. The method used was to place the vessel containing the gum in a large box, heated by a coil of iron wire. The temperature was governed by an automatic regulator, and the hot air penetrated through the pieces of material to be melted so that the melting commenced evenly, and was finished much sooner than usual, and there was an almost absolute absence of black products of decomposition.

While the experiments demonstrated the complete success of the process as regards the making of varnish from inferior gums, the gain in this way was so nearly offset by the loss through the increased expense, due to the use of electricity, that the process was never worked on a large scale. With improved means of preventing radiation, however, there is little doubt that it would prove a success.

A third type may be illustrated by the manufacture of sulphuric acid. To concentrate this there are at present two methods in use. (A third method, that of letting the dilute acid trickle over heated stoneware, is only suitable for the manufacture of commercial acid, and would not do where the chemically pure acid is required.) The first is the distillation of the water from the acid, while contained in glass vessels heated externally. This method is expensive on account of the great amount of breakage of the glass vessels, the least draught of air sufficing to crack them.

The second method is hardly less expensive, as it involves the use of large platinum stills. The first cost and the interest on these is very high; moreover, they do not last, as the sulphuric acid acts on them, slowly but surely dissolving the platinum.

It is very easy to devise a method of performing this process by the use of electricity, the acid being contained in shallow glass vessels and surrounded by a lead chamber, so arranged that there can be no drip back into the glass vessels. Here again, however, experiment showed that the losses through radiation were too great to make the process pay.

We see, therefore, that in the three cases where temperature rather than quantity of heat is required—where an even distribution of temperature is necessary—and where the application of heat requires expensive vessels, that the use of electricity is indicated, and would be commercially profitable were it not for the great losses from radiation. It is the object of this note to describe a simple method by which such losses can be greatly reduced.

In 1892, the writer, while considering the question, conceived that the principles pointed out by Fourier ("Theory of Heat," Sec. 88, Freeman's translation), might be practically applied. Though the proof was not free from inexactness, it was thought worth while to give the method suggested by the equations a trial. The subject was given to two of my senior students, Messrs. Keiper and Fisher, by whom the experimental work was done. The results were most satisfactory, and showed the method to be much better than any one with which the writer is acquainted.

In describing it the words heat, conductivity, etc., are, in accordance with recent usage, applied in a more definite manner than was till recently the custom. The heat is supposed to flow, as electricity does, from a place of high potential to one of low potential. Quantity of heat

corresponds to quantity of electricity. The unit of quantity is the calorie. Temperature corresponds to potential. (Some confusion has arisen lately in regard to this question, it being stated that if temperature is heat potential, its dimensional formula must be unity, while since capacity for heat or specific heat is a numeric, this cannot be the case. The error comes in supposing that specific heat is a numeric, for from Dulong and Petit's law, the quantity of heat required to raise a body one degree is equal to the unit of kinetic energy multiplied by a numeral. Therefore the dimensions of specific heat are $L^2 M T^{-2}$ and not unity.)

Heat conductivity, or impartivity, corresponds to electrical conductivity, and heat resistance, or morativity, to electrical resistivity. Specific heat corresponds to specific capacity.

The theorem of Fourier referred to may be given as follows:

"If we take a surface and maintain it at a constant temperature so that its loss per second is K calories, and then surround it with a thin shell of conducting material of impartivity i , and thickness t , then the body must be kept at a temperature $3 + ht/i$ times the original temperature in order that the heat loss may be the same, the space between the body and its surrounding shell being very small and filled with air, i being the impartivity of the substance of the shell, and h that of air." This theorem only holds in the case where no heat passes from the body to the shell by radiation. Fourier does not suggest any means of preventing this radiation, and goes on to consider what will be the law of loss when the space between the body and its envelope is small and free from air.

It is evident, however, that radiation can nearly be completely prevented by polishing the surface of the body and the surface of its envelope. For instance, Trowbridge found that the loss of red rays when twice reflected from silver was only 6 per cent., and for the heat rays it would probably be less, as silver has its greatest absorption in the short wave lengths.

We have here a method of cutting down the heat losses in a geometric rate, instead of in an arithmetical one, as is the case when ordinary heat insulating substances, such as asbestos, magnesia, etc., are used. The object of the experiments was to prove whether this theory is correct or not, and though the evidence is scant, owing to the fact that but two envelopes were tried, it will be seen that it held very nearly for the first envelope, and would possibly have held for the second also, but that the two outer envelopes touched at one point, a fact which was not discovered until too late to repeat the experiment; but even then the reduction was very considerable. The body containing the heat source was a polished tin box (no attempt was made to make it brighter than when bought), and the source consisted of a resistance of iron wire, the energy lost being measured by the product of the current passing through the wire into the drop in voltage across its terminals.

(In passing it may be noted that this is probably by far the best means for measuring the heat insulating power of materials which can be used, being far superior to the ordinary methods of measuring by condensed steam, etc.)

The other boxes were also of tin, 1-2 and 1 inch larger, and separated from one another and from the inside box by small pieces of glass tubing. Narrow strips of asbestos were used at first to separate the boxes, but the flow of heat through them was found to be too great; though they were not more than half an inch wide, they entirely vitiated the results, and so the glass was substituted for them.

In making the experiments a steady current was passed through the resistance, and the point noted at which the temperature of the box became constant, or at which, after the lapse of fifteen minutes, there was not a change of one degree. The difference between the temperature of the box

and the outside air was then noted, and the watts necessary to maintain that temperature difference. The current was then increased, and a new reading taken, and so on till the highest temperature desired had been obtained, when the process was reversed, and a curve taken for various reductions of current, till the temperature of the box reached that of the air once more. If the up and down curves did not agree, as they sometimes did not, on account of convection currents, which it was impossible to get rid of entirely, the experiment was repeated till they did. The box was then surrounded by another box, or a half-inch wrapping of asbestos, and a new set of observations taken.

In the curves shown in Fig. 1 Curve 1 represents the relation between watt loss of radiation and difference of temperature for the inside box (whose area was six square feet), when both its inside and outside surface were bright.

Curve 2 represents the effect of surrounding the same box, which we will call A, with a wrapping of asbestos board 1-4 inch thick, the surface of the asbestos being left white.

Curve 3 the same, but covering of asbestos 1-2 inch thick.

Curve 4.—Result when box A was surrounded by box B

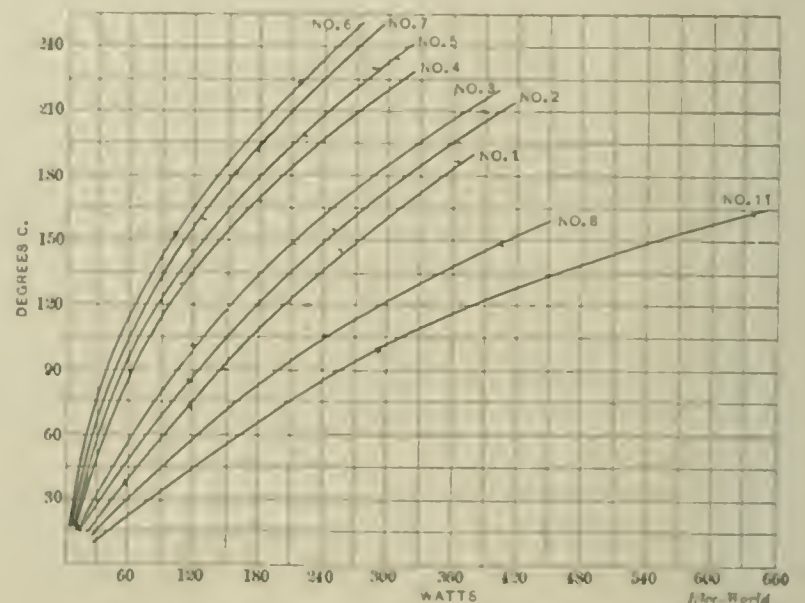


FIG. 1.—CURVES OF HEAT RADIATION.

and separated from it by a few small strips of asbestos; both boxes bright. (The differences of temperature given are in every case the difference between that of the inside of the inside box A, and the air in the room, at a distance of 15 feet from the boxes.)

Curve 5.—The same, but separated by bits of glass tubing.

Curve 6.—Box C outside of both box B and box A; all boxes bright. It was afterward found that the top of box B touched the top of box C, but before this was noticed box A had been tarnished and the experiment could not be repeated. In later experiments this was guarded against.

Curve 7.—Same as 6, but with inner box tarnished.

Curve 8.—Box A alone, but painted on inside with gold size and lampblack. Outside surface bright.

Curve 11.—Box A, but both sides coated with lampblack and gold size.

(To be continued.)

A New Telephone Central Exchange.

The Metropolitan Telephone and Telegraph Company opened a new telephone exchange at 95 Broadway, New York City, on Jan. 3, from which 1,000 subscribers in the district bounded by Broadway, Wall street, Battery and East River, are already being served, thus relieving the Cortlandt street station. The new exchange has an ultimate capacity of 3,000, and represents the most modern development of telephone engineering. It contains the latest type of metallic circuit multiple switchboards, and notable features are the ingenious self-restoring indicators, the apparatus for ringing subscribers' bells, for testing lines, for locating troubles and for complete supervision of the work.

Unipolar Dynamos Which Will Generate No Current.

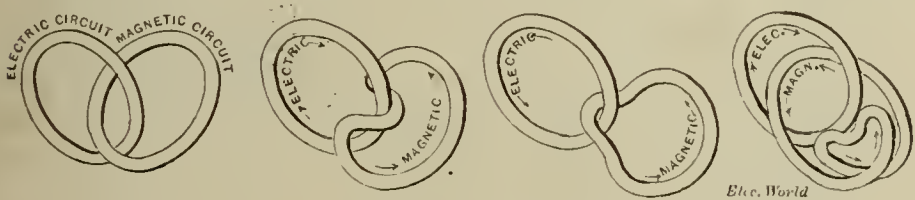
BY CARL HERING.



THE ideal commutator-less unipolar machine which will generate voltages capable of being used for lighting and power, is to many electricians about what perpetual motion was to many mechanics; they are both fascinating ideals on which much brain work, time and money have been spent, but which have both resisted stubbornly every attempt at a solution; they differ in the important respect that every intelligent engineer knows positively that perpetual motion is an impossibility, but in the case of unipolar machines of more than a few volts, the impossibility of the problem has perhaps not yet been demonstrated, and it is doubtless for this reason that so much time is still being devoted to attempts to make such machines, even by very intelligent men. As they have generally, if not always, been unsuccessful attempts, little is heard about them except perhaps in the Patent Office, where the examiners make short work of such applications by resorting to their privilege of requiring "a working model" before proceeding with the case.

As much time, money and intelligent brain work is doubtless still being spent in the attempts at the realization of this fascinating problem, particularly by beginners, the writer will endeavor to show, not that the solution is an impossibility, but that there are certain fundamental principles which may as well be recognized at the start, and which when so recognized will show inventors at once that probably nine-tenths of their designs will not be operative, thus saving them and their capitalists the work and expense of constructing experimental models. Text-books usually describe operative apparatus, but we will here reverse the custom and show what is inoperative. As the fundamental principles to which we are going to call attention are doubtless all well known to those who have a thorough knowledge of the laws of electricity and magnetism, the present remarks are intended more for amateurs and beginners, with the hope that they may save such inventors much time and trouble.

One of the first principles which may be assumed as fundamental is that an electric circuit and a magnetic circuit may both be considered as closed links, shown in Fig. 1.



FIGS. 1, 2, 3 AND 4.

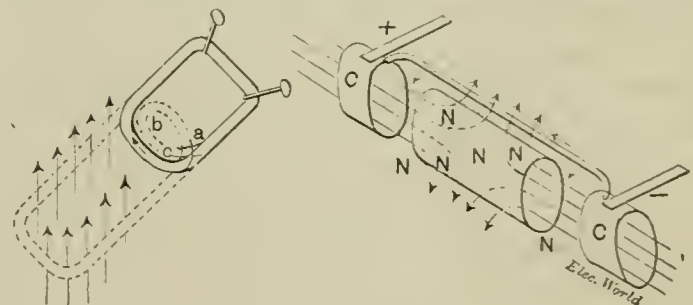
The act of linking them together, as shown in Fig. 2, by making one "cut" the other, will generate a current as indicated, while unlinking them, as in Fig. 3, will generate a current in the opposite direction. The unfortunate term unipolar machine may be said to refer to a dynamo in which the current in the armature wire is "unipolar," that is, it does not reverse periodically, as in all other dynamos and alternators, but always has only one direction. In such unipolar induction it is therefore essential that there must either be a continuous linking or a continuous unlinking of the two circuits, for if there is an alternate linking and unlinking it will at once become an ordinary dynamo or alternator. The only possible solution, therefore, is, that one and only one, of these operations must be continuous.

Before proceeding, attention should be called to the fact that a magnetic circuit, although somewhat analogous to a stretched rubber band, cannot be cut like it in order to unlink it, or to get it out of the way, so to speak, without

affecting the electric circuit with which it was linked. It appears that the only possible way for a magnetic line of force to be obliterated or gotten out of the way entirely is to allow it to collapse, that is to become smaller and smaller until it is reduced to a point, but in this reduction of its circuit it will "cut" any inductor which was within its circuit; that is, which was linked with it; it appears to be absolutely impossible to unlink it in any other way, except by opening the electric circuit, which, of course, means a commutator or other device for so opening the circuit, and this is the very thing that the unipolar machine is intended to avoid. It is therefore axiomatic that if in a unipolar machine a magnetic and an electric circuit have once been linked together they cannot possibly be unlinked again without reversing the current in the inductor, and thereby making it an ordinary dynamo requiring a commutator. All intended unipolar machines in which the idea is to cut the lines in one direction, then obliterate them or reverse them quickly and cut them again in the opposite direction, will therefore be inoperative.

Let us see how it is possible to cut or link them continuously in one direction. In Fig. 4 the magnetic circuit has been linked once and is being linked again in the same direction. If this is continued indefinitely there will be true unipolar induction, and if the electric circuit is a coil of many turns, any desired voltage may thus be generated. But there does not seem to be any way in which the lines of force can be so twisted and moved; furthermore, this necessarily would "stretch" them and wind them, so to speak, around the coil; but they do not accommodate themselves to such manipulations as stretching to an infinite length or winding around a conductor as a spiral, and it is therefore unlikely that there will ever be a solution of the problem in this direction.

But if instead of manipulating the magnetic circuit the electric current be made to go through the process, the problem is easily solved. This is best shown in Fig. 5, leav-



FIGS. 5 AND 6.

ing out of consideration at present the dotted loop *a b c*. If the electric circuit be fixed at one part, as shown, and if the other part be made to move through a field represented by the arrows, by stretching it, there will be unipolar induction as long as this motion is continued in one direction. As is well known, this is accomplished in practice as shown in Fig. 6, in which the movement is a circular one, thus permitting the field to be a limited instead of an unlimited one, and the infinite "stretching" of the circuit is then accomplished practically by means of sliding contacts at *C, C*. If instead of these sliding contacts the electric circuit be supposed to be winding itself up on these cylinders, it will readily be seen that this method is an equivalent of the one shown in Fig. 4, by supposing the two circuits to be interchanged, making the electrical one the flexible one. These machines are operative, but generate only very few volts; 5 or 10 is believed to be the maximum which has been generated by commercial machines.

In many projected unipolar machines, based on this principle, it was thought that if the wire be coiled on itself in some way, as shown by the dotted line *a b c*, Fig. 5, that the electric circuit would then cut the field repeatedly, the E. M. Fs. being in series, thus generating a high E.M.F. This is the principle in probably nine-tenths of the many inopera-

tive unipolar machines. But it will readily be seen that the return wire *a b* cuts the lines just exactly as much as the useful part, *b c*, and what is gained by *b c* is exactly balanced by the volts in the opposite direction in *a b*, and there is absolutely no gain. As the circuit must be a closed link, it must in some way be brought back to one side of the field before it can be made to cut it again. It is the counter-induction in this return wire which makes most of the proposed unipolar machines inoperative. It will always be found, although it may sometimes not be as easily seen as in Fig. 5, that if there is such a return portion of a circuit it will cut the same lines, and an exactly equal number of them, not a single line will escape it.

If this return winding *a b* be fixed like in the first winding, then the machine becomes operative, but it then requires, like the first, a separate sliding contact at each end; if there are no objections to a multiplicity of such contacts, then unipolar machines of any voltage are possible; but there must be two such contacts (in some cases only one) for each of these windings.

It has often been claimed that by enclosing this troublesome return wire in an iron tube, or surrounding it by iron, it will be shielded from the lines of force, but this is an error, as a wire enclosed in an iron tube when moved through a field will cut precisely as many lines of force as it would without the iron. The lines (or more correctly, the flux) must pass from one side to the other, and as their circuits cannot be opened, they must cut the wire within the tube.

Another favorite method is to make this return wire cut the lines at a lower speed, say near to the axis, thus generating a lower E. M. F. and leaving an available difference. But this is also an error, as it will always be found that either the field is more intense or else the wire cuts many of the lines where it passes from the periphery to the axis; the lines will always be found to be somewhere, and they will always be cut by this return wire, as they are all closed links.

Still another favorite method is to cut the lines rapidly in one direction and slowly in the reverse direction and then utilizing only the higher E. M. F's. But this is then no longer a unipolar machine. If the equivalent of a flap valve could be introduced to keep out the lower E. M. F's. (as is done, for instance, when a Leyden jar is charged from a Ruhmkorff coil) such a machine would be operative, but would have a pulsating current with long periods of rest between the pulsations, which would make it practically useless. Although the E. M. F., and therefore the current of the reversed motion, would be smaller, they would last for a longer time.

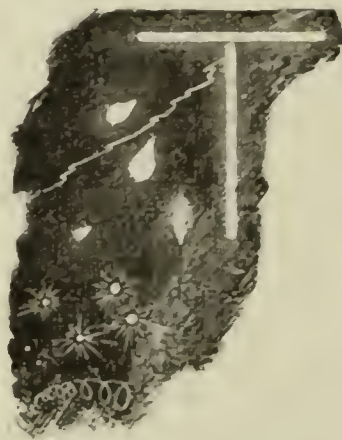
There is still another principle which is not usually stated in text-books, and which if it had been well known would have saved much work in designing inoperative unipolar machines. It was believed by some that when the lines of force in a unipolar machine reached the armature iron they were carried with this iron and they could in this way be transported, as it were, to some place where they could be released again, meanwhile the circuits have been reversed without induction and are ready to be cut again. Or, in more general terms, it was thought that if an iron core in a coil be revolved, the coil remaining fixed, the lines of force would move with the iron, and not remain fixed with the coil. But this also appears to be an error, as lines of force are said to remain and move with that which generates them; that is, with the coil of an electro-magnet; they are stationary if the coil is stationary and revolve if the coil revolves. This statement is made, however, on the authority of others, the writer not having made any experimental demonstration himself. But whether it be true or not, we believe that it may be safely assumed that a magnetic circuit or link cannot be temporarily opened, as it were, like an electric circuit containing a condenser, and afterwards closed again, keeping its

properties; nor can it be stretched out indefinitely and wound around a cylinder, the equivalent of which, in the electric circuit, is accomplished as shown in Fig. 6; if either of these were possible high voltage unipolar machines, with repeated inductions in a coil, would be possible.

It seems therefore that the future of operative unipolar machines lies in the use of large and strong fields, great speeds and more or less numerous sliding contacts; with these it is quite possible to obtain 100 volts, but whether such machines would have any advantages over a well constructed dynamo with a commutator is a question.

The Most Economical Age of Incandescent Lamps.--II.

BY LIEUT. MANNING K. EYRE.



THE first part of this paper appeared in the last issue of this journal, and as the continuation of the subject contains constant references to the tables and curves, published in that issue, these data are here repeated, with the addition of Table III. In the last issue the columns in the tables were marked erroneously, "Total cost." They are here corrected and are marked as they should be, "Lamp cost." The curves A, B and C are the same carbons burned at different efficiencies: A at 3.1 watts, B at 3.6 watts, and C at 4 watts per candle power.

TABLE I.

Life.	Percentage of Candle Power.	Watts Per Candle or Efficiency.
0 hours	100	4.2
100 hours	95.6	4.5
200 hours	90	4.8
300 hours	84	5.0
400 hours	78.4	5.3
500 hours	73	5.6
600 hours	68.6	5.9
700 hours	64.7	6.3
800 hours	62	6.6
900 hours	57.4	6.8
1000 hours	56.6	6.9

TABLE II.

16-c. p. 4.2 Watt Lamp.

Lamp Smashed at	Lamp Cost.	Mean C. P. for 3000 Hrs.	Cost of 1 Candle of Light for 3000 Hrs. When El. H. P.		
			Hour Costs, 3c. 5c. 8c.		
200 hours	\$5.25	15.2	\$0.88	\$1.25	\$1.79
300 hours	3.50	15.	.77	1.14	1.69
400 hours	2.62	14.4	.75	1.13	1.69
500 hours	2.10	13.9	.75	1.13	1.71
600 hours	1.75	13.4	.75	1.14	1.73
700 hours	1.50	12.9	.745	1.15	1.76
800 hours	1.32	12.5	.745	1.17	1.81
900 hours	1.17	12.	.76	1.19	1.85
1000 hours	1.05	11.6	.77	1.22	1.90

TABLE III.

20-c. p. 3.1 Watt Lamp.

Lamp Smashed at	Lamp Cost.	Mean C. P. for 3000 Hrs.	Cost of 1 Candle of Light for 3000 Hrs. When El. H. P.		
			Hour Costs, 3c. 5c. 8c.		
200 hours	\$5.25	19.4	\$0.655	\$0.910	\$1.30
300 hours	3.50	18.4	.596	.860	1.27
400 hours	2.62	17.6	.574	.857	1.28
500 hours	2.10	17.1	.560	.852	1.29
600 hours	1.75	16.5	.559	.860	1.31
700 hours	1.50	16.1	.557	.867	1.33
800 hours	1.32	15.7	.560	.878	1.36
900 hours	1.17	15.4	.562	.885	1.38

Table III. is calculated in the same manner as Table II., using as data curve A of Figs. 1, 2 and 3. These curves represent the average performance of a number of modern lamps of

20-c. p. and 3.1 watts per candle power efficiency. A glance at Tables II. and III. will impress any one with the advantages of using, at the present day, 3.1-watt lamps in preference to lower economy, as shown in Table II. Although Table II. represents the performance of 16-c. p. lamps, we find the energy expended per lamp greater throughout than for the 20-c.p. lamp of Table III. The smashing point remains very nearly the same, but the saving of expense per candle of light is very marked. Taking, for instance, the cost of power as 5 cents and smashing both lamps at 500 hours, the cost of a candle of light for 3,000 hours, using the 4.2-watt lamp, is \$1.13 and using the 20-c. p. lamp is 85 cents; and in the first case, we have averaged only 13.9 candles of light and in the second case, 17.1. The saving per candle is 28 cents and per lamp \$1.18 in 3,000 hours. Supposing the 4.2-watt lamp to be a 20-c. p. lamp of initial efficiency of 4.2-watts, instead of a 16-c. p. lamp, the mean candle power for 500 hours would be 17.4 and the total cost per lamp for 3,000

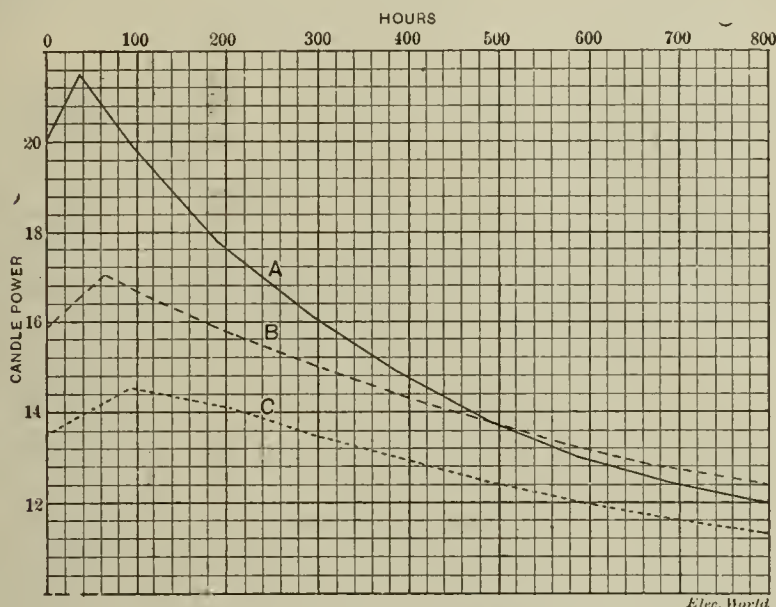


FIG. 1.—CHANGES IN CANDLE POWER WITH LENGTH OF LIFE.

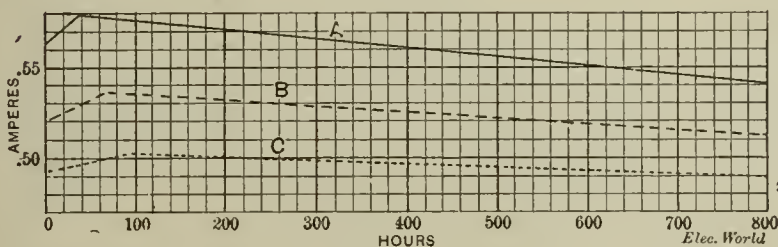


FIG. 2.—CHANGES IN CURRENT CONSUMED.

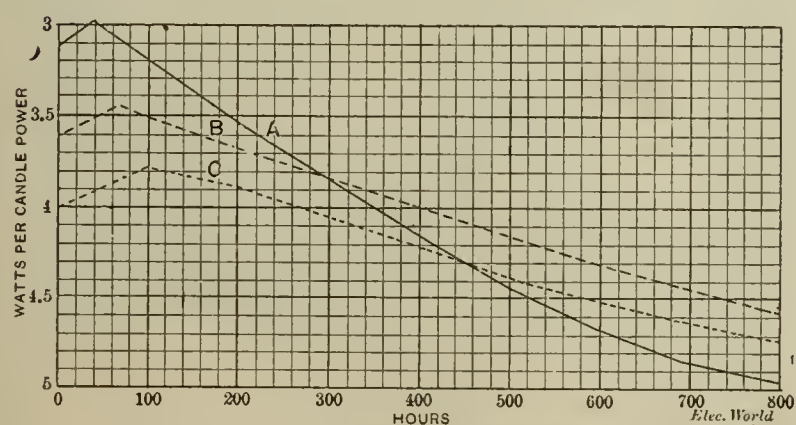


FIG. 3.—CHANGES IN EFFICIENCY.

hours \$19.66, while for the 3.1-watt lamp of 20-candle power, the average candle power would be 17.1 and the total cost per lamp for 3,000 hours \$14.53. In other words, a man with a 1,000-light plant, paying 5 cents per electrical horse power hour, delivered to the lamps, in 3,000 hours would save, approximately, \$5,000 by using a 3.1-watt lamp in preference to the 4.2-watt lamp, smashing either at 500 hours.

Referring again to the smashing point of lamps, by reference to Table I. we see that the candle power, if the lamps are broken at 800 hours, with a cost of power of 3 cents, averages 12, but it must be remembered that for the last 100 hours or so of the run the candle power is down as low as 9.1-2, and the customer is probably complaining bitterly.

To large users of lamps, who buy in large quantities, the

first cost of the lamp is much less and this means, of course, that for large consumers the lamp should be broken earlier. Another point that must be remembered is that the above Table II. is for 16-c. p. lamps, and since the price of 20 and 24-c. p. lamps is generally no greater; on the other hand, the cost of power is greatly increased, and this again would induce us to break the lamps earlier. For example, a 24-c. p. lamp takes 50 per cent. more power than a 16, with generally the same cost of lamp; a 32-c. p. lamp takes twice as much power, with a lamp cost generally from 30 per cent. to 50 per cent. higher. Consequently, the higher the candle power of the lamp the sooner it should be renewed to get the most economical and satisfactory results.

Many people will have the impression that if they use 4-watt lamps they can run them economically for a longer time; but by what we have just seen, this is not tenable. If the regulation of a plant is not good enough to warrant the use of a high economy lamp it must be remembered that a low economy lamp on such a plant will act very nearly as a high economy lamp would on a well regulated plant. In other words, a 4-watt lamp on a station whose voltage runs 4 per cent. high will drop in candle power as much as a 3.6-watt lamp on a station where the voltage at no time averages more than 2 per cent. high—and will live no longer.

The curves of Figs. 1, 2 and 3 speak for themselves, and we can only notice from them how well the modern lamp of high economy keeps up its candle power as compared with experiments made two years ago. Another noticeable feature is the increase in candle power and current consumed and the decrease of the watt per candle in the early part of the life of the lamp. If station managers fully realized this fact of the increased consumption of energy during the first three or four hundred hours of the life of the lamp they would not be so ready to state that the average consumption energy per lamp decreased as the lamps burned. A study of the curves of current consumption would show at once that practically up to 800 hours the mean consumption of current is constant. Or, in other words, if these curves were assumed as horizontal lines, the results based on this assumption would be very near the truth.

The above results, concerning the smashing points of lamps, lead me to the following deduction:

Let M = cost per lamp exclusive of renewals.

Let P = the normal candle power.

Let K = decrease in candle power per hour of life.

Let L = cost of one lamp.

Let y = the number of hours lamp has burned at any time.

Let x = the cost per candle power hour during any time

y

On the assumption that the candle power decreases uniformly with the life of a lamp (which assumption is so near to the truth that it will be sufficient for the deduction of an approximate formula) the mean candle power for any time y is

$$P = \frac{Ky}{2}$$

Then for the cost per candle power x for any time y we have

$$X = \frac{M + \frac{L}{y}}{P - \frac{Ky}{2}}$$

Reducing

$$X = \frac{2L + 2My}{2Py - Ky^2}$$

Differentiating and putting

$$\frac{dx}{dy} = 0,$$

we have for the value of y , at which cost per candle power hour x is a minimum,

$$y = \sqrt{\frac{2(LP - K)}{K \times M}}$$

Example :- $L = 35$ cents ; $P = 16$ c. p. ; K , from the curve of table II, $= .008$; $M = 3.4$ cent.

Solving the equation for these values, we have for the value of y , at which the cost per candle power hour is a minimum, 430 hours.

For practical purposes this formula can be reduced to

$$y = \sqrt{\frac{2LP}{KM}}$$

This formula is only approximately true and its value is perhaps questionable; nevertheless, it is inserted here in hopes that it may be useful to some.

A New Lamp Board.

BY GEO. D. SHEPARDSON.



NE of the necessary adjuncts of an electrical laboratory or testing room is an absorption rheostat that may be left in circuit continuously to dissipate energy. For many purposes, such as taking magnetic or dynamo curves or calibrating instruments, it is necessary that the resistance be changed from high to low values by more or less definite amounts, and that at each change it takes a certain fixed value. Iron wire strip tin, carbon blocks, powdered carbon, liquid solutions, in fact most substances except expensive alloys, are unsuitable for such purposes, because on account of temperature changes the resistance alters after the current is turned on or is changed. Such resistance is also affected to some extent by draughts of air. When an iron wire coil is connected across a constant potential circuit the current that

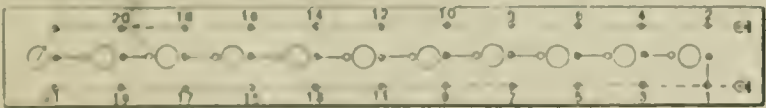


FIG. 1.

passes is that due to the voltage divided by the cold resistance of the iron. In a few seconds the iron becomes heated, its resistance increases, and the current decreases. Such uncontrollable changes in current strength are fatal to accuracy in many lines of work. Perhaps this is one reason why the method of reversals gives higher values in hysteresis curves than the step-to-step method.

Incandescent lamps have long been recognized as being a convenient, economical and reliable means of dissipating definite amounts of energy. When the filaments are small they reach a constant temperature and resistance almost the instant current is turned on. They are not sensibly affected



FIG. 2.

by air draughts. They may be arranged to give a wide variation in resistance with ease, certainty and rapidity.

One form of lamp board designed and made in the electrical laboratories of the University of Minnesota is shown in the accompanying sketches. Figs. 1 and 2 show a plan and elevation. Eleven lamps with Edison bases are so arranged as to be connected in series, parallel or any intermediate combination by the movement of three-way switches. Each socket consists of a device known and used

by the writer since 1887, and is similar to sockets now upon the market.

In constructing these lamp boards, brass wire about one-sixteenth inch thick was wound into a long spiral on a mandrel seven-eighths inch in diameter. (The proper diameter of mandrel will vary with the stiffness of the wire, and should be determined by experiment. This spiral was cut into pieces containing six turns each. Three turns of each piece were straightened and beat so as to be parallel to the axis of the coil. The other end of the wire was bent out so as to

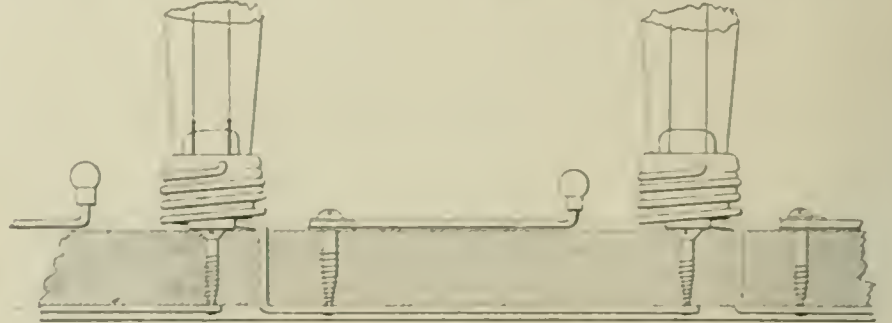


FIG. 3.

project about one-quarter inch. On one side of a pine board 6 inches wide, 5 feet long and 1 inch thick, were sawed three grooves a quarter inch deep, one about an inch from each edge and one in the middle. The wire coils were placed about 5 inches apart along the medial line on the opposite side of the board, the straight portions of the wire being passed through and bent in the middle groove as shown in Fig. 3. A flat-headed brass screw at the centre of each coil passes through the board and is soldered to the end from the next socket. The lamps are inserted by untwisting the spiral by means of the projecting upper end of the wire noted above, and screwing in the lamp until the terminal cap strikes the flat-head screw. The outer terminal of one lamp is thus electrically connected with the inner terminal of the next.

TABLE SHOWING CURRENTS WITH DIFFERENT POSITIONS OF SWITCHES.

Current.	Switches closed.										
.03.....	1										
.04.....	3										
.05.....	5										
.06.....	7										
.07.....	9										
.08.....	11										
.1.....	13										
.12.....	15										
.18.....	17										
.22.....	17	2									
.23.....	17	4									
.25.....	17	6									
.27.....	17	8									
.29.....	17	10									
.33.....	17	12									
.40.....	17	12	1								
.44.....	17	12	3								
.5.....	17	12	5								
.59.....	19	17	12	6							
.68.....	19	17	15	12	5						
.78.....	19	15	12	7	5						
.93.....	19	15	12	7	2						
1.03.....	19	15	12	7	4						
1.4.....	21	19	15	12	7	4					
1.8.....	21	15	13	12	7	4					
2.2.....	21	13	12	9	7	4					
2.53.....	21	13	12	9	7	5	4				
3.03.....	21	18	13	12	9	7	5	4			
3.4.....	21	20	18	13	12	9	5	4			
3.75.....	21	20	18	16	13	12	9	5	4		
4.4.....	21	20	16	13	12	9	5	4	1		
5.7.....	21	20	16	13	12	9	8	5	4	1	
6.93.....	21	20	17	16	13	12	9	8	5	4	1

A stout wire is laid in each of the outer grooves in the board and is soldered to the points of round-headed brass screws opposite each lamp, and also fastened to a binding screw at one end. Wires with insulating handles pivot about round-headed brass screws which are soldered to the wires connecting the sockets. When turned to one side or the other these connect the lamps with either main lead, the

screws on the sides all being turned with the slots in such a direction as to receive the tongues of the switches. The various screws being numbered, we may connect the lamps in any combination of series or parallel. When all the switches are in the medial position the circuit is entirely open. When the switch near the terminals is thrown over to post No. 1 as shown in Fig. 1, the lamps are all in series, the central screw of the last lamp being permanently connected to one lead wire as shown by the dotted line.

The accompanying table shows the currents obtained with different positions of the switches, the potential of the dynamo varying between 112 and 108 volts.

This lamp board has proven so satisfactory that it is in-

pies and Christmas puddings. Perhaps some method of integrating the specific heats, latent heats, and density of the heterogeneous mass to be cooked will be found necessary before the temperature can be finally determined. This will mean Royal Society Papers on the subject. Besides all this, the cooking appliances are depicted as being fitted with a whole battery of switches, various combinations of which, like the stops on an organ, will be necessary to produce various effects. "Afterward," says our contemporary, in an account of the destructive distillation of a joint, "four of these switches are turned off, and the heat is applied from one side only." Just think of the high scientific knowledge required in order to be able to manipulate these cookery stops, so as



THE ELECTRICAL INDUSTRY COURAGEOUSLY FACES THE SITUATION.

tended to construct others with more lamps and a correspondingly greater and more uniform range.

Electric Cooking.

The advent of electric cooking apparatus seems likely to evolve a highly scientific species of cook, with, we may be sure, highly up-to-date notions about the "living wage." "Cookery," we are told by a daily contemporary in a description of the electric process, "is raised from the rule-of-thumb level to that of an exact science by the use of a graduated thermometer. For bread or puff pastry a temperature of 370 deg. Fah. is required; for pork, veal, or ordinary pastry, 350 deg.; for beef, 340 deg."; and so on. All this must mean a table of constants in the kitchen, with possible formulae with different coefficients for jam tarts, mince

to produce any given thermal distribution on the three Cartesian axes of the kitchen oven!

Refuse Utilization Scheme.

A scheme of electric lighting by power derived from refuse, says the London "Electrician," has been drawn up, and is intended to be tried at Harrogate. The process in outline is as follows: The refuse is brought in carts or otherwise and tipped upon a platform, whence it is automatically carried into a rough-sifting apparatus which separates the old pots, cans, etc., the smaller material passing through the sifter into a large hopper, from which it is forced in regular quantities into a drying cylinder. It then passes on to another sifter which takes out the fine dust, the resultant fuel being injected into the boiler furnaces.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE PRINCIPAL FOREIGN ELECTRICAL JOURNALS.

R. F. OUTCALT

BY CARL HERING.

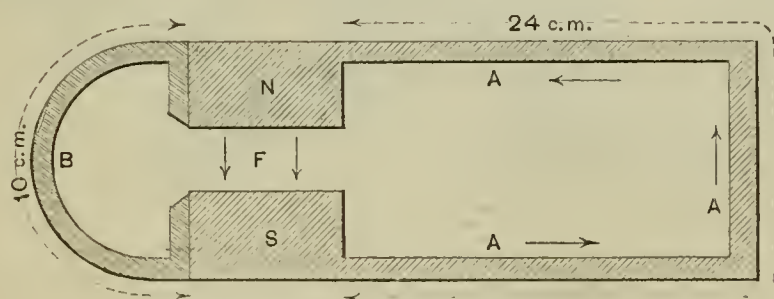
ELECTRO-PHYSICS.

Electricity.—In an editorial in the Lond. "Elec. Rev.," Dec. 22, in which attention is called to the one in The Electrical World, Dec. 2, it is questioned whether the theory of electricity is so far behind the theories of light, heat, chemical action and gravitation; Maxwell's theory of light has gone far to make the theories of light and heat merely the particular cases of electricity; Lodge appears to believe electricity to be of the nature of a material fluid, whose locomotion, radiation or vibration produced the electric current, magnetism or light; Poynting does not believe in the substantiability of electricity, and thinks that the electric energy does not flow along the wire, but takes short cuts to it through the dielectric; the ether has until recently been considered to have the properties of an elastic solid, but it has now been found necessary to abandon this position; Mr. Glazebrook recently stated that the elastic solid theory of the ether had failed and suggested as a substitute Lord Kelvin's labile, or froth ether; the great objection to the former is that it cannot transmit transverse vibrations without, at the same time, transmitting longitudinal vibrations, which is inconsistent with the known phenomena of light; the labile ether, whose elasticity is due to surface tension, transmits transverse, but not longitudinal, waves; Lord Kelvin's molecule and vortex sponge theories give better explanations in many points than the labile ether theory.

Oscillations in Cylindrical Conductors.—Mr. Blondin's mathematical article is continued in "La Lum. Elec.," Dec. 16.

MAGNETISM.

Compensation for Hysteresis.—In the Lond. "Elec. Rev.," Dec. 22, the following method, devised by Prof. Perry, is described. In the accompanying figure *AAA*, is the electro-



COMPENSATION FOR HYSTERESIS.

magnet, and *B* a strip of permanent magnetic steel placed as a shunt to the field *F*; when excited the lines have the direction as indicated, and when the current is broken the lines due to hysteresis still circulate in *A* and *B*, in the same direction; if the length and section of *B*, taking into account the greater residual magnetism of the steel, are chosen so that the number of lines of force in *B*, shall be equal to the number in *A*, then none shall appear in *F*. The magnetization curve of *B*, may bear such a relation to that of *A* that through all decreasing currents the extra induction in *A* due to hysteresis would be just balanced or taken up by the induction in *B*. An ingenious apparatus is described and illustrated for measuring the field; it consists of a modi-

fied Lippmann instrument. One of the best curves obtained from experiments is given, together with that for the iron alone; the addition of the steel reduces the strength of the field 25 per cent., but the effective hysteresis is reduced to practically nothing; the sectional area of the steel was 0.4 times that of the iron; it was found that the section of the steel must be very great, reducing the field to less than one-third, and in order to enable a smaller section of steel to be used, the reluctance of the iron circuit was increased by an adjustable gap, produced by inserting a piece of brass in the magnetic circuit in the yoke piece. Representing the magneto-motive force in the iron and steel by *M* and *m*, respectively, and the reluctances by *R* and *r*, then the condition in which there will be no flux across *F* is $m \div M = r \div R$; the latter ratio may be decreased by increasing *R*, and this is done by means of the air-gap; this removal of a restriction as to the length and section of the steel facilitates the obtaining coincidence in other parts of the curve; the experiments were not wholly successful, showing that if the current was reversed it was necessary to increase it to the same maximum as before in order to get satisfactory results; the method is, therefore, practicable only when the current is never reversed; if, however, the current be passed around the steel also, it is possible to reverse both simultaneously.

Magnetic Rotation.—The Lond. "Elec. Eng.," Dec. 22, quotes briefly from a chemical society paper by Mr. Perkin.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Insulation and Fault Detection in Three-Wire Systems.—The Lond. "Elec. Eng.," Dec. 22, reprints an interesting paper by Mr. Wilson, describing the method used at the Glasgow station. The description is too long to be fully abstracted here, but the principle is briefly as follows: Two multicellular voltmeters are connected in series between the positive and negative wires, the connection between them being led to earth; as one of the lines becomes grounded the corresponding voltmeter will fall to nearly nothing, while the other will rise; if the fault is on the neutral wire they will both read exactly 100 on a 100-volt circuit; this indicates on what line the fault lies; to calculate the absolute insulation the voltmeter readings are taken and also the current leakage from each two of the wires by connecting the other through a low-resistance ammeter to earth; this gives three current readings, from which, together with the potential readings, and measurements, made with an auxiliary resistance put in parallel with the greater of the two insulations, the insulation resistance may be calculated by a method which he gives; this is done every morning and requires but three minutes; the insulation resistance required from the customers is 60 megohms per lamp, the mains being fully up to this standard; the voltmeters must be electrostatic or otherwise this is a modification of the well-known lamp-test, which, he says, is of no real value except to mislead the public, for which purpose he claims it is often used; if, for instance, the insulation is very low all over in comparison with the lamp resistance, the lamps will not glow unless there is a heavy fault. For locating the faults without

disconnecting the wires he uses a pocket compass in the manholes, laying it on one of the faulty feeders, bringing it back to parallelism with the wire by means of a strong bar-magnet, after which the other side of the system is momentarily earthed, giving the direction and roughly the magnitude of the current by the throw of the compass needle; the feeder on which the largest current goes to the fault is noted; this is repeated at successive manholes until the point is reached where the direction of the earth-seeking current is reversed, the fault must lie between this and the last manhole; by means of a straight length of 20 feet of insulated wire and a telephone, the wire being led (on the surface of the street) parallel to the conductor, a buzzing will be heard in the telephone when a momentary current passes through that conductor; as this wire is carried along, the noise ceases when the fault is past, and in this way, he states, that the fault can be located to within a yard; faults below 10 ohms can thus be found, those greater than this can safely be left alone as they will soon get either worse or better; the system has been very successful in Glasgow.

Measurements at Central Stations.—Dr. Kallmann's article is continued at some length in the "Elek. Zeit.," Dec. 22; he discusses the measurement of the mean and individual voltages of the circuits and the measurement of the voltage of the machines.

Double Registering Meter.—In "L'Elec.," Dec. 16, Mr. Haubtmann calls attention to the importance of supplying current at cheaper rates from central stations during the daytime, chiefly for power purposes, stating that the same would be advantageous to both the consumer and the central station. He adds an illustrated description of the device of Messrs. Dreyfus and Roche, which, it appears, can be added to a meter enabling it to register at different rates during the day hours; neither the illustrations nor the description are as clear as might be desired, but the apparatus appears to consist of a double set of registering dials which are thrown into action alternately at any desired hours by a clock, the shaft of which turns once in every twenty-four hours; it can easily be made to change the readings to different hours according to the season of the year.

Measuring the Earth Connections of Lightning Rods.—Mr. Wiechert describes in the "Elek. Zeit.," Dec. 22, a new method devised by himself which has been in use for some time and has been found very satisfactory; the apparatus used is a Weinhold telephone bridge (a Wheatstone bridge in which a telephone and Ruhmkorff coil are used in place of the galvanometer and the battery); if there are not two separate grounds to the lightning-rod, a second one must be made, besides which an earth contact must be made, as for instance, by means of an iron wire run into the earth, which is moistened with water; a bridge wire with sliding contact forms two arms of the bridge, the ground connection to be measured forms the third, while the fourth is, in one case, a resistance of 10 ohms, in series with the second earth connection, the telephone being connected to the auxiliary earth contact, the resistance of which does not enter; in the second case it consists of the resistance of 10 ohms alone, the second earth connection being then in series with the first, and constituting with it the other arm of the bridge; by means of this double measurement the resistance of each of the two ground connections is readily obtained; a diagram showing the connections is given in the article.

Self-induction.—In "Ind. and Iron," Dec. 17, J. S. state that an electric circuit has unit self-induction when, if the current increases at the rate of an ampere per second, there is a back E. M. F. of one volt; a self-induction of one henry may therefore be defined as such, that if there is one ampere the product of the turns by the total induction enclosed by each of them is 10^8 magnetic reluctance and self-induction

are thus seen to be closely related; the former considers the magnetic circuit only while the latter considers the number of turns also; if the magnetic reluctance is taken as the magnetic potential divided by the total induction, it is a reciprocal of the self-induction where there is only one turn of the wire; the self-induction is the reciprocal of the magnetic reluctance multiplied by the square of the number of turns.

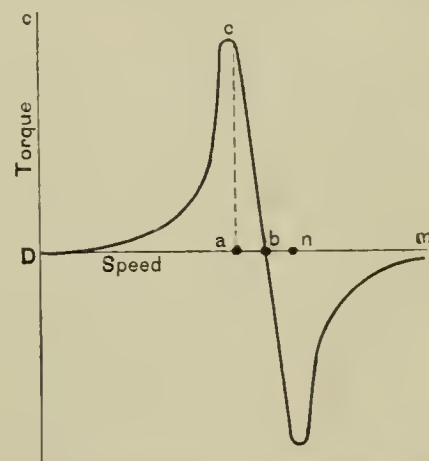
Impedance of Mutually Inductive Circuits Containing Capacities.—Referring to Mr. Kennelly's article in The Electrical World, Oct. 21, Mr. Rimington, in the Lond. "Elec. Rev.," Dec. 22, calls attention to his (Rimington) recent Physical Society paper on "An Air Core Transformer" (see Digest, Nov. 25), which, he says, with but a slight modification in case of capacity, gives a similar method to that of Mr. Kennelly, but which he claims is simpler; he then discusses his method together with the modification necessary when one or both of the circuits contain a capacity. The article does not admit of being abstracted; it is to be continued.

Bristol Recording Voltmeter.—The Lond. "Elec. Rev.," Dec. 22, contains a short illustrated description of this voltmeter.

Shunts.—The Lond. "Elec. Eng.," Dec. 22, contains two communications regarding shunts, but they apparently contain nothing new.

DYNAMOS AND MOTORS.

Experiments with Brown's Non-Synchronizing Motors.—The Lond. "Elec. Rev.," Dec. 22, contains the first part of an article on this subject, in which the principle is briefly



RELATION BETWEEN SPEED AND TORQUE.

described; the accompanying diagram of Dr. Sahulka (which was described but incorrectly reproduced in the Digest, July 29), is discussed; it shows the relation between the speed and the torque; between *a* and *a* the speed falls for an increasing torque, showing that when the motor starts the tendency of the load is to decrease the speed and thereby the torque, thus bringing it to a stop; between *a* and *b* the reverse is the case and the motor should therefore be used between those points; the point *n* represents the synchronous speed; it is stated that the calculations from which this curve is derived are based on special hypotheses and will be very different if the motor is properly constructed; experiments with these motors are promised in the next portion.

Theory of Rotary Field Motors.—The discussion between Mr. Boucherot and Mr. Farman, mentioned before in these columns, is concluded in "La Lum. Elec.," Dec. 16, which contains a short article by the former and a communication from each of them.

Pyke and Harris Dynamo.—The Lond. "Elec. Rev.," Dec. 22, gives a short illustrated description of this continuous-current dynamo.

ARC AND INCANDESCENT LIGHTS.

Arc Lighting.—Mr. Carter's serial is continued in the Lond. "Elec. Rev.," Dec. 22, in which he discusses the de-

sign of arc lamps; he classifies them by dividing them into continuous and alternating current lamps for series and for parallel working, and describes continuous current lamps for series working, using the Brush lamp as a typical one of that class.

TRANSMISSION OF POWER.

Transmission of Power at Niagara Falls.—The conclusion of the discussion of Prof. Forbes' paper is given briefly in the Lond. "Elec. Eng.," Dec. 22. The Lond. "Elec.," Dec. 22, gives the whole discussion at the two meetings in abstract, as revised by the speakers; the following is an abstract of the remaining portion, which has not already been given in these columns. Mr. Ferranti states that the question of transforming up was, in practice, a very awkward one, it led to many objectionable results, and was especially bad where it was combined with other dynamos working directly on the circuit at high pressure; he thought that it was a great fallacy to assume that 20,000 volts, with both poles insulated, was as safe as 10,000 volts with one pole to earth; with two cables, both insulated from earth, it was exceedingly unstable and dangerous; regarding the frequency he thinks 40 would have been more satisfactory, being about the happy medium; 100 or even 80, as at Deptford, would be fatal to an economical working of the system; regarding the transmission to very great distances he said that while he did not see the faintest chance of its being done with continuous currents, with our present knowledge, he at the same time saw very grave difficulties in the way of doing it by alternating currents. Mr. Alexander Siemens did not think there was any question about using 20,000 volts on underground cables; he would be perfectly ready to supply such cables; the project for the Niagara plant made by his company was for continuous currents, and he was not sure that the Cataract Company would not be converted to the continuous current system before they had finished. Mr. Evershed called attention to the induction between the conductors of the lines, which he calculates to be 880 volt per mile at a frequency of 100 for 333 amperes per square inch, 3 square inches in cross-section and 6 inches apart, while at 25 periods it was reduced to 192 volts, the resistance drop being 27 volts; this he thinks is an important argument in favor of low frequency. Mr. Crompton states that a question of great interest, namely the cost of power in Buffalo, had been entirely omitted; he thinks that if an arc started at one end of the subway it would travel the whole 18 miles in a very short time; he did not appear to favor porcelain insulators; after a long trial he considers oil insulators entirely useless; he did not think continuous currents had been condemned on sufficient evidence; he thinks that grave difficulties exist in coupling alternators in parallel; he did not think 40 periods enough to produce good lighting, as he had seen many Gantz stations where the lighting at 42 periods was disgraceful. Mr. Brown, of Oerlikon, through Mr. Kapp, advocated a higher frequency, and stated that he had been unable to detect any difference in parallel coupling between frequencies of 15 and 100; he has never found any difficulty in running machines, even of very different types, in parallel under the most difficult conditions, and he believes their coupling is even easier than that of direct current machines; he approves of the two-phase system with four wires; he believes that the machine decided upon was the worst possible arrangement, it was impossible to get at the machine while in motion, and the ventilating effect of the revolving armature was entirely lost. Quite a number of those who discussed the paper criticised very severely the action of the Niagara company in soliciting designs and plans and then rejecting them all, but using the suggestions in making their own designs; Mr. Crompton stated "the barefaced attempt to take the brains of the world and then utilize the information gained for the benefit of the American manu-

facturers was a thing to be admired." Mr. Ferranti said that "it was upon the work of the world, unrecompensed, that the undertaking would be carried out at Niagara." Prof. Forbes replied at some length, particularly to the remarks of Mr. Mordey, but gave nothing new; he claims that the only serious mistake which he made was to recommend the adoption of the Mordey alternators; he thinks that most of the speakers did not realize the real nature and scope of the problem, and he believes that they would, after further study, ultimately arrive at his position; his own opinions had been strongly confirmed by the general results of the discussion. Editorially the "Elec." says that this paper should never have been presented to an engineering society, that the subject was unripe for discussion, and that many details were unanimously condemned by practical engineers; "the less said about Prof. Forbes' reply the better"; it refers to some experiments in parallel running made in July, 1891.

Utilization of Water Power.—The Lond. "Elec.," Dec. 22, quotes briefly from a report made for a proposed plant in India, in which power is to be transmitted to Madras, 350 miles distant, where it is claimed that electricity at low pressure will be supplied at about \$19.40 per h. p. per annum, and in which Prof. Forbes prefers the two-phase system, and decides on units of 5,000 h. p., generating from 50,000 to 40,000 volts, at a frequency of 50.

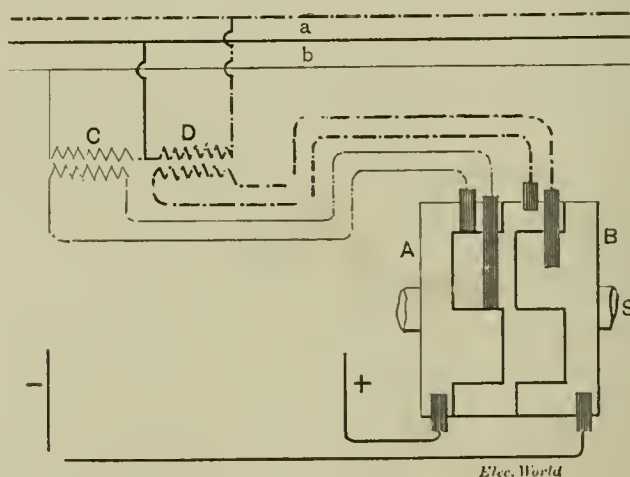
Transmission of Power from Central Stations.—Prof. Unwin's sixth lecture is concluded in the Lond. "Elec. Eng.," Dec. 22.

ELECTRIC RAILWAYS.

Return Railway Circuits.—The General Electric Company of Berlin state in the "Elek. Ziet.," Dec. 22, that in the railway at Halle they have avoided the use of earth plates, the whole of the return current passing through the rails and through wires laid in the ground between them (presumably to avoid the evil effects of the current in the earth).

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Two-Phase System.—Mr. Kennedy's article is concluded in the Lond. "Elec. Rev.," Dec. 22. This serial was abstracted in the Digest, Nov. 18, 25, Dec. 9, 23, 30 and Jan.



KENNEDY TWO-PHASE SYSTEM.

6. He describes several converters, meaning by that term an apparatus for changing alternating into continuous currents without transforming them to a higher or lower potential. The adjoining cut shows one of his own designs for two-phase currents; the shaft *S* of the double commutator *A B* is driven by a self-starting synchronizing motor; *C* and *D* are transformers for reducing the high tension current; it will be seen that the two secondary currents are commutated and put in series; for high pressures and small currents he states that this works very well; for low pressures and large currents the continuous currents are coupled in parallel by the commutator, each being taken off only during a portion of the time of one wave, that is, only down to the point where the waves intersect each other, at the point where

their pressures are equal; this apparatus is illustrated and consists simply of a four-part commutator and a single pair of brushes, the two transformers being connected respectively to two opposite segments; each current is in contact with the brushes for one quarter of a revolution only; as there would be sparking, the segments overlap slightly as in a Brush dynamo, in order to prolong the contact by lengthening the segments in the opposite direction from the rotation, by which means the rising pressure of one transformer overpowers and partially reverses the current before breaking the contact. He calls attention to the fact that the Brush arc light machine is much easier explained by considering it as a multiphase generator, in which the currents are rectified and put in series; this dynamo, he says, makes an excellent two or three-phase generator, motor or converter from alternating to continuous currents; the same is true of the Thomson-Houston arc dynamo for three-phase currents. He also describes the Appolony method for single-phase currents, which can be combined to advantage with the Hutin and Leblanc series coupling. In conclusion, he speaks again of the advantages of the two-phase system as compared with those at present in use, saying that "direct supply from the generators is a barbaric stage through which the art is at present passing."

Polyphase Currents.—The serial in the Lond. "Elec. Eng." is concluded in the issue of Dec. 22; a number of simple motor formulas are given, but it is stated that it is almost impossible to arrive at any calculations of this kind that shall be absolutely general; owing to the very small number of such motors constructed, there are few experimental facts at hand regarding the values to be given to factors of equations and the formulas given must therefore be regarded as indicating a direction rather than an exact path. The paper is concluded by a discussion of the transforming of polyphase currents into continuous currents, in which the usual well-known method is described.

Rotary Field Apparatus.—Mr. Blondel's mathematical article on an elementary theory of rotary field apparatus is continued in "La Lum. Elec.," Dec. 16; among other things he compares the star and polygon system of windings, giving a table of the various constants in each case and their ratios.

Cost of Running an Alternating Current Station.—In Lond. "Elec.," Dec. 22, Mr. Feldmann gives a very complete set of figures from the official report of the Cologne station for one year; a table is given comparing the cost of gas and electric lighting in seven different German cities, showing that the latter is from 25 to 75 per cent. higher; also tables showing the distribution of the load among the various consumers; by far the largest consumer is the station itself, next come factories, workshops and warehouses, then restaurants and hotels, the smallest consumption being in private houses; a table is given showing the distribution of the costs, that for coal being about 1.55 cents per kilowatt-hour, and the total cost 6.59 cents per kilowatt-hour; another table gives the distribution of the income, showing a total of 17.6 cents per kilowatt-hour; the total output was about 308,000 kilowatt-hours and the total net earnings about \$37,000; the price per kilowatt-hour is about 19.1 cents, and including the rebate, 18.4 cents; the cost of the current for power has been reduced to 6 cents with additional rebates for large consumers. Editorially the "Journal" states that these costs are better than the best figures in London.

Driving Alternators in Parallel by Gas Engines.—Mr. Dowson, a gas engineer, discusses this question in the Lond. "Elec.," Dec. 22, stating that while he does not deny that alternators can be so driven, he does not believe that it has yet been done, and he does not seem to advocate it; the extra complication involved in increasing the number of im-

pulses in a gas engine is very great, and he does not think that such engines will be used to a great extent; he speaks favorably of the two-phase system devised by Mr. Kennedy (which has been fully abstracted in the Digest), and which he thinks simplifies greatly the use of the gas engines for generating alternating currents and avoids the trouble of driving them in parallel.

Refuse Utilization for Harrogate.—According to the Lond. "Elec.," Dec. 22, a scheme is to be tried in that city for electric lighting by power derived from refuse.

Automatic Accumulator Switch.—The Fery apparatus is illustrated and described in "La Lum. Elec.," Dec. 16; the magnet which operates the mercury cut-outs consists of two parts, one being wound for a series current and the other for a shunt or potential current, the magnetic action of the two being alike so as to aid each other; the latter is connected either to the dynamo or the accumulator; it can be used also for automatic coupling or uncoupling dynamos running in parallel.

Edwards' Steam Turbine.—"La Lum. Elec.," Dec. 16, gives a well illustrated description of this steam turbine, which contains one disc moving between two others, the curved turbine blades being contained on the adjacent surfaces.

Fuel Economy.—The Lond. "Elec. Rev.," Dec. 22, contains a communication on this subject.

WIRES, WIRING AND CONDUITS.

Networks of Conductors.—Mr. Coltri's article, mentioned in the Digest Dec. 30, is continued in "La Lum. Elec.," Dec. 9.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephone Station at Paris.—The article describing this station, mentioned in the Digest last week, is concluded in "L'Elec.," Dec. 16; the description is somewhat lengthy and includes 17 cuts.

Statistics for France.—The Lond. "Elec.," Dec. 22, gives briefly some telegraph statistics for France for the year 1892.

ELECTRO-CHEMISTRY.

Purification of Sewage.—In "La Lum.," Dec. 16, Mr. Rigaut gives a short illustrated description of the Hermite apparatus as used at Havre and Lorient; the illustrations include a view of the electrolyzer, an interior view of the building with the apparatus and a complete apparatus with tanks. Sea water is passed through the apparatus where it is partially electrolyzed, after which it is conducted through a system of lead pipes to the various houses, where it can be drawn upon at will for disinfecting purposes; the disinfecting action is due to chlorine which is developed; it is stated that by this means the germs are destroyed, but the fertilizing properties of the sewage are not impaired; the destruction of the germs seems to be absolute, as tests have shown that they do not afterwards develop again; from experiments it has been found that the electrolyzing should be such that the resulting liquid contains from 0.1 to 0.05 grammes of chlorine per litre; each group of apparatus contains a dynamo developing from 1,000 to 1,200 h. p. at 6 to 7 volts and a pump circulates the water at the rate of about 600 litres per minute; it is estimated that the cost of an installation for thus disinfecting sewage by means of sea water will cost about 2 francs (40 cents) per year per head of population, and it is said to be no more expensive than other processes; the installation appears to be quite successful.

Electric Purification of Sewage.—A paper by Mr. Williams, reprinted in "Ind. and Iron," Dec. 22, describes briefly the electric process for which he thinks there is no future, as the cost must be very high; the sewage flows through a series of brick cells, entering alternately at the top and bottom; the cells consist of a number of cast-iron plates,

half an inch thick, connected alternately with two poles of the dynamo; the hydrogen gas evolved carries up the suspended matter which afterward settles; the iron is dissolved from the positive plates and is precipitated as ferrous hydrate, carrying down with it the suspended matter. It is simply the dissolved iron which accomplishes the work and this is obtained by a very expensive process.

Lead-Dust Accumulators.—In a paper by Mr. Huber (of the company making these accumulators), abstracted in the "Elek. Zeit.," Dec. 22, he states the advantages claimed for these accumulators, in which the object is to increase the ratio of the surface exposed in proportion to the volume of the material: the lead-dust is made by blowing superheated steam through a tube immersed in the molten lead, which converts the lead into a fine dust: this has the property of being capable of being pressed into coherent plates or into a grid, remaining quite porous: care must be taken that this dust does not oxidize, which is accomplished by keeping it under water; it is then mixed with a neutral porous body (the nature of which is not stated), and pressed into grids. In the discussion Mr. Pollak stated that the process was not new, as it had been tried and abandoned in England a number of years ago: he thinks that the principal fault of accumulators, namely, the sulphating between the active material and the conductor, is not overcome by this method; the value of such a method can only be determined after several years of use of the accumulators.

A translation of the article by Mr. Liebenow, abstracted in the Digest, Nov. 25, is given more fully in the Lond. "Elec. Rev.," Dec. 22.

Dangers of the Lead Industry.—The Lond. "Elec.," Dec. 22, publishes an official report regarding the dangers to the workmen in the manufacturing of accumulators. The process is briefly described and recommendations are made.

Electrolysis of Fused Salts.—Mr. Andreoli's serial is continued in "Ind. and Iron," Dec. 22: he mentions a number of properties of materials when heated, showing some of the difficulties involved in such electrolysis; he describes briefly, together with some illustrations, the first attempts, made many years ago, to apply the electric current to heating and metallurgy.

Craney Electrolyzer.—"La Lum. Elec.," Dec. 16, contains a short, well illustrated description; one electrode consists of granules of carbon in the bottom of a vessel while the other is made of a band of metal in another vessel, the two vessels being connected by means of a siphon.

Silver Plating Industry.—The serial in "Ind. and Iron" is continued in the issue of Dec. 22; the subject of scouring being described.

Dissociation.—The Lond. "Elec. Rev.," Dec. 22, notices briefly some articles in scientific papers.

The Color and Speed of the Ions.—The Lond. "Elec. Rev.," Dec. 22, calls attention to articles in "Zeit. Phys. Chem.," 9, p. 579; also 12, p. 56, and "Ann. d. Phys. u. Chem.," No. 11.

Decomposition of Organic Compounds.—The Lond. "Elec. Rev.," Dec. 22, contains a short note on some recent researches.

MISCELLANEOUS

Electric Ignition of Benzine in Laundries.—The "Elek. Zeit.," Dec. 22, states a peculiar case in which Dr. Richter, of Hamburg, has shown that most of the frequent fires occurring in chemical laundries where clothes are washed in benzine are caused by the sparks due to the electricity generated by the friction of the benzine and the articles of clothing as they are rinsed and withdrawn from the bath: from statistics in Hamburg it is claimed that 15 out of 21 of such fires were due to this cause; a large number of careful ex-

periments were made, in which it was found that the woollen material becomes positive and the benzine negative; the discharge on withdrawing materials from the bath is often great enough to be painful, and in several cases the experimenter was thrown to the ground and for some time after could not stand up; in a dark room the discharges produced quite an illumination and have a number of different forms, some of the discharges being two inches in length; with higher temperatures and with more moisture in the air there is less tendency to fire than in cold, dry rooms; he also found that the greater the amount of dust in the air the less is the danger. (No suggestions are made regarding methods for preventing such fires: the danger might possibly be greatly diminished by charging the air in the room with steam.)

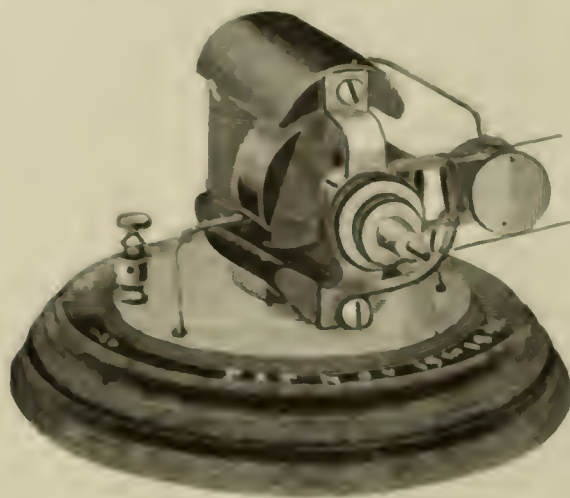
Saladin Furnace.—The "Bul. de la Soc. Chem.," Vol. 9, No. 5, contains a paper by Mr. Saladin, describing a new furnace, an abstract of which is given in the Lond. "Elec. Rev.," Dec. 22; a platinum spiral placed in a vessel of refractory material and enclosed in a cast-steel case is heated to incandescence by means of a continuous or alternating current: the materials to be heated may be subjected to a high pressure up to 1,000 atmospheres; the temperature is from 1,500 to 1,800 degrees C. and is measured by a platinum-rhodium couple; it is used for the experimental reproduction of minerals from elementary matter by imitating the probable conditions under which they were naturally formed.

Welding.—In "La Lum. Elec.," Dec. 16, Mr. Richard gives a short, well illustrated description of various welding apparatus, including the Thompson machine for making chains, of which also a number of details are given, a Thompson machine for shaping metals, and for making projectiles.

Physiological Effects of High Frequency Currents.—The article by Dr. Hedley from the "Lancet," mentioned in the Digest last week, is given in the Lond. "Elec. Rev.," Dec. 22.

The Boston Motor.

The popularity of small motors is increasing, not only through the interest taken in electrical matters by amateurs, but also for use in driving ventilating and cooling fans in the summer time. The Boston Motor Company, 17 Battery-march street, Boston, Mass., has recently made several improvements in the Boston motor and battery outfit, which is

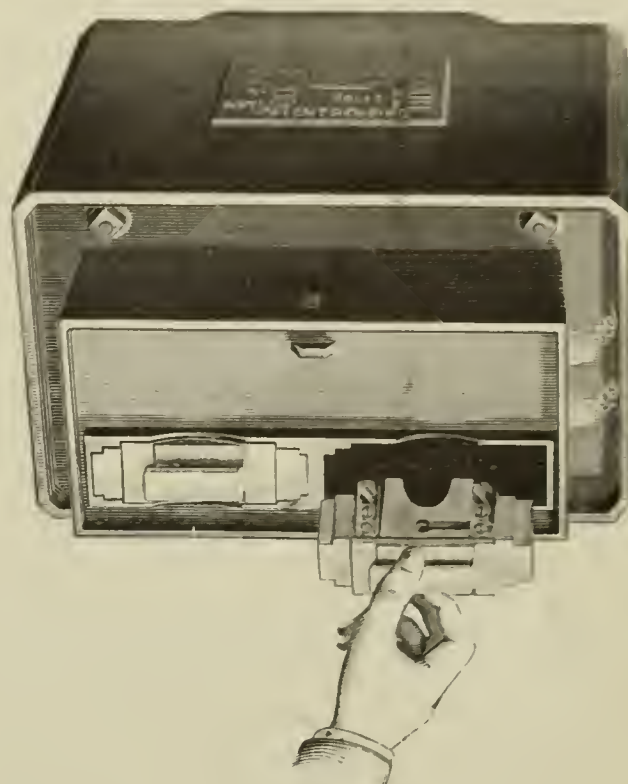
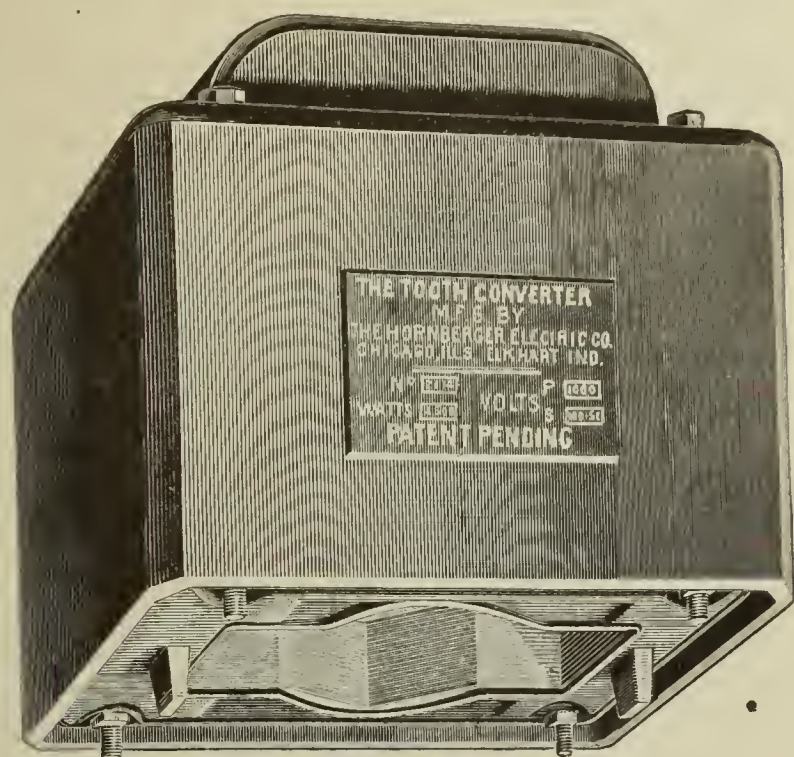


THE BOSTON MOTOR

one of the best known for these purposes. They are similar in form to the original machine, which was described in The Electrical World of June 24, 1893, but the base is made in one piece, of a durable and highly finished material like hard rubber, manufactured by the Durand Manufacturing Company, of Newark, N. J., which is much better than the wood base and iron frame first used. While the motor is small in size, yet unlike such motors ordinarily, it is efficient in operation, and particular attention has been paid to mechanical details.

The Elkhart Converter.

The converter which we illustrate has been on the market for some four years, and is in use in over 500 central stations throughout the United States and Canada, but is here described for the first time, it having been the policy of the manufacturers, the Hornberger Electric Manufacturing Company, of Elkhart, Ind., to let their apparatus speak for itself, rather than proclaim its merits loudly in print.



FIGS. 1 AND 3.—ELKHART CONVERTER.

Referring to the illustrations, Fig. 1 represents the case with the coil removed. Fig. 2 shows the coil with the cores placed in position ready to insert into the case, and Fig. 3 shows the arrangement of the primary fusing device, which is made of porcelain, and, as may be seen, is unusually convenient for the operation of replacing a fuse, which may be done by a lineman on the darkest night without tools. The

sort, as the case is suspended from a forged hook, which is placed in a permanent position on the pole or building, and is adapted to receive and support any converter manufactured by this company.

While the patents of the inventor, Mr. William H. Hornberger, are broad and cover every portion of their device, the manufacturers have not neglected the mechanical features, and lay especial claim to excellent workmanship and minute attention to all mechanical details, which the success they have met with has shown to be abundantly justified.

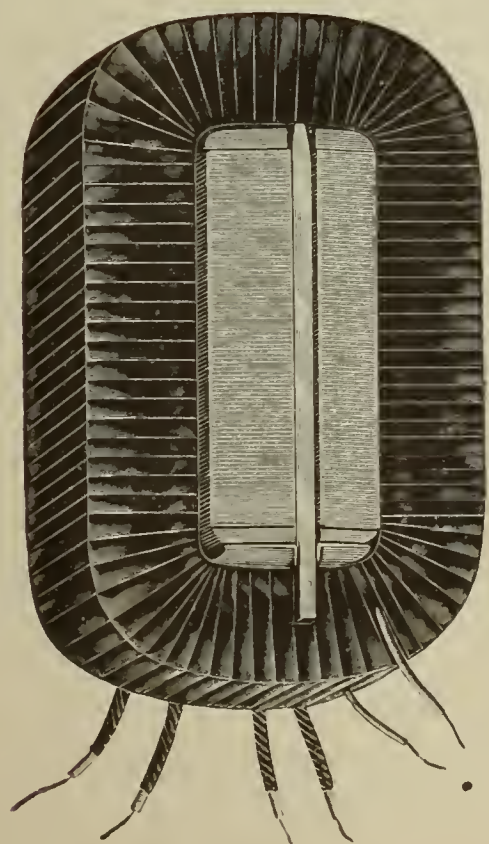


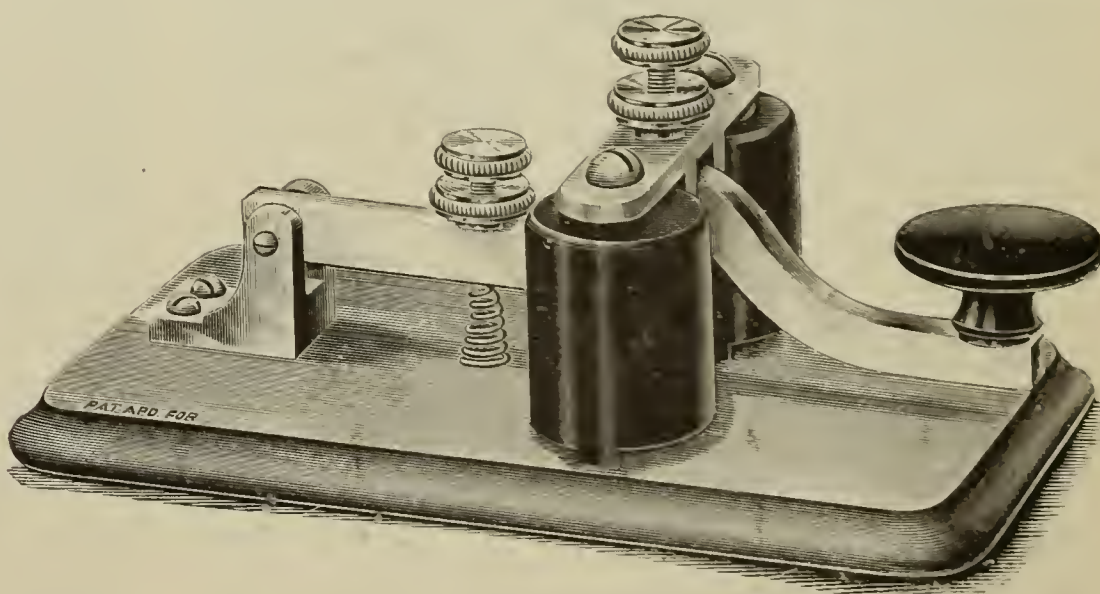
FIG. 2.—ELKHART CONVERTER.

fuse case forms the bottom of the converter case, and is closed by a sliding lid.

It will be readily seen that in case of any accident to the

A Mechanical Telegraph Key.

We illustrate a neat mechanical telegraph key for learners.



MECHANICAL TELEGRAPH KEY.

manufactured by The E. S. Greeley & Company, 7 Dey street, New York, which requires no battery whatever. As far as external appearances are concerned, the apparatus is an

exact copy of a regulation key and sounder, having a complete set of adjustments. It is provided with special resonators that give the correct sounder click to the instrument.

New Books.

HOW TO WIRE BUILDINGS: A Manual of the Art of Interior Wiring. By Augustus Noll, E. E. 162 pages, illustrated. Price, \$1.50.

A practical book on the methods and details of incandescent wiring is much needed, particularly one giving plans for buildings of different kinds, with actual calculations of wiring, based upon these or upon a typical plan. While the author does give plans of wiring, their practical application—and to show this should be the main object of a book of this character—is not indicated with reference to typical cases, and the calculation of wiring is relegated to chapters in which they are treated with no reference to an actual wiring plan.

We do not agree with the author that "the most general and satisfactory method (of distribution of drop) is, assuming the loss to be five per cent., to allow one-half per cent. in the lamp circuit, one per cent. in the floor mains, one and one-half per cent. in the vertical mains, and two per cent. in the main feeders." On the contrary, by having the greater percentage of loss in the small wires, the variation in drop is in general less; with a large percentage of drop in the large wires a considerable variation in the number of lights in one part of the system will largely affect all the other lights, while in the reverse case different parts of the system will be to a great extent independent of each other in this respect. Even if the rule laid down were not open to this criticism, it would still be unsatisfactory on account of being a mere rough approximation that would not give the best distribution in any case. It is not a difficult matter to calculate the conductors on the assumption that all lead back to the dynamo or primary distributing point, beginning with the branches and ending with the feeders; the operations are simple, and as the normal current in each wire can be thus considered, a nearly perfect distribution of drop may be obtained, while the additional time required by this method of calculation would ordinarily have no practical significance.

The extraordinary feature in the author's method of calculating the area of conductors, is, that he bases it upon the hot resistance of lamps! As the ordinary formula for determining the area of conductors is so extremely simple the reason for the introduction of this absurd factor, which has to be separately calculated—though in what way is not stated—is inexplicable. We venture to say that on account of the involved explanations in this portion of the book, divorced as they are from the principles concerned, the wireman will find it far from being as simple as it was evidently intended, and even the advanced electrician may find it more laborious reading than some chapters in Maxwell.

We do not coincide in the author's advice to the practical wireman to "confine his studies to a general knowledge of electricity sufficient to enable him to trace the direction of the current in dynamos, motors and appurtenances and also in wires"—partly because we see no reason why he should be thus limited, partly because a wireman or no one else will be enabled by a general knowledge of electricity to thus trace the direction of current, and principally because the knowledge would be of absolutely no practical use even if attained. Nor do we agree with the statements that "with proper care the generating apparatus, its appurtenances, wire appliances, and fixtures will not depreciate to any considerable extent," and "therefore the cost of maintenance will consist chiefly in the amount of fuel necessary for generating current and the renewal of lamps." Labor and depreciation are items that cannot thus be summarily dismissed. Nor can we see, without qualification, that "the renewal of lamps

depends largely on the breakage due to the action of excessive current."

The preface of the book cautions us against being misled by theories, and this advice should be strongly borne in mind by the reader in the portion where the author "drops into theory," as the following examples illustrate: "Ampere is that current having an electric pressure of one volt which flows through a wire having a resistance of one ohm." "To ascertain the available current in amperes, *not generated at the dynamo*, but for consumption by or in the lamps, the resistance of the conductors must be added to the internal resistance of the dynamo." "The term difference of potential denotes that portion of the electromotive force which exists at, or between, any two points in a circuit, and equals the electromotive force (in a dynamo) at the point where the armature 'cuts' the lines of force, minus the amount lost in transmission, due to the resistance of the conductors." "The term 'electromotive force' is generally used to denote the pressure at the highest pressure point; in all other parts of the circuit the pressure is noted as the potential difference, or difference of potential."

A table is given of the safe carrying capacity of conductors as "a safe practical guide," but, unfortunately, as it gives a larger capacity for wires than the Underwriters' rules will permit, it is worse than useless.

While the book is thus far from complying with the requirements of a work of the character which it purports to represent, yet it will be found useful to the wireman in the absence of a better. Much practical information is scattered throughout its pages, and hints for laying out wiring may be obtained from some of the plans of distribution.

THEORETICAL ELEMENTS OF ELECTRO-DYNAMIC MACHINERY. By A. E. Kennelly. Vol. I. New York: D. Van Nostrand Company. 1893. 87 pages, 37 illustrations. Price, \$1.50.

The object of this work, as stated by the author in the preface, is to develop for students of electrical engineering the applied arithmetical theory of electro-magnetism, as distinguished from the purely mathematical theory. While the present volume merely opens up the subject, the groundwork of electro-magnetic theory is laid, in which respect the book may be considered as complete in itself. Mathematics are avoided as much as possible, many of the equations that appear being merely formulas for numerical substitution.

In Chapter I. the fundamental principles of magnetic flux are considered and Chapter II. deals with magneto-motive force and potential. The treatment of magneto-motive force in the latter chapter is particularly satisfactory, and will go a long way toward dispelling the mystery often associated in the minds of students with the formula by which it is represented. The numerical examples here and elsewhere throughout the book are especially helpful in assisting to a grasp of the principles developed, and the same may be said of the numerous accurately plotted curves. Chapter III. is on resistance and permeance and points out the analogy of the magnetic with the electric current, at the same time showing the limits of the analogy in practical application, owing to the fact that there is no known magnetic insulator. Chapter IV. relates to the influence of iron in and on the magnetic circuit, in which the effect of air gaps in magnetic circuits is particularly clearly treated. The last two chapters, on stress distribution and on electro-magnetic energy, are extremely suggestive and in accordance with the latest views, which are turning more and more toward the conceptions of Faraday and Maxwell.

To the student and electrician who wish to obtain exact ideas on the principles underlying dynamo designs, this book will prove of great value, while the general electrical student will find it an easily read introduction to the mathematical treatises of Maxwell, Gray and others.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, Jan. 8, 1894.

THE ELECTRICAL STOCK MARKET did not open in a Happy New Year fashion, but with other industrials started the new year in a grand slump. It was but for one day, however, for on Wednesday electrical securities took an upward turn, and the rise was of such a healthy sort that on the closing day electrical stocks were several points above the closing prices of the week previous. The advance was due to the recovery from a scare based on some discouraging rumors, and the consequent better feeling and activity when there was found to be no reason for fright. Electrical stocks seem to be on the upward move, though still quoted at extremely low figures.

GENERAL ELECTRIC STOCK dropped to one of the lowest figures it has ever been quoted, on the opening day of the market. It was on the confirmation of the news of the removal of the main offices and store room to Schenectady, which was taken as a confession of the weak financial condition of the company. The decline of the other industrials also pulled the stock down. But it went up on a rising wave the next few days and made a gain of one point over last week's closing at the end of the week. The moving of the headquarters to Schenectady, as announced in these columns, though showing the straits the company is driven into, may have a wholesome effect on the stock in the end. When it is shown that the General Electric people are attending more to their manufacturing interests than stock manipulations, the security may have more value on Wall Street. From the actions of the company it is evident that economy is now rigidly entering all the company's management. A number of the executive department and several district agents have been dismissed. It looks as if Drexel, Morgan & Co. (who are now said to be the ruling factor) intend to run affairs on a strictly business basis. The stock is now quoted at 34 1-2 bid and 35 asked.

THE WESTINGHOUSE ELECTRIC COMPANY has declared a semi-annual dividend of 2 1-2 per cent. on its preferred stock, payable January 10. This shows the company is holding its own in the business world and has good financial management back of it. Reports continue of more work and bright business prospects at the Pittsburgh plant. The common stock is now rated at 23 1-2 bid and the preferred 41.

THE EDISON ELECTRIC ILLUMINATING COMPANY'S stock does not seem to be traded in extensively nowadays, there being few transactions in it during the week. The company has declared a quarterly dividend of 1 1-2 per cent. on the capital stock, payable Feb. 1. Though the stock has not made any advances during the week, it is still strong, and is ranging around par. The annual meeting of the stockholders of the company will be held Jan. 16 for the election of thirteen directors, to serve for the ensuing year, and other business that may come before the meeting.

WESTERN UNION TELEGRAPH has made a gain of 33-8 points during the week, and is now up to 86. There was the usual number of heavy transactions in the stock, and it looks as if the security was now on the bull side.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York.....	50	20	40
Detroit Electrical Works.....	10	2	3
Cleveland General Electric Co.....	—	85	90
East River Electric Light.....	100	—	65
Electric Con. & Supply Co. pref.....	15	15	16
“ “ “ com.....	15	15	17 1/2
Edison Electric Ill., New York.....	100	96	99
“ “ “ 1sts.....	—	103	104
Edison Electric Ill., Brooklyn.....	100	99	102
“ “ “ Boston.....	100	115	120
“ “ “ Chicago.....	100	220	230
“ “ “ Philadelphia.....	100	120	125
Edison Electric Light of Europe.....	—	2 1/2	5
“ Bonds.....	—	80	85
“ Ore Milling.....	—	5	12
Fort Wayne Electric.....	—	5	9
General Electric Company.....	100	34 1/2	35
“ “ “ deb. 5's.....	—	71	72
Interior Conduit and Ins. Co.....	100	25	35
Mount Morris Electric.....	—	—	65
Westinghouse Consolidated.....	50	23 1/2	24 1/2
“ “ “ pfd.....	50	41	43
Western Union Telegraph.....	—	86	86 1/4

New Incorporations.

CANISTEO, STEUBEN COUNTY, N. Y.—The New York State Electric Company has been incorporated to manufacture electric supplies. Melshor Eckstromer and Peter Hanlon, of Canistota, are interested.

THE SOLDIERS' GROVE ELECTRIC COMPANY, Soldiers' Grove, Wis., capital stock \$1,500, has been formed by A. Paterson, M. B. Seward and F. P. Briggs, to build and operate an electric plant in that town.

THE CHICAGO RECORDING SCALE COMPANY, Chicago, Ill.,

capital stock \$50,000, has been formed to make and sell electrical machinery, other machinery, recording scales, etc. The promoters are H. S. Clark, C. C. Russell and E. H. Anets.

THE MANHATTAN ELECTRIC EQUIPMENT COMPANY, Chicago, Ill., capital stock \$1,000, has been formed to erect electric plants for various purposes. J. M. Troit, Wm. Frederickson and L. A. Dickey are the promoters.

THE SIDNEY POWER COMPANY, Salem, Ore., capital stock \$50,000, has been formed to erect and operate a plant for generating and transmitting electricity. J. M. Wallace, J. M. Kyle and H. T. Wallace, all of Salem, are interested.

THE STEPHENSON ELECTRIC BELT COMPANY, Stromsburg, Neb., capital stock \$25,000, has been formed to manufacture and sell the Stephenson electric belt. J. B. Buckley, P. T. Buckley, J. A. Frawley, G. S. Osborne and W. A. Post are the promoters.

THE MORRISON'S COVE ELECTRIC RAILWAY COMPANY, Morrisons, Pa., capital stock \$175,000, has been formed to construct and operate an electric railway. S. A. Hamilton, Roaring Spring; I. S. Mock, Ore Hill, and J. P. Jacobs, Hollidaysburg, Pa., are the organizers.

THE M'MILLAN MILL AND POWDER COMPANY OF NESHO-NOC, Neshonoc, Wis., capital stock \$100,000, has been formed to maintain an electric light plant, etc., at that place. S. D. McMillan, D. McMillan, J. K. Johnson and J. W. Ranney are the interested parties.

THE UNITED STATES WENSTROM ELECTRIC COMPANY, Jersey City, N. J., capital stock \$30,000, has been formed to manufacture, buy, sell and lease dynamos, motors, etc. B. Blum, C. S. Cowan, New York City, and J. B. De Lery, South Lakewood, N. J., are the organizers.

THE FULLER INCANDESCENT HEAT LIGHT COMPANY, Chicago, Ill., capital stock \$1,000,000, has been formed to purchase patent rights, generators and motors for generating electricity, etc. The interested parties are J. T. Kretzinger, C. E. V. Akerburg and M. F. Gallagher.

THE UNIVERSAL ELECTRIC HEAT LIGHT COMPANY, Chicago, Ill., capital stock \$100,000, has been formed to purchase sell and operate, patent rights, generators, motors, etc., for generating electricity. The promoters are J. T. Kretzinger, C. E. V. Akerberg and M. F. Gallagher.

CHICAGO, ILL.—The Fogerty Gas and Chemical Company, \$10,000,000, Ambrose A. Worsley, H. N. Nanchette and C. J. Satterlee, has been incorporated to manufacture gas under certain patents issued to manufacturers in the East. The process involves the use of electricity, and in consequence the company will erect, or acquire plants for the generating of electric power on a large scale, with a view to supplying electricity to the public, as well as for their own acquirements. H. N. Nanchette, of 172 Washington street, will give details.

THE NEW DECATUR (ALABAMA) NATURAL GAS, PETROLEUM AND MINING COMPANY, Freehold, N. J., capital stock \$100,000, has been formed to manufacture, buy and sell, etc., machinery, generators, motors, pipes, etc., apparatus, supplies, and articles of every kind appertaining to or in any wise connected with the production, use, distribution, etc., of electricity, natural gas, petroleum, etc. Thomas Butter, James Swann C. Y. Kent, of New York City; A. Hartshorn, Freehold, and J. D. Probst, Englewood, N. J., are interested.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD, 167-176 TIMES BUILDING, NEW YORK, Jan. 8, 1894.

THE NASSAU ELECTRICAL COMPANY has filed a claim with the Comptroller of \$392.80 for loss of electrical goods which the company alleges were stolen from their offices by city firemen on duty at a fire in the Cornell Building, 137 Centre street, on Dec. 2.

THE CONSOLIDATED CAR HEATING COMPANY, of Albany, has begun suit in the United States Circuit Court against the Chicago and West Michigan Railway for infringement of the Sewall coupler patents. The infringement consists of using an imitation of the Sewall steam coupling recently put upon the market. Such railway is the first to continue the use of the imitation coupler after proper notification, and the Consolidated Car Heating Company at once determined to take action to protect the patents issued to Messrs. D. D. & J. H. Sewall.

GEORGE WESTINGHOUSE, Jr., has acquired absolute control of the Westinghouse Machine Company, one of the most profitable of the several Pittsburg corporations comprising the Westinghouse industries, by purchasing outright Ralph Bagaley's stock in the company. The transaction involved 2,000 shares of the stock, and the price approximated \$50 a share, or \$100,000. Mr. Westinghouse's holdings now amount to nine-tenths of the company's stock. Ralph Bagaley has been identified with the company since its organization in an official capacity as treasurer and general manager.

THE BROOKLYN "EAGLE" says that within the last week one of the political electric light companies has been putting up 175 lights on the streets. When its officials were asked why they were putting up so many all at once, the answer was frankly returned: "Well, as we have been receiving pay for them for a long time it was thought better to have them up before S. Dieron got in." When again asked where they got the power to supply the lights, their own plant being admittedly inadequate, the rejoinder was: "We propose to hire the power from the Excelsior company." If there had been no change voted last November, the pay without the lights would have gone on all the same.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
107 MONADNOCK BUILDING, CHICAGO, ILL., JAN. 5, 1894.

THE WINDSOR LOCKS Electric Light station has just installed a 25-h. p. engine.

THE EDDY ELECTRICAL WORKS, at Windsor, Conn., have started up again on six months time.

MAYOR WARDEN, of Waltham, Mass., recommends that all electric wires in that city be put underground.

THE DIRECTORS of the Consolidated Street Railway Company, at Worcester, Mass., voted to issue bonds to the amount of \$500,000 to cover the company's floating indebtedness.

CONSIDERABLE ATTENTION is paid by the mayors of the different municipalities in this vicinity to their recommendations in regard to street lighting. The mayor of Newton, Mass., recommends a municipal plant, while the mayors of Waltham and Malden deem it inadvisable to their cities to operate their own plants.

THE NEW ENGLAND TELEPHONE COMPANY is completely revolutionizing its service in Newton, Mass. All the main lines in Newton proper are soon to be put underground, and ultimately all the poles in the city will be removed. The wires on Centre street, from the Watertown line to Sargent street, a distance of over a mile, are already underground.

THE "INVESTMENT EDITOR," of the Boston "Advertiser," in reply to a question about the New England Street Railway, asking if it is going to pass its dividend and whether the enquirer should sell at present prices, replies that he understands that the dividend is to be passed, at which he is not at all surprised, for the reason that the corporation is very much inflated and a good thing to keep clear of unless one is on the inside.

IT IS RUMORED that a foreign electric concern is negotiating for the purchase of the factories of the General Electric Company, at Lynn. Though nothing authentic can be learned from the officials of the company here, or at Lynn, the intending purchaser is said to be the Siemens-Halske Electric Company, which is one of the largest electrical concerns in existence, having an immense plant in Germany, besides factories in England and in Chicago.

DIVIDENDS have been declared on the following stocks: American Bell Telephone Company, a regular quarterly dividend of \$4 per share, payable Jan. 15; the Boston and Great Falls Power and Electric Light Company, a dividend of \$1 per share, payable Jan. 15; the Boston Electric Light Company, a regular quarterly dividend of 2 per cent. payable Jan. 15; the F. B. Holden Mica Mining Company, a monthly dividend, payable Jan. 15; Westinghouse Electrical and Manufacturing Company, a dividend of 5 1/4 per cent. on its preferred stock, payable Jan. 10.

JACOB C. ROGERS, president of the Edison Electric Illuminating Company, Boston, corrects the statement made in some of the papers to the effect that the fire in the Globe Theatre was caused by the electric wires in the cast room. The theatre was lighted by the Edison Electric Illuminating Company, and Mr. Cabot, the inspector for the Boston Board of Fire Underwriters, who has examined the premises, gives it as his opinion and authorized Mr. Rogers to state that the fire was not caused by the electric wires. Moreover, according to the testimony of the employees of the theatre, all the electrical circuits were turned off at the close of the evening performance.

CIRCUIT COURT OF APPEALS, First Circuit, Putnam, Nelson and Webb, J. J. The court rendered a decision dismissing without costs the appeal of the Gamewell Fire Alarm Telegraph Company from the order of Judge Cobb, of the Circuit Court, granting an interlocutory injunction restraining it from infringing upon a patent owned by the Municipal Water Company. The patent was granted June 15, 1878, to Henry Hunt for an invention of a telegraph consisting of a telegraph, and it was assigned to the Municipal Company. Before the argument the patent in question expired, and the court says there is nothing remaining for it to decide upon the appeal, as the interlocutory injunction awarded from bounds with the expiration of the patent.

MAYOR MATTHEW S. of Boston, in his inaugural address, dwelt considerably on the question of electric street lighting, and pointed out that the electric lights now used upon the highways have been placed haphazard for the benefit of individual pedestrians, rather than for the convenience of the community. His criticisms of the road lighting, considering the number of lights in use, Boston now uses 45,088 electric lights, which cost 40 cents apiece per night, or

about \$25,000 a year. In comparison with other cities, this price would not seem excessive. New York pays 42 cents per light, Brooklyn 50 cents, Providence 44 cents and Philadelphia 43 cents. This shows that Boston is getting its light more cheaply than the other large cities above quoted. The Boston Electric Light Company furnish the light, and as the demand increases and more lights are ordered it is probable the price per light can be reduced.

THE WASHBURN & MOEN MANUFACTURING COMPANY on Jan. 1 sent the following circular to the salaried men in their employ: "Owing to the continued uncertainty in business, the directors deem it necessary to make a general reduction in the salaries of the officers and salaried employees of the company. Salaries less than \$2,000, 10 per cent.; from \$2,000 to \$2,500, 15 per cent.; \$2,500 and over, 20 per cent.; to take effect Jan. 1, 1894. With decreased production, the earnings of the company, as well as its dividends, have been materially diminished and wages have been reduced. It is expected that all having salary contracts will cheerfully acquiesce in this action of the directors, in order that every one may share in the burden due to existing business conditions. The general manager is instructed to carry this action into effect. A second circular was sent out to stockholders as follows: "Believing that the unstable condition of general business renders conservative action desirable, your directors have decided to declare a quarterly dividend of \$1 a share, payable on this date." Last quarter the dividend was 2 per cent., and for a number of years previous 3 per cent. a quarter has been regularly declared. The stockholders the past year absorbed \$1,000,000 of new stock at par.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
107 MONADNOCK BUILDING, CHICAGO, ILL., JAN. 5, 1894.

MR. WALKER C. MCKINLOCK, secretary of the Metropolitan Electric Company, Chicago, has just returned from a successful business trip and reports the outlook for his new company as very promising.

THE WESTERN ELECTRIC COMPANY open the new year with great activity in their electric lighting department. At present they are employed in perfecting arrangements for the lighting of the Mid-Winter Exposition at San Francisco, for which they have a contract.

THE CENTRAL ELECTRIC COMPANY will commence 1894 on the floodtide of prosperity. Notwithstanding the distressing times and the present unsettled condition of the supply business in the West, the Central goes right on increasing its business week by week. Mr. George McKinlock is still at the helm.

THE PERKINS ELECTRIC SWITCH MANUFACTURING COMPANY has opened an office at 1536 Monadnock Block, under the charge of Mr. G. W. Conover. The business of this company is increasing in volume every day. It will carry a large stock of its goods at the Chicago branch, from which all orders can be filled promptly.

THE COMPLETE ELECTRIC CONSTRUCTION COMPANY, whose home office is in New York, has opened a Western office at 1401 Monadnock, Chicago, and placed Mr. Clift Wise in charge. Mr. Wise is well known to the fraternity, and is meeting with a cordial welcome in the West.

THE WASHINGTON ELECTRIC COMPANY is now shipping many of its new alternating current arc lamps, about which so much has been said. This lamp is destined to meet with popular favor on account of its extreme simplicity. The works are at 197 South Canal street. President Stein promises to become a notable figure in future electrical assemblages.

C. M. SPAULDING, who was first introduced to the electrical fraternity through his connection with the Leonard & Izard Company, of Chicago, and who was only recently connected with the Ansoma company, has been appointed Deputy Collector by Internal Revenue Collector Mize. A host of friends, including The Electrical World, extend congratulations.

THE STANDARD ELECTRIC COMPANY is among the most successful firms in the West, judged by the record of 1893. Its arc lighting apparatus has met with success wherever introduced, and was one of the most conspicuous at the World's Fair, both in Electricity Building and Machinery Hall. This apparatus is now favorably known in all sections of the country, and its prospects for 1894 are of the brightest.

THE GREAT WESTERN MANUFACTURING COMPANY, the organization of which was perfected a little more than a year ago, finds itself on its first anniversary one of the leading electrical manufacturing concerns in the country. Its very complete works at Duluth are particularly busy just now turning out apparatus for some of the handsomest orders placed in the last six months. It now has on hand orders for arc incandescent, alternating and power generators.

CHARLES SORLEY, for so many years one of the leading storage battery experts in the United States, and more recently of the Propellor-Sorley Storage Battery Company, has opened an office on his own account at 1,562 Monadnock. Mr. Sorley will

give expert advice on the handling of storage batteries, and will guarantee to insure the successful operation of any existing storage battery plant, no matter what type of cell is used. He has the best wishes of a host of friends for his success.

GOODHUE & LINCOLN, although a newly organized firm, with offices in the Monadnock, have secured some very satisfactory contracts, among others a three-thousand light capacity transformer order. Mr. Goodhue has had a long experience in handling transformers, and has made some very large sales in the past. Associated with him is Mr. Lincoln, a bright and enterprising young business man. They expect, and have every reason to receive, a cordial New Year's reception from the electrical fraternity.

GEORGE G. CARTER & COMPANY.—Although this firm started in business in one of the worst months of the worst years for business in twenty years, it is doing remarkably well with the lines it handles. It now adds a new and very valuable name to its list, an incandescent lamp to be known as the "Anchor" lamp. Already it has sold a large quantity of these, although its announcements have heretofore been confined to correspondence. It commences the new year with the brightest prospects of success.

D. C. SPRUANCE, of the Helios Electric Company, enjoys the distinction of having made the largest purchase of rubber covered wire in history. He has just been successful in purchasing from the World's Fair all the wire used in their electrical work, amounting to about 600,000 pounds of Safety Grimshaw, Okonite and E. M. W. Mr. Spruance has established headquarters at the Auditorium Hotel, Chicago, from which point he will handle this gigantic deal. The wire is now for sale on the market, and can be had cheap.

THE ELECTRIC APPLIANCE COMPANY has been having a particularly Merry Christmas, principally on account of the fact that by hard hustling it was able to get its entire trade supplied with copies of the latest edition of its catalogue, and for the past week the company has been in receipt of numerous congratulatory letters complimenting the completeness, attractive appearance and intelligent arrangement of the work. A great many of the letters were accompanied with a substantial proof of appreciation, in the shape of large orders for material selected from the new book.

THE BROWN TELEPHONE AND TELEGRAPH COMPANY, of the Manhattan Building, announce that Feb. 1 it will place on the market its perfected Magneto telephone, which will be absolutely free from patent contention. Some of these instruments have been in successful operation over many miles of territory, and as they are exceedingly simple and effective will no doubt have a wide sale. S. W. Groesbeck is president of the company, George W. Wilson, secretary, and Thomas H. Murray general manager. Inventor Brown is vice president and electrician.

G. W. CONOVER, who has been well known in Western electrical circles for many years as purchasing agent of the Ansonia Electric Company, has resigned from that position to become Western manager for the Perkins Electric Switch Manufacturing Company, of Hartford, Conn. He will make his headquarters at 1,536 Monadnock Block, where he has already fitted up a comfortable office. Mr. Conover has a wide acquaintance among electrical men, and, judging by his experience and success with the Ansonia Company, the results of his work in his new position will be very gratifying, not only to himself and his friends, but to his company.

THE STROWGER AUTOMATIC TELEPHONE EXCHANGE, of 301-303 The Rookery, announces that with the commencement of February, 1894, it will supply magneto telephones that will in no way infringe the group of telephone patents which has heretofore made a monopoly of the business possible. This concern has become widely and favorably known, by reason of its automatic telephone exchange, introduced to the public more than a year ago at La Porte. It has been in continuous operation at this place since its installation, and has worked so successfully that existing telephone interests have offered to buy it. Licenses have been granted for the introduction of this system in nearly every State in the Union, and contracts have been closed for the equipment of many central telephone stations, as well as a host of private and commercial systems. The continued success of this automatic exchange will be of the greatest value to telephone service, and there is every reason to believe that the year 1894 will see its introduction on a surprising scale.

WALTER CAMPBELL, president of the Illinois Electrical Forging Company, has disappeared, and many stockholders in the alleged company, whose subscriptions amount together to \$215,000, are looking for him. The Boston Electrical Forging Company, well known in the East, had an exhibit at the World's Fair of a method of welding metals by means of electricity, and Campbell secured State rights of the patent for Illinois. Under the terms of the negotiation with the Boston firm the latter was to receive 25 per cent. of the stock in the new concern, for the Illinois right. Campbell himself was to be the principal stockholder, his claim being 50 per cent. of the stock. He managed to collect altogether over \$100,000, while the company was being formed. Among those whom he has swindled are President Bush, of the Bank of Yolo, Woodland County, Cal., who purchased stock to the value of \$20,000; H. J. Thompson, of Chicago, \$10,000; Oliver Rice, Lewis-

ton, Ill., \$20,000. While at Lewiston, Campbell induced a merchant named Phelps and his son William to pay \$115,000 in notes for the worthless stock. From Lewiston Campbell went East, where he successfully discounted the notes given for something over \$100,000. Since then nothing is known of his movements.

OREGON CITY, Jan. 12, 1894.

PORT ANGELES, WASH.—The contract for an electric light plant has been let to W. C. Williams, who will take \$37,000 in city bonds for his pay.

O. A. PETERSON, railway constructing engineer, with the General Electric Company, late of Lynn, Mass., recently visited the Portland General Electric Company's water power station in Oregon City, while on his way to San Francisco.

Canadian Notes.

OTTAWA, Jan. 6, 1894.

VANLEEK HILL, ONT.—The Vanleek Hill Electric Light Company, whose capital stock was recently increased to \$10,000, is erecting a fine new power house, in which they have placed a 60-h. p. engine, three large dynamos and a generator.

HAMILTON.—The city clerk has received a check from the street railway for the amount due for the past quarter under the by-law. The amount was \$3,065, made up as follows: 6 per cent. on gross earnings, \$1,622; mileage, \$1,443. The total amount received for the past year was \$12,504; over \$500 above the estimate.

TORONTO.—The revenue of the street railway during 1893 was \$902,927, of which \$72,234 went to the city in the form of percentages. The city's share for December was \$5,529, as compared with \$5,621 during December, 1892. Last year the earnings of the company were \$815,492, and the city's share \$65,239. It is expected that the earnings of 1894 will reach the million mark.

THE RELIANCE ELECTRIC LIGHT COMPANY, Toronto, have apprised the City Engineer that they expect to receive concessions from the city similar to those enjoyed by other lighting corporations, unless the exclusive right to light Parkdale is granted, when they would be prepared to pay for the franchise. Mr. Wright, of the Toronto Electric Light Company, in a communication, says that his company will insist upon the right to erect poles if the Reliance Company is granted permission to do so.

TORONTO.—Notice is given that application will be made to the Legislative Assembly of Ontario, next session, for an act to incorporate a street railway company to be known as the "Toronto Suburban Railway Company," with power to take over and acquire all the assets, rights and franchises of "The City and Suburban Electric Railway Company (Limited)" and "The Davenport Street Railway Company (Limited)" and to issue paid-up stock in payment therefor, and to assume the liabilities of the same; with power also to acquire other franchises. The capital stock of the company to be fixed at the sum of \$250,000, divided into 2,500 shares of \$100 each.

WINDSOR, ONT.—A company has been formed to build an electric railway from Windsor to Amherstburg, to be known as the Detroit, Windsor and Amherstburg Railway. Application for a charter will be made at the approaching session of the Ontario Legislature. The capital stock will be \$300,000, and the provisional directors will be Colonel James M. Clarke and William McGregor, M. P., of Windsor; Mayor J. G. Mullen, John A. Auld, J. David Burk and William D. Balfour, M. P., of Amherstburg. The Sandwich, Windsor and Amherstburg Railway Company have a charter, but as they have made no move to extend their line toward Amherstburg, the new company propose to take hold of the matter and organize as soon as their charter passes the Legislature.

English Notes.

(From our own Correspondent.)

LONDON, Dec. 27, 1893.

ELECTRIC TRACTION AT WALSALL.—According to a recent report, the overhead trolley system of electric traction at Walsall has led to a 20 per cent. increase of traffic in the past twelve months.

THE GOVERNMENT AND THE TELEPHONES.—The long delayed draft of the agreement between the Post Office and the National Telephone Company still continues to hang fire, and it is now stated that there is no prospect of the agreement being laid on the table of the House of Commons this session.

CENTRAL STATIONS IN CROWDED CITIES.—The St. James and Pall Mall Company, by the frequent legal actions which it is involved in, is experiencing one of the drawbacks of having a genuine central station. The latest action with which it is threatened is by the St. James vestry, who propose to prosecute it for discharging hot water and steam into sewers, and for being a source of bad smells.

ELECTRICAL RAILWAY ENTERPRISE IN LONDON.—In a recent letter, I mentioned that electric enterprise in London had

been at a complete standstill for some little time; no new schemes being formulated, and the ones which had obtained Parliamentary sanction having dropped into oblivion. The directors of the Exploration Company (Limited) in their report for the present year, state, in connection with the Central London Railway, in the promotion of which they are interested, that everything is ready for the carrying out of the scheme, with the exception of the necessary money, which it has been impossible to obtain, owing to the unfavorable state of the money market.

TOWN COUNCILS AND FREE LUNCHEONS.—The treating, which has been going on for some time past, of the members of the Electric Light committees of town councils by expectant electric light contractors, has, I am glad to say, met with a slight check. At a recent meeting of the York Town Council, a protest was made by one or two members against some recent visits made to electric light works by a sub-committee of the council at the expense of some electrical firms. It was remarked that after having been four years amassing information the sub-committee was still not content, and were not, as might have been expected, "above being feasted with the not very distant object in view of those who feasted them obtaining some advantage." A formal resolution was finally moved stating that all such expenses must in future be paid out of the city rates.

News of the Week.

Electric Light and Power.

ALLIANCE, O., will have a new electric light plant in the near future.

GRAND JUNCTION, Ia., is contemplating seriously the question of electric lights.

WACO, TEX.—W. W. Larmour is in the market for an electric elevator for an office building.

CANTON, O., has resolved to ask legislative authority to issue bonds for a \$60,000 electric light plant.

BUTTE, MONT.—Proposals are wanted to Jan. 17 for furnishing an electric plant for the public library.

ST. PARIS, O.—An electric light petition is being circulated and the prospects are good for securing a plant.

SCHENECTADY, N. Y.—The Lamp Committee has advertised for proposals for lighting the city, to be in by Jan. 9.

LARCHMONT, N. Y.—An electric light plant will be established and be in operation next summer. It will be a local corporation.

BRUNSWICK, MO.—An election will be held Jan. 13 to vote in the matter of issuing \$10,000 in bonds for an electric lighting plant.

DETROIT, MICH.—The public lighting board will receive bids for building the new lighting station Jan. 23, and for the machinery Jan. 30.

SAUGATUCK business men are contemplating the establishment of an electric lighting plant large enough to light the stores of the town.

ROCK FALLS, ILL.—The City Council of Rock Falls rejected all bids for the proposed electric light plant, on the ground that they were too high.

PHILADELPHIA, PA.—The "Record" states that Mayor Stuart is anxious to make his administration notable for electric lighting and improved streets.

HAVERHILL, MASS.—The Board of Aldermen has unanimously passed an order for the establishment of a municipal electric light system.

TOLEDO, IA.—The town council has decided to hold a special election Jan. 11, for the purpose of deciding whether the town shall be lighted by electricity.

DETROIT, MICH.—P. L. Chapton, of 245 Woodward avenue, is architect for the proposed incandescent light station to be built at Michigan avenue, near Fifteenth street.

EASTON, PA.—Councilmen have received with favor, but not passed officially, a suggestion for a bond issue, to pay for an extra dynamo, as well as other necessities.

HUDSON, N. Y.—On motion of Supervisor Duntz, a committee of three was appointed to look into the matter of an electric lighting plant for the county building at Hudson.

RICHMOND, VA.—The resolution of Mr. Murphy authorizing an issue of \$75,000 in 4 per cent. bonds for an electric lighting plant has been referred to the Finance Committee.

DETROIT, MICH.—The Public Lighting Commissioners have decided to accept the plans and specifications of Architect John Scott, and they will receive bids to January 23.

GRISWOLD, IA.—It is proposed to put in an engine with the water works plant, powerful enough to operate an electric plant in connection with the water works system.

BRUNSWICK, MO., will vote on Jan. 13 as to whether the city shall become indebted in the sum of \$10,000 for the construction and erection of a system of water works and electric lights.

HAVERHILL, MASS.—The Common Council has refused to concur with the Mayor and Aldermen in the passage of an act favorable to the establishment of a municipal electric light plant.

ABERDEEN, MD., will be lighted by electricity, and is also subscribing \$30,000 toward the capital stock of an electric road from that place to Glenville and the Susquehanna paper mills.

BATAVIA, N. Y.—The Board of Aldermen of Batavia have decided to require contractors to furnish dynamos of the capacity of 120 lamps of 2,000-c. p. The clerk has been authorized to call for bids.

FALL RIVER, MASS.—In his annual message, Mayor Coughlin states that Fall River is now paying very high for her electric lighting, and that it would be good policy for the city to begin now and prepare for owning her own plant.

ROCHESTER, MINN.—The electric light plant at Sleepy Eye is owned and controlled by the city. In November, the total expense of running the plant was \$177 and the amount received from rentals \$260, leaving a balance in favor of the city.

ROMEO, MICH.—E. P. Kinney, a Detroit electrician, will put in an electric lighting plant at Romeo if the citizens will take \$700 worth of the stock. This has been assured, and all that is needed now is a five years' franchise from the village.

CAMBRIDGE, MASS.—The Cambridge Gaslight Company and the Cambridge Electric Light Company have been requested to file with the city authorities a complete statement of their plants to guide the authorities in the matter of purchasing the same.

ATTLEBORO, MASS.—The electric power station of the Interstate and Attleboro, North Attleboro and Wrentham Electric Street Railways, located at Farmer's, on the Wrentham branch of the consolidated road, was burned with all contents. Loss, \$75,000.

WILMINGTON, DEL.—Proposals will be received at the office of the Water Department, southwest corner Sixth and King streets, to Jan. 9 for wiring the city mill filter pumping station for electric lighting, details to be had on application to J. A. Bond, chief engineer.

NEWARK, N. J.—The Harrison Park Water and Supply Company has bought the artesian well plant of the Iron Hall Land and Improvement Company, and they propose to put in a steam pumping plant, which will also furnish power for a village electric lighting system.

YORK, PA., has been making some investigations as to the relative cost of a municipal electric light plant and lighting by contract. The present cost of lighting is \$18,000 a year. A committee has reported that a city electric plant can be supplied for \$35,000 and operated at a cost of \$10,000 a year.

RED BANK, N. J.—Proposals are wanted for lighting the town with sixty or more arc lights of 2,000-c. p., all night, and every night, on a five years' contract. Proposals may include incandescent lights for stores and dwellings. Also cost of plant should town decide to purchase. Address H. H. Curtis, Commissioner.

BELLEfonte, PA.—The Edison Electric Illuminating Company has received the contract for lighting the streets of Bellefonte for the term of three years with twenty-one arc lights, every night and all night except clear, moonlight nights, at \$105 per light per year. Also for fifty 16-c. p. incandescent lamps at \$21 per year each.

WILKESBARRE, PA.—Simpson & Watkins are putting in an electric light plant at their Mt. Lookout colliery for the purpose of lighting the mines, and propose furnishing electric light to the borough of Wyoming, if the citizens desire to have it. There is not a town in the whole Wyoming Valley that cannot be supplied with electric lights from the culm waste from the mines. The only wonder is that our mine owners are not utilizing this waste material in the manner indicated.

WINONA, MINN.—Sealed proposals will be received to Feb. 11 for furnishing the city with gas or electric lights for street lighting for the period of three, five, seven, or ten years. 1. With arc or incandescent lights, or both. 2. With gas. 3. With arc or incandescent lights, or both, or gas. 4. With arc and incandescent lights, the city to have option of purchasing plant complete after two years, the city to furnish a site. 5. For furnishing a plant for lighting the city with arc or incandescent lights, or both, the city to furnish site, building and power; plans to be completed July 1; proposals will be opened at regular meeting of city council Feb. 11. O. H. Clark is recorder.

The Electric Railway.

DECKERTOWN, N. J., wants an electric railway.

CHARLOTTESVILLE, VA.—An electric street railway seems to be assured.

HOT SPRINGS, ARK.—George W. Baxter is interested in the project to build an incline railway to the summit of West Mountain.

ASHEVILLE, N. C.—The gas plant and railway system of the Asheville Street Railway Company are soon to be enlarged and improved.

BOSTON, MASS.—The West End Street Railway will build their proposed short cut from Boston to Brighton via North Beacon street to the Watertown line.

BRIDGEPORT, CONN.—The Sanford & Stillman Company of Jersey City, N. J., will be among the bidders for the construction of the lines of the traction company in Bridgeport when the proper time arrives.

ATLANTA, GA.—Mr. Adams, formerly of Corinth, Miss., has succeeded Mr. S. W. Divine in the presidency of the Chattanooga Electric Street Railway Company. Mr. C. P. Young is still the efficient superintendent.

KANSAS CITY, MO.—The Kansas City Electric Railway Company has been granted a franchise to build a line from Summit street to Westport. W. W. Kendall is president of the company and T. S. Case is secretary.

BRISTOL, PA.—The representatives of the company which proposes to build a trolley line in Bristol are conferring with the Borough Council. If their terms are acceded to, they promise to have the line in operation by July 1.

CAMDEN, N. J.—William Thompson, owner of the Gloucester, N. J., race track, has filed incorporation papers of the Manahawkin and Long Branch Transportation Company, to carry passengers and freight between these points. Capital \$500,000.

FALLS CHURCH, VA.—The proposition to issue bonds for \$10,000 to aid any company that will build an electric railway here meets with much favor and at the next meeting of the Council, the committee will request that the matter be submitted to a vote.

GLOVERSVILLE, N. Y.—The Gloversville "Leader" states positively that a road will be built from Amsterdam to Gloversville and Johnstown, to accommodate both electric and steam motors. No names have yet been mentioned in connection save that of a Mr. Caten, of Gloversville.

TOLEDO, O.—The Toledo and Maumee Valley Railroad Company, capital \$300,000, has been incorporated to build a railway, to be operated by electricity, or other motive power, from Toledo to Perrysburg. William B. Taylor and Josiah D. Cook, civil engineer, 47 Produce Exchange, are interested.

BRIDGETON, N. J.—The Bridgeton, Port Norris and Cedarville Railway Company has been granted a franchise. Among those interested are John Smalley, Prof. W. O. Garrison and Walter H. Bacon. Owing to strong remonstrance, the franchise applied for by the West Side Railway was not passed upon finally.

CHESTER, PA.—S. M. Patterson, of the Pennsylvania Traction Company, is seriously considering the advisability of running a branch of the proposed electric railway to Oxford. The idea is to connect it with the main line of the electric railway at Parkesburg, the distance from which place to Oxford is about fifteen miles.

BROCKTON, MASS.—Mayor Whipple, in his inaugural address before the city council, recommends immediate application to the Legislature for adjustment of corporation tax, so that cities may tax the franchises of street railway companies, said tax to compensate for the expense and disadvantages incurred by the cities by location of tracks.

JERSEY CITY, N. J.—By a vote of 8 to 3, the Board of Freeholders of Hudson County have granted a franchise to the Jersey City, Harrison and Kearney Railroad Company to operate a railroad on the Heights and highway from Newark to Jersey City, through Kearney and Harrison, over the New Hackensack bridge, no engine ever to be used on the road.

BROOKLYN, N. Y.—The Highway Commissioners of Flatlands, L. I., have granted a franchise to the Brooklyn, Bergen Beach and Canarsie Railway Company to build eighteen miles of railway there. The line will extend to Bergen Beach, with a branch across country to the Canarsie shore. An electric plant, to cost \$30,000, will be erected at Flatbush avenue and King's Highway.

GARDNER, ME.—The electric street railway project here in town is assuming tangible shape, in anticipation of spring, and the beginning of work then. The Selectmen will give a hearing in a few days on final matters in connection with the franchise. There has been enough stock taken to hold the franchise should it be granted, and the rest is pledged. Altogether the outlook is bright indeed.

NEW UTRECHT, L. I., N. Y.—Martin H. White, Commissioner of Highways of New Utrecht, has decided to grant a franchise to the Thirty-ninth Street, Brooklyn, Ferry and Suburban Railway, and to refuse a franchise to the Mapleton, Van Pelt Manor and Bath Beach Railway Company. This action was owing to absence of opposition to the former road, and the strong opposition to the plans of the Mapleton Company.

READING, PA.—The matter of the proposed electric road from Temple to Reading is being discussed, and John H. Rothermal, representing the Reading and Southwestern Street Railway Company, has submitted a proposition, which will be considered. The Reading Traction Company is also in the field, and residents of Muhlenburg township are considering the matter. The farmers in this township are asking a high price for damages.

CORNING, N. Y.—The Corning "Democrat" calls attention to the fact that a prominent citizen of Corning has offered to furnish the cash capital to build a street railway, if citizens would

guarantee him 5 per cent. on his investment, with the understanding that all net income over 5 per cent. should be divided between the company and the capitalist. The "Democrat" urges citizens to take action, and will furnish any additional details.

PITTSBURGH, PA.—The Pittsburgh Elevated Railroad Company, \$100,000, has been chartered to build a ten-mile road from Pittsburgh to Wilkesburg Borough. John H. Dalzell is president, and the directors are Joshua Rhodes, W. B. Rhodes, G. B. Hill, J. D. Nicholson, R. S. Frazer and A. M. Neeper. The Northside Elevated Railroad Company, \$50,000, was also chartered, with John H. Dalzell as president, and G. B. Hill and Joshua Rhodes as directors. The route of the latter company is not given.

TRENTON, N. J.—A new electrical railway is being projected by Joseph H. Reale, of Bloomfield, N. J., to connect the Delaware and Hudson Railway cities with spurs to take in all the slidetowns from the mountains to the seashore; the cars are to be double motor of 30-h. p. each, and five electric power plants will be located, one each in Trenton, Rocky Hill, Bound Brook, Westfield and Orange. It is stated that most of the capital has been subscribed and that work will be begun within six months. Among those interested are John H. Reale, of Bloomfield; Charles E. W. Smith, of Morristown, and J. H. Baldwin, of Orange. E. Chamberlain is engineer.

NASHVILLE, TENN.—The United Electric Railway has been placed in the hands of a receiver. This road was formed six years ago by the consolidation of all the street railways then in Nashville and has at present over sixty motor cars in operation and fifty miles of track. The receivers are the Nashville Trust Company and Thomas W. Wrenne, the former president of the road. Owing to the financial stringency of 1893 the road's earnings fell off to over one-half of what they had been in 1892, in which latter year they amounted to \$334,000. The road was unable to pay its January interest. It is understood that one of the conditions of the receivership is that the Nashville Trust Company will advance funds to pay off the floating debt and January interest.

FITCHBURG, MASS.—The prospects for electric street railway extension in Worcester County, north, are decidedly better than they were a month ago, for it is evident that the Selectmen of Lancaster are very favorably disposed toward the petitioners for leave to run rails in that town in connection with the Clinton line. The Clinton company is largely owned here, and the local company already owned here, and the local company already has in operation a line extending nearly through Leominster and well over toward Lancaster. Now that the Worcester North Company of Leominster is out of the field, having allowed part of its franchise to expire by limitation, it is more than ever probable that the Fitchburg and Leominster Company will renew its petition for leave to extend its tracks to Lancaster, and, of course, to Clinton, making a valuable and available system, connecting a number of large towns with this city.

THE ATLANTA CONSOLIDATED STREET RAILWAY COMPANY has failed to pay the interest on its bonded indebtedness, due Jan. 1. The amount of this indebtedness is about \$1,833,000, the rate of interest being 6 per cent. per annum. Mr. Joel Hunt, president of the road, has been making every effort to abridge the present trouble and bring about an agreement among the bondholders, which will prevent the appointment of a receiver with its various consequences. It is stated that he has obtained such an agreement, in which the bondholders agree to accept 3 per cent. interest instead of 6 per cent. for two years, after which a rate of 5 per cent. will be adopted. It is necessary for 90 per cent. of the bondholders to agree to this proviso to have it carried out. It is also proposed to assess the stockholders to pay off the floating indebtedness. Such a plan deserves support. The Consolidated is one of the first and finest pieces of electric railway property in the South, and will prove valuable to its stock and bondholders. The recent depression in business has crippled the road's finances, but with the close economy practiced by the road, it will pull through successfully.

CANANDAIGUA, N. Y.—The Littleville plant has been built by the Canandaigua Electric Light and Railroad Company, which is the union of the Canandaigua Electric Light Company and the Canandaigua Street Railway Company. The new company is incorporated with a capital stock of \$80,000. The officers are M. D. Munger, president; H. B. Ferguson, secretary and treasurer, and C. J. Purdy, general superintendent. The cost of the plant is about \$50,000. To obtain the needed water rights, the company bought 240 acres of farm land, about 150 acres of which will be flooded. It is proposed to light from Littleville, Palmyra, seven miles away; Canandaigua, five miles; Manchester, a mile and a half, and Shortsville, three-quarters of a mile distant. The officers of the company give assurance that an electric street railway will be laid in the spring through Canandaigua over the route of the old horse-car line, and will be put in operation as soon as possible. It is an open secret that the managers of the company propose to construct at an early date a railway from Canandaigua to Shortsville and Manchester, connecting at the latter place with the Lehigh Valley Railroad. This proposed road will carry both coal and passengers. The lamps of Canandaigua, it is expected, will be lighted by the Littleville plant within a month. The old plant will be used for some time yet, but its use will be gradually discontinued, until finally all the power will be centred at Littleville.

AN ELECTRIC RAILWAY, between Boston and Portland, will be built, it is rumored, within the next three years. A syndicate has been formed, and it is understood that Hon. Frank Jones, of Portsmouth, N. H., is a prime mover in developing the rapid transit scheme. The ground has been looked over very carefully, and the line will be located as soon as the civil engineer finishes his survey, which will probably be in a few days. The plan, as it now stands, is to run trains every hour from the terminal cities, and it is expected to make the run from Boston to Portland in four hours. In some parts of the road the rails will be placed on trestlework, some four or five feet above ground. This will be done to make the removal of the snow from the tracks easier. It is understood that Arthur Sewall, late president of the Maine Central road, is also interested in the plan. He is owner of an electric line in New York State, and has the control of some valuable patents which pertain to the storage system. He is a firm believer that electricity will replace steam. What electric roads are operated in Massachusetts and can be used advantageously are now controlled by the syndicate or its friends. This syndicate also has its eye on an electric line in Maine, and here Arthur Sewall's hand in the scheme is shown. He is building the line between Brunswick and Bath, and is interested in other lines which will be consolidated into one line.

Personal.

MR. J. V. Z. ANTHONY, the young and enterprising manager of the Middletown Electric Light and Power Company, Middletown, N. Y. (which concern is under the control of the Port Wayne Electric Company), was quietly married to Miss Frances James, of Jersey City Heights, on Jan. 4. Miss James is conceded to be the belle of the section wherein she resides, and the young people have the best wishes of their many friends for many years of happiness.

JOHN WALKER is a name which bids fair to become as familiar in electrical circles as it already is in other fields. The recent announcement that the Walker Manufacturing Company, of Cleveland, had decided to engage in the manufacture of electrical machinery was received with the greatest interest, and has created considerable stir among electrical men. Mr. Walker has been closely identified with the company that bears his name, and his engineering skill and executive ability are to a great degree responsible for the magnificent manufacturing plant that has been built up. He has made some important inventions in cable railway apparatus, which are now embodied in almost every modern cable plant. With its past record for high class work, with its splendidly equipped plant and with John Walker as its vice president and general manager, the Walker Manufacturing Company may enter the electrical field confident of success.



Miscellaneous Notes.

NEW ORLEANS, LA. The newly organized electrical club of New Orleans will have a house fitted with rooms for electrical experimental purposes.

THE NEW YORK ELECTRICAL SOCIETY will hold its next meeting at Columbia College, on Tuesday, Jan. 16, at 8 p. m. Prof. M. I. Pupin will deliver a lecture on "Electrical Resonance," accompanied by experiments, showing the properties and influence of self-induction and capacity on electric circuits.

A NEW CONDUIT SYSTEM—William T. Dolany, of 289 Broadway, New York, has devised a system of operating street railway cars by a trolley on the underground plan, and has applied to the authorities in Brooklyn for permission to lay underground wires for a distance of one mile, when he will give a public exhibition of his new invention.

AN ELECTRICAL SCHOOL—G. C. Stiebert, an electrical engineer, has started an electrical school at 47 Church Street, Montreal. This school fills a long felt want. A thorough knowledge of electricity can be obtained without the time and expense of a McGill course. Mr. Stiebert has a thorough knowledge of his subject, both in theory and practice.

ELECTRIC GAMBLING—Electricity has been applied to a novel use in Birmingham, Ala. R. D. Burnett, of that city, has been arrested for using a dice-throwing device in which electricity was used to manipulate the dice. The current could be turned on from behind the counter or bar by pressure of the foot, and the dice were so constructed as to fall a fixed way when the current was on, the current of course, being turned off while the customer was playing.

UNIVERSITY EXTENSION LECTURES.—Dr. Charles Forbes will deliver a University Extension course of lectures on electricity and its practical applications at Rochester, beginning on Jan. 9. Prof. Arey also started a course of lectures on Jan. 6 at Buffalo, which will cover the forces of nature as related to modern life, the nature of light and heat, music and the development of sound magnetism, and the applications of electricity.

THE MONTREAL (CANADA) ELECTRIC CLUB has adopted a new constitution and by-laws, which give the following qualifications necessary for membership: Members—Those actively engaged in any branch of the electrical profession, and students in electricity equal to third and fourth years at McGill University. Associates—Business managers of electrical firms, and members of other branches of the engineering profession. Associates to have full club privileges, with the exception of holding office.

THE WESTERN NORMAL COLLEGE, Lincoln, Neb., is building up, under the guidance of Mr. A. M. Craig, a course of electrical engineering, whose aim is to produce judicious workmen rather than technical experts or scientific investigators. It proposes to accomplish this result by requiring every student not only to handle, but to build electrical machinery. Students will be given practice in making castings and trimming and fitting them, in building converters, in winding various styles of armatures and field magnets, and in all parts of dynamo and motor construction. It is hoped in this way to make the education truly practical, and at the same time prevent graduates from making the mistakes so frequently committed by college graduates.

Trade and Industrial Notes.

THE CHICAGO ELECTRIC WIRE COMPANY, Wilmington, Del., received a contract to furnish eighty-four miles of 7-conductor submarine cable for the United States Government, to be used in the torpedo service.

THE PITTSBURGH REDUCTION COMPANY has, it is rumored, absorbed the Cowles Electric Smelting and Aluminum Company, whose works will be removed to Niagara Falls, with those of the Pittsburg Company.

THE JONES BROTHERS' ELECTRIC COMPANY, of Cincinnati, O., is making long strides toward procuring its share of the sales of all kinds of electrical supplies, including those for electrical railways. It has just taken an order from the Cincinnati Street Railway Company for fifty miles of trolley wire.

THE BEACON VACUUM PUMP AND ELECTRICAL COMPANY, Irvington street Boston, has issued a reduced price list, thus keeping abreast of the times. Its lamps have now reached that stage of perfection that it feels justified in maintaining that their quality is equal to the standing of the old Beacon lamp.

THE COLUMBIA LAMP COMPANY, St. Louis, Mo., has reduced the price of its lamps to meet the cut of the General Electric Company, and states that the same high grade of the Columbia lamp will be maintained. It says that it is enabled to make this reduction by reason of the magnificent support which has been given to it by users of incandescent lamps throughout the United States during the past year, which has enabled it to largely increase its manufacturing facilities and add additional machinery, which has reduced the cost.

THE STAR ELECTRIC LAMP COMPANY, 102 Michigan avenue, Chicago, brought out about Nov. 1, its new Sunbeam incandescent lamp, with luminous vapor. It is claimed for this lamp that it is a great improvement over both the vacuum and gas lamps which are now on the market. The luminous vapor prevents absolutely, it is claimed, the drop in candle power, and a clear white light is given out during the entire life of the lamp instead of the yellow light produced by the vacuum lamps after they have been running a few hundred hours.

WILEY & PHELPS, of the Monachnock, Chicago, have been fortunate enough to secure the agency of the De Laval steam turbine, the rotary engine which created so much talk at the late World's Fair. It was in continuous operation in Machinery Hall and its running attracted wide attention. It is the invention of the famous scientist, Dr. De Laval, of Stockholm, Sweden, and has met with great success abroad. Phelps & Wiley are now prepared to supply this very ingenious machine to the American market, and anticipate a most cordial reception among electricians.

"ACME" PORTABLE TESTING SET—Queen & Co., incorporated Philadelphia, are making a renewed push of their "Acme" portable testing set, which was temporarily withdrawn from the market because of certain small defects which have now been overcome in a thoroughly satisfactory manner. After a careful test the United States Government has informed the makers that the set will be accepted for service on shipboard in the navy, where the requirements are extremely exacting. In addition to this a World's Fair diploma was awarded Queen & Co. for "testing sets and standard resistances."

M. T. DAVIDSON, the prominent steam pump builder, of Brooklyn, N. Y., is one of the few manufacturers who starts on the new

year full of business. The works at 43-53 Keap street are running the regular ten hours a day with a full force of men, and at no time during the past year has the dull times made any change necessary or desirable. The outlook for the year 1894 is very promising. The export sales of the Davidson pump have been of late worthy of remark, and a number of important orders have also been placed in the United States. We notice a recent contract awarded to Mr. Davidson for two additional pumping engines at the city pumping station, Fall River, Mass. There are already two Davidson engines in use at these works.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY, of 440 Monadnock Block, Chicago, anticipating the expiration of the last Bell telephone patent, which affects their apparatus, already has orders for several thousand telephones, including a number of telephone exchanges throughout Wisconsin, Iowa and Minnesota. Work will be commenced in every instance after February 1, 1894, the date of expiration of the patent. This company has exclusive territorial rights in several States for nearly one hundred of the most valuable patents ever issued, including some of the newest and most valuable telephonic service. It proposes to install nothing but the very best apparatus, and expects that its prestige, already secured, together with the excellent systems which it proposes to equip, will give it a great advantage over smaller concerns which expect to enter into the telephone business.

THE METROPOLITAN ELECTRIC COMPANY, of Chicago, has been fortunate enough to secure the services of Mr. J. J. Nate, who for the past ten years has been closely identified with the Chicago Telephone Company. The first six years of his work there was confined to the practical and construction part of the business. He arose in the company through the successive stages of foreman, manager, superintendent and finally purchasing agent. This experience gave him a thorough knowledge both of the practical and commercial departments of the telephone business, and will be of great service in his present connection, as the Metropolitan Company will do a large business in handling telephones and telephone supplies after the expiration of the patents. Mr. Nate is thoroughly posted on electrical matters in general, having attended the various electric light and street railway conventions, and having maintained a close relationship with the prominent figures in the industry. He resigned from the telephone company, where his services were highly valued, because of his more favorable offer from the Metropolitan, and has received a great many letters of congratulations and good wishes on the change he has made.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, has issued its No. 6 catalogue, being the latest edition of its complete catalogue of electrical supplies. The book is bound in heavy purple "Princess" covers, with lettering on two sides and back, in fire bronze, while the title page bears, in red, The Electrical Appliance Company's well-known triangle trademark. The catalogue

contains no less than 350 pages, six by nine inches. The first pages are devoted to Packard lamps and incandescent supplies and fittings, followed by arc light and station supplies. A complete and well illustrated list of construction and general tools comes next, after which is a carefully selected list of construction material, including Paranalite and O. K. wire. Interior conduit material and test instruments receive the next attention, and a full line of Weston motors closes the electric light department of the catalogue. The remaining 100 pages are devoted to electrical house goods, telephone and telegraph supplies and fire alarm and district telegraph material. The book is very completely indexed, there being an alphabetical index of contents, and an index to trade numbers, as well as one of code words. The entire catalogue leaves nothing to be desired, looking at it from any standpoint.

THE GREAT WESTERN MANUFACTURING COMPANY is the title of one of the most thrifty enterprises in Duluth, Minn., it not in the West. T. B. Casey is president, R. S. Munger, J. S. Young, of Maine, and O. H. Simonds, first, second and third vice-presidents; E. R. Gilman, general manager, and H. A. Odell, secretary and treasurer. J. B. Boyd, an old and favorably known resident of Duluth, is manager of the factory, and Force Bain is electrical and mechanical engineer in chief. The general offices of the company are located in Chicago, with branch offices in St. Louis, Denver and Pittsburg. The Great Western manufactures everything electrical. It, however, makes a specialty of manufacturing and exploiting the electric lighting and power systems, the inventions of its engineer in chief, known as the Bain systems. They consist of dynamos for local incandescent lighting and for long distance lighting; and dynamos and motors for the transmission of power. The company has a large department in which it produces high class gas and electric fixtures, and all kinds of switches, cut outs and appurtenances for dynamos, meters, rheostats, sockets and shades. It has a large and well equipped factory for insulating electric wire for its own use, besides furnishing quantities for the market. It will add a wire drawing mill in the spring. The company makes its own brass and iron castings, and produces every item of its manufacture necessary for the installation of an electric plant of any magnitude. The plant is large and well adapted to the work and is equipped with the latest and most improved machinery. It employs now about 150 men and is working every night until 11 o'clock. Within the next six months it is thought that the number of employees will be increased to 500.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED DEC. 26, 1893.*

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

511,328. METHOD OF ELECTRIC COMMUTATION AND FLUID ELECTRIC COMMUTATION; C. E. Emery, Brooklyn, N. Y. Application filed Dec. 28, 1892. The combination of a commutator and a brush formed of circulating conducting fluid.

511,342. CONDUIT RAILWAY TROLLEY; J. C. Love, Chicago, Ill. Application filed May 17, 1892. This comprises a grooved contact shoe, supported by a main arm adapted to swing in a vertical plane, and consisting of two parts, connected by a transversely arranged pivot adapted to allow lateral oscillatory movement in the outer end of the arm, a horizontally arranged arm pivoted to the other end of the main arm and adapted to swing in a vertical plane and to which the shoe is connected by a vertical pivot, and springs yieldingly sustaining the main and horizontal arms.

511,343. TROLLEY FOR CONDUIT RAILWAYS; J. C. Love, Chicago, Ill. Application filed May 17, 1892. The combination of a horizontal laterally moving carrying bar having sliding connections at both ends with the car, of two oscillating notched retainers adapted to engage the ends of the carrying bar.

511,344. SUPPORT FOR ELECTRICAL CONDUCTORS; J. C. Love, Philadelphia, Pa. Application filed Jan. 21, 1893. This comprises two gripping plates having jaws which engage the conductor, and a support for the plates consisting of a two-part socketed clamp, and insulating material surrounding the plates within the socket of the clamp.

511,345. TENSION DEVICE FOR ELECTRICAL CONDUCTORS; J. C. Love, Philadelphia, Pa. Application filed Jan. 21, 1893. This comprises a sliding block and abutment, a spring applied between the sliding block and the abutment, a clip supporting the

conductor, and an adjustable coupling rod connecting the clip with the block.

511,346. TROLLEY BAR CARRIER FOR CARS; J. C. Love, Philadelphia, Pa. Application filed Jan. 21, 1893. The combination of a trolley bar carrier capable of lateral movement at both ends, and means for automatically confining the advance end of the carrier when the direction of movement of the car is reversed.

511,347. GOVERNOR FOR ELECTRIC MOTORS; J. Marty, Jr., Cleveland, Ohio. Application filed Oct. 10, 1892. This consists of an armature having its bars diagonal to the axis, and the commutator brushes, mounted diagonally to the axis in a frame adapted to be moved longitudinally back and forth, according as the speed of the dynamo is increased or diminished.

511,358. TELEPHONE; B. Pickering, Dayton, Ohio. Application filed Jan. 29, 1891. In a combined telephone and microphone, having but a single vibrating diaphragm, a bonnet wire coil as a bearing for the under edge of the diaphragm.

511,375. METHOD OF AND MEANS FOR COMPOUNDING DYNAMO-ELECTRIC MACHINES; E. Thomson, Swampscott, Mass. Application filed Nov. 23, 1892. A dynamo having near each of its field magnet poles a "dead pole."

511,376. ELECTRIC MEASURING INSTRUMENT; E. Thomson, Swampscott, Mass. Application filed March 2, 1893. The combination of an oscillating horseshoe magnet having its poles closely approximated with a coil having a fan-shaped winding upon a conducting bobbin extending between the poles of the magnet.

511,401. ELECTRIC METERS; L. Brillie, Paris, France. Application filed Nov. 22, 1893. An electric meter having a dynamometer serving to control the speed of an electric motor exerting an opposite tendency on the dynamometer through the medium of a magnetic retarder, with a metal cylinder connected to the other and a plurality of U-shaped magnets, with their poles projecting on opposite sides of the cylinder, and connected to the other part.

*Owing to an unavoidable accident, it was found necessary to omit patent illustrations this week.

- 511,407. PROCESS OF MAKING RESISTANCE PLATES; C. E. Carpenter, Bridgeport, Conn. Application filed Feb. 7, 1893. This consists in attaching a coating of enamel to a support, shaping a conductor into curved or reflex form, placing the conductor upon the surface of the coating, covering this with a coating of enamel having a lower fusing point than the enamel already applied, and raising the whole temperature sufficient to fuse the second layer.
- 511,419. TROLLEY WIRE CROSSING; H. Gelse, Philadelphia, Pa. Application filed June 26, 1893. The combination of wires insulated at the point of crossing each other at a point above the normal level of the wires, and a travel plate provided below the point of crossing, upon which the trolley wheels are adapted to run.
- 511,434. GALVANIC BATTERY; H. T. Johnson, New York, N. Y. Application filed April 21, 1893. In a dry battery the combination of a containing cup forming the positive electrode, a semi-solid filling within the same, and a negative electrode having an uneven surface embedded in the filling.
- 511,448. ELECTRIC LOCOMOTIVE; J. G. McCormick, Louisville, Ky. Application filed April 1, 1892. This comprises an electric motor mounted on the axle, a bar for preventing the rotation of the field of the motor, and arms secured at one end to the bar and at their other ends made to embrace the casing of the motor.
- 511,451. ELECTRIC BELL; A. J. Gehring, Chicago, Ill. Application filed April 25, 1891. A bell having magnets and cores of oblong cross section, the magnets occupying positions with their greatest diameters parallel, and an armature pivoted to the axis at right angles to the greatest dimensions of the magnets.
- 511,452. CONDUIT ELECTRIC RAILWAY; H. D. Oler, Paterson, N. J. Application filed Aug. 23, 1892. A conduit having wooden blocks fastened therein, the blocks having grooves formed in them in which a conductor is held, sliding blocks in the groove, plates hinged in the conduit and connected with the blocks and a wheel passing through the conduit slot to act upon the hinged plates.
- 511,456. TELEPHONIC INSTRUMENT; P. Rabbidge, Sydney, New South Wales. Application filed April 22, 1893. A receiver case, diaphragm, magnet and spring armature, the spring armature being distinct from the diaphragm and inclosed within the case, in combination with a gravity switch for cutting out the alarm circuit when the receiver is held to the ear.
- 511,459. CARBONIZING APPARATUS; I. L. Roberts, Brooklyn, N. Y. Application filed Dec. 8, 1892. A perforated electrically conductive vessel and an outer non-conductive covering.
- 511,461. SAFETY DEVICE FOR ELECTRIC CIRCUITS; C. H. Rudd, Evanston, Ill. Application filed Dec. 10, 1888. This comprises a shunt circuit around the working circuit, the shunt circuit containing high ohmic resistance, and a central connection to the ground from the shunt circuit.
- 511,462. FIRE-ALARM TELEGRAPH; S. H. Rudd, Chicago, Ill. Application filed May 19, 1892. This comprises two magnetic helices adapted to operate in opposition to each other upon an armature, heat responsive devices adapted to open the circuit when actuated, and mechanism controlled by the armature for sending the alarm signal.
- 511,464. MULTIPLE SWITCHBOARD SYSTEM FOR TELEPHONE EXCHANGES; C. E. Scribner, Chicago, Ill. Application filed April 26, 1893. A system of circuits such that the signal receiving annunciator of any line while connected with the line circuit is irresponsive to signaling currents in the circuit during the connection of the line with another telephone line.
- 511,495. ELECTRIC ARC LAMP; R. Belfield, London, England. Application filed April 5, 1893. This comprises a feeding mechanism carrying an actuating stem, a core loosely sleeved thereon, an abutment for the core at one end of the stem and a solenoid for raising the core.
- 511,503. ELECTRIC MEASURING APPARATUS; T. Bruger, Bockenheilm, Germany. Application filed Aug. 19, 1893. This comprises a stationary polarized solenoid and a double solenoid of alternate positive and negative poles, the double solenoid being mounted coaxially with the stationary solenoid and adapted to move over the same.
- 511,512. MACHINE FOR SEPARATING MAGNETIC FROM NON MAGNETIC SUBSTANCES; C. G. Crosby, New York, N. Y. Application filed Jan. 11, 1893. The combination with a carrier and the electro-magnetic wheel of a feeder comprising a chute having steps, and adjustable vertically and horizontally relatively to the wheel.
- 511,514. PROCESS OF AND COMPOSITION FOR THE MANUFACTURE OF POROUS CUPS FOR ELECTRICAL BATTERIES; F. G. Curtis, Philadelphia, Pa. Application filed Feb. 13, 1893. This consists of moistening clay with a solution of carbonate of ammonia and carbonate of potassium in molding the moistened clay and then baking the same.
- 511,523. CURRENT REGULATOR FOR DYNAMO-ELECTRIC MACHINES; C. D. Haskins, Brooklyn, N. Y. Application filed Nov. 12, 1892. This comprises a magnetic field whose strength varies with the strength of the generated current and an independently mounted rotatable armature adapted to shift the position of the brushes upon the commutator to maintain a constant current in the working circuit.
- 511,524. CONVERTER SYSTEM FOR ELECTRIC RAILWAYS; G. E. Hese, Brooklyn, N. Y. Application filed Nov. 21, 1892. A rail for an electromagnetic railway having branches wound with an insulated electric conductor for utilizing the rail as a primary magnet.
- 511,547. ELECTRIC WIRE COVERING; F. S. Randall, Philadelphia, Pa. Application filed June 2, 1893. A covering consisting of raw cotton in bulk.
- 511,559. ELECTRICAL TRANSMISSION OF POWER; N. Tesla, New York, N. Y. Application filed Dec. 8, 1888. A method of operating motors having independent energizing circuits, consisting of passing alternating currents through both the circuits and retarding the phases of the current in one circuit to a greater or less extent than in the other.
- 511,560. SYSTEM OF ELECTRICAL POWER TRANSMISSION; N. Tesla, New York, N. Y. Application filed Dec. 8, 1888. The combination of an alternating current dynamo with a motor having independent energizing circuits connected in multiple arc with the circuit and of different active resistance.
- 511,570. ROTARY ELECTRO-MAGNETIC MACHINE; H. P. White, Kalamazoo, Mich. Application filed Feb. 15, 1893. The combination of a multipolar armature magnet and coils, with a number of circular-head hollow wedges of magnetic material interposed between the adjoining coils of the armature.
- 511,574. ELECTRIC TRANSFORMER; J. J. Wood, Fort Wayne, Ind. Application filed May 19, 1893. An iron-clad transformer-punching, having limbs of unequal length, with its middle, or core limb, formed in a reverse curve, longer on one side of its middle than on the other.
- 511,589. TELEPHONE SYSTEM; F. R. Colvin, New York, N. Y. Application filed June 26, 1893. A telephone system having an independent wire for each station, normally open circuit closers at each station connecting with the individual wires of the other stations, and a generator and telephone adapted to be put into circuit with any of the individual lines by mere engagement of the contacts.
- 511,599. PATROL BOX; W. Eglin, Philadelphia, Pa. Application filed Jan. 19, 1892. A patrol box having a signal, with a rising and falling rod carrying a weight, an armature engaging with the weight, and means for breaking the circuit by the movement of the door of the box.
- 511,611. INSULATOR; C. N. Hammond, Boston, Mass. Application filed Sept. 1, 1892. An insulator having a recess to receive the wire, lips or projections, and a slot leading to the recess, the wall on one side being cut away to form a retaining point.
- 511,612. INSULATOR; C. N. Hammond, Boston, Mass. Application filed April 12, 1893. An insulator having openings to receive the wire, the openings being curved and having an overhang on one side.
- 511,613. ROSETTE FOR ELECTRIC LIGHTS. C. N. Hammond, Boston, Mass. Application filed June 30, 1893. A rosette having at its opposite sides flanges or ears provided with projections, serving as binders for the feed wires, and also having guides for the lamp cord strands adapted to apply the strands directly to the feed wires at the points protected by the ears.
- 511,621. ELECTRIC MOTOR APPARATUS; W. A. Johnston, A. W. Browne and J. C. Davidson, Prince's Bay, N. Y. Application filed April 25, 1893. A box for a foot actuated motor switch mechanism provided with locking mechanism for holding them needed heel rest for the foot.
- 511,627. ELECTRIC RAILWAY SWITCHING MECHANISM; C. J. Kintner, New York. Application filed June 24, 1893. This comprises an insulated main, a series of pivotal sectional trolley conductors provided with locking mechanism for holding them in electrical contact with the current main.
- 511,647. ELECTRIC GRAIN WEIGHING SCALE; J. and D. De P. A. Outcalt, Spotswood, N. J. Application filed July 8, 1893. A weighing apparatus having separate aligned solenoids with a single intermediate core, a cut off attached to the solenoids' core, and means for automatically energizing the solenoids separately.
- 511,720. FIRE GUARD FOR LAMP CORDS; E. E. Angell, Somerville, and S. Porter, Boston, Mass. Application filed April 20, 1893. A fire guard, comprising two connected discs, each provided with slots for receiving the strands of the lamp-cord, the discs being adapted to turn on each other to close their slots.
- 511,731. ELECTRIC SIGNALING APPARATUS; T. B. Doolittle, Bridgeport, Conn. Application filed Feb. 13, 1893. A visual annunciator consisting of a magnet and a rolling indicating armature confined and guided in a casing having an aperture at which the indicating armature is displayed.
- 511,739. TELEPHONE SYSTEM; J. J. McNally, California, Mo. Application filed Aug. 31, 1892. The combination of separate line circuits normally open and an electromagnetic step-by-step mechanism at the central office, whereby when the switch of a subscriber is closed the step-by-step mechanism will automatically close the circuit with the subscriber desired.
- 511,742. ELECTRIC CAUTERY APPARATUS; J. A. Wotton and E. A. Bostrom, Atlanta, Ga. Application filed June 26, 1893. This comprises primary and secondary coils, a transformer movable to and from the same, a rack secured to the movable coil, a plunger mounted on the shaft set in the casing, and a handwheel thereon outside of the casing.

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1880 contained 25 different adv'ts.	1887 contained 154 different adv'ts.
1881 " 28 " "	1888 " 175 " "
1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 289 " "
1884 " 82 " "	1891 " 325 " "
1885 " 100 " "	1892 " 316 " "
1886 " 138 " "	1893 " 317 " "

The first issue of 1894 contained 320 different Advertisements.

No announcements of the Publisher are included in this list.

"WANT" AND "FOR SALE" ADVERTISEMENTS are a special feature of THE ELECTRICAL WORLD. Position Wanted small advertisements cost but \$1 an insertion; Help Wanted and For Sale small advertisements cost but \$1.50 an insertion. Remit in advance for the number of insertions desired.

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MAILING THE ELECTRICAL WORLD.

The present number of The Electrical World will be rolled in its wrapper for mailing, and we hope to hear from our readers as to whether this method is satisfactory to them, it always being our desire to conform to their wishes in matters affecting their convenience.

THE NOVAK LAMP CASE.

The stay granted by Judge Shipman in the Novak lamp suit was somewhat of a surprise and on the face is rather inconsistent with the terms of his opinion. From the remarks, however, of the Judge from the bench it seems that he was impressed with the testimony of the defense in regard to two important claims—the immunity of the Novak lamp from blackening and the manner in which the candle power was maintained uniform throughout the life of the lamp. While in the original opinion these points were given little weight in face of the contention that the use of the bromine vapor was a subterfuge resorted to in order to obtain the benefit of Edison's exhausted receiver, it is probable that when the case again comes before the court more stress will be laid on these points. It certainly seems to be against public policy that a claim for a valuable improvement in an art should not receive full consideration, and be given no weight as against a counter claim which either avoids or admits this improvement. The expeditious manner in which this case has been advanced is a refreshing exception, and only fair toward both parties and particularly the plaintiff, in view of the short term of life remaining for its patent.

PROF. ROWLAND'S CHARGES.

We print elsewhere an account of the charges of Prof. Rowland against the Cataract Construction Company, which are made the basis of a suit against the latter, now on trial before a Federal court. As will be noted, the charges are extremely sweeping in character, and amount to a claim of proprietorship of the ideas contained in the plans finally adopted by the Cataract Construction Company, thus by implication placing Prof. Forbes in the light of a mere adapter of the ideas of others, and this without proper acknowledgment, professional or pecuniary. As the defendant declines to make any statement in advance of the trial in regard to the charges, it would be unfair to accept the ex parte charges of the plaintiff's counsel, given elsewhere, in the absence of further facts bearing on the case, particularly as Prof. Forbes' professional reputation, which has heretofore been irreproachable, is seriously concerned in the issue. The outcome of the trial will be awaited with much interest, as it will also to a great extent dispose one way or the other of the similar charges made recently in England, and at the same time bring out expert testimony and perhaps a technical history of the Niagara plans that will be of great value to the electrical engineering profession at large.

TELEPHONES FOR LOCAL USES.

The expiration on Jan. 30 of the patent on the Bell metallic diaphragm telephone will develop a new field of usefulness for the telephone, and perhaps entirely displace the speaking tube and electric bell annunciator. The cost of telephones for hotels and houses will probably not greatly exceed, if, indeed, they will not be cheaper, than the cost of speaking tubes or an electric annunciator service, while their convenience will be immensely greater. While the mo-

nopoly of the transmitter and switchboard devices will prevent the residents of large cities from obtaining much benefit from the expiration of the patent referred to, farmers and residents of small towns, on the other hand, will obtain full advantage. They will be enabled to run short lines to their stables, places of business, or elsewhere, and in small towns it would seem to be possible to also have exchanges, as the necessary devices will be simple, and can be so selected and used as to avoid switchboard patents. In fact, several such exchange systems are already in a state to put on the market with guarantees that they constitute no infringement on existing patents. There will be no scarcity of instruments when the patent expires, as besides the firms who are preparing for that contingency there are great numbers of telephones made for companies that were afterward declared infringers, and which have been stored to await this opportunity to place them on the market.

THE STREET RAILWAY PRIZE

If the inquiries we receive are a criterion of the interest taken by electrical inventors in the contest for the \$50,000 prize offered by the Metropolitan Traction Company of New York for a system of street railway traction as economical as the trolley, that company will be most abundantly supplied with projects. While thus inventors are presumably responding with alacrity to the demand made upon them, an obligation rests with the company to meet them in a similarly liberal spirit, or at least to give assurance that their labor will receive the consideration that it deserves. If, however, the date first given, March 1, before which a working exhibit must be placed in operation, is adhered to, there is no chance, except under extraordinarily favorable circumstances, for any competition under the terms given. We learn that the Waddell-Entz Company has formally entered the competition with its storage battery system, which has been working so efficiently on the Second Avenue line, but this required no preparation on its part on account of having a practical plant already in operation. We also learn that a system based upon contacts made by means of magnets is preparing to compete, but this also was in experimental shape before the prize was offered. Unless the time of competition is considerably extended these two may be the only systems in shape to compete, and thus no benefit will be derived from impetus given to invention by the offer of the prize. While we believe any suspicion as to ulterior motives on the part of those who offered the prize would be most unjust, yet the discussion over the alleged manner in which the Niagara Construction Company benefited from information obtained in a similar manner would tend to give color to charges by a disappointed inventor based upon the same grounds, if the competition were brought to a close before an opportunity for trial were afforded. We trust that the Metropolitan Traction Company will see the impossibility of accomplishing its purpose within the time limit given, and offer an extension sufficient to enable any inventor who can enlist the necessary support to put his system to a practical test. By so doing it will not only derive the benefit desired but perform a public service of no mean proportion.

MULTIPHASED CURRENTS

In the section of Laboratory Notes in the present issue Lieut. Patten gives a very clear explanation of multiphased currents and of the rotary field, which will go far toward clearing up the mystery associated in the minds of many with this subject. As pointed out, two or three phased currents are merely ordinary alternating currents, are generated separately as such, and therefore possess no peculiar property in themselves. Owing, however, to the difference in phase, the fields produced by the currents have different values at the same instant, and it is in this alone that the peculiar

properties of a multiphased system reside. As regards the rotary field, it is probable that all of its actions can be more easily explained by considering that the poles act alternately on the coils of an armature to induce a current and to produce motion. That is, while one pole or series of similar poles is inducing a current in an armature coil, another set of poles is acting on this coil so as to produce motion, or, in other words, a multiphased motor may be considered as a combination of a transformer and motor, each part alternately discharging one or the other of these functions. This seems to be not only the simplest way of looking at the case, but one from which all of the various phenomena may be most clearly conceived. Whether this is true or not, however, Lieut. Patten shows that mathematics are not necessary to a proper understanding of the subject, which is particularly fortunate in this case, as the mathematical difficulties would be so great otherwise as to debar the great majority of those seeking information on a subject that is daily advancing in importance. As we have remarked before in these columns, the mathematical treatment of alternating currents involves such inherent difficulties as to promise little aid in making investigation having a practical bearing, even at the hands of accomplished mathematicians. It is through methods such as employed by Patten and the graphical methods of Kennelly that the subject can be approached, not only with the greatest ease but with the best promise for practical results. For rigorous proofs and many other purposes a mathematical treatment has its value, but ordinarily it is best to use graphical methods, if not also too involved, and to view the subject from a physical as opposed to a purely mathematical standpoint.

CANDLE POWER OF ARC LAMPS.

Disputes in regard to the candle power of street arc lamps are, judging from our exchanges, of almost daily occurrence throughout the United States, and the opinions offered by experts on one side or the other betray a most unusual ignorance of the subject. In some cases so-called photometric measurements are resorted to, but apparently with no idea as to the proper method by which such measurements should be made or interpreted. The true measure of an arc light is its mean spherical candle power, which involves measurements at different angles in different vertical planes. While the nominal candle power is roughly based upon the candle power of the maximum ray, the position and intensity of this ray may vary widely, depending upon the length of the arc and character of the carbons as well as on the quantity of current, so that no dependence can be placed upon this method for comparative results. Measurements made at the Antwerp Electrical Exposition on 10-ampere, 45.5-volt, 2,000 nominal candle power lamps, gave a maximum candle power of 2,070, a horizontal candle power of 421, and a mean spherical candle power of 750, of which 640 was given out in the lower hemisphere. From this it will be seen that the mean candle power is but little more than one third that of the maximum ray, while the part of light utilized with street lamps is less than one third, the difference being radiated in directions above the horizontal. With different carbons, or a different adjustment, the intensity or direction of the maximum ray would have varied, but—and this is the important point—with the same watts the mean candle power would have remained sensibly the same. The practical measure, therefore, of the candle power is the watts used; that is, 2,000 or 1,200 candle power arcs will be produced by 450 or 300 watts respectively; or, as arc lamps are almost invariably adjusted for 45 volts, these figures correspond to 10 and 6.8 amperes, so that for ordinary purposes the measurement finally resolves itself into merely a reading of a standard ammeter in circuit. Even if photometric measurements are made ac-

According to a proper system, they are likely to have little value on account of the practical difficulties in getting accurate results. Whoever has made such measurements, even in a well equipped laboratory, is aware of the considerable discordance there may be between the readings of different observers, which follows from the great disproportion between the intensity of the arc and that of the usual standards, and the difference in the colors of the lights. Measurements made outside of a laboratory and by untrained observers are therefore unworthy of any confidence, as is almost invariably demonstrated by the absurd results arrived at. The rule to be followed then is, Measure by means of a standard voltmeter the voltage at the terminals of an average arc lamp on a given circuit, and also determine by means of a standard ammeter placed anywhere in the same circuit the current flowing in amperes; if the product of the two numbers thus obtained is equal to or greater than 450 in the case of 2,000 nominal candle power lamps, or 300 in the case of 1,200 nominal candle power lamps, the quantity of light paid for on the basis of these ratings is given out or exceeded.

The Novak Lamp Case.

Arguments were made before Judge Shipman in the United States Court at Hartford on Saturday last on the form of the order of the injunction granted the Edison Electric Light Company and the Edison Electric Company of New York against the Waring Electric Company of Manchester. Attorney Dyer, of New York, argued for the plaintiffs and W. E. Simonds and Attorney Morse, of Boston, for the defendants.

The provisions of the order granted by Judge Shipman will allow the Manchester factory to continue operations for a time at least. The principal provisions follow:

The operation of the injunction shall be stayed until the 23d of January, or on such a day thereafter as the Court of Appeals shall first assemble, and that this stay shall then "ipso facto" terminate unless the defendants have perfected their appeal and said case is ready to be called for argument in its due order as a preferred case on the calendar on that day and the defendants then stand ready to argue the same. In which case this stay shall continue until said appeal is decided by the appellate court. The above stay is granted on the condition that the defendants on or before Tuesday, Jan. 16, 1894, file a good and sufficient bond in the sum of \$10,000 with satisfactory securities to pay to the complainants any damages or profits to which they may be entitled because of the continuance of the manufacture by the defendants of the lamps alleged to infringe said patents in suit during the period covered by said stay.

The case will come before the United States Circuit Court of Appeals some time during the middle or latter part of February, it is thought.

The Rowland Suit.

A case which promises to be a most interesting one is that of Prof. Henry A. Rowland, of Johns Hopkins University, against the Cataract Construction Company, pending in the United States Circuit Court, for \$30,000 claimed by Prof. Rowland for services rendered the Cataract company.

The Cataract Construction Company first employed Prof. Forbes to take charge of the technical work, but also consulted a number of authorities in England and America. Prof. Rowland was employed to make a comprehensive review of all opinions and submit his views. He did so after, as he claims, devoting six months' time to the subject. The result of the opinion and advice submitted by Prof. Rowland was, he affirms, that the Cataract company modified their plans as to the things of which he disapproved, altered them in accordance with his recommendations, and followed his opinions to a large extent.

Prof. Rowland sent in his bill at \$10,000. This the com-

pany treated as of no importance whatever, and sent him a check for \$3,500, saying it was, they thought, enough. Prof. Rowland returned this check and proceeded forthwith to sue the Cataract Construction Company, not only for \$10,000, but for \$30,000, claiming that he had made the bill too low in the first instance, and that, as he had to sue for his pay, he would claim the full value of his work.

The plaintiff states that the Cataract Construction Company then tendered another \$3,500, and offered to submit the whole matter to arbitration, but he declines all overtures of peaceful settlement, and demands that a jury shall say whether he has asked too much. On behalf of Prof. Rowland there will be much expert testimony, including Edison, Sir John Hopkinson, Prof. Barker, Prof. Jacques and others, and we may look for a battle royal of the experts.

The Cataract Construction Company officials declined to make any statement of their side of the case.

Electricity on the Canals.

Superintendent of Canals Edward Hannen, in his annual report, prints without comment the report of Mr. C. R. Barnes, city electrician of Rochester, whom he had engaged as electrical expert for the recent trial of trolley electrical canal propulsion. Two tables are included in the report, giving the result of measurements made, of which the following are the averages:

Average speed.	Amperes.	Volts.	E. H. P.
2.65 miles.....	63.08	294	24.87
4.24 miles.....	63.55	312	26.21

The boat was 98 feet long and equipped with a "dish pan" propeller having a disc of 51 1/2 inches diameter, to which four screw blades were attached. To turn the propeller out of water required 5.35 c. h. p., which should therefore be subtracted from the above figures.

It will be noted that an inordinate amount of power was required and little more to propel the boat at 4.24 miles per hour than at 2.65 miles, which is a discrepancy not easily explained. In deep water it requires more than four times as much power to propel a vessel at the higher speed given over that required for the lower speed, and the power required in the latter case with the boat experimented on would probably not exceed three or four h. p. in deep water.

After the Fair is Over.

Since the first day of the year the grounds of the Exposition have assumed a very unusual aspect. On that date they fell into the hands of the South Park Commissioners and the gates of Jackson Park are once more open free to the public. The buildings are still in the hands of the Exposition company and closed to the public, and will remain so until the exhibits are all removed. But very few exhibits are now remaining besides the foreign ones, and a large number of these have been shipped.

In the Electricity Building practically nothing whatever is left of the American exhibits, and now that the foreign ones are out of bond, there is little delay in removing these. The General Electric Company removed the last of its machinery and vacated its offices some days ago. The Edison tower is now a ruin. Most of the General Electric machinery was returned to the factories, although several machines were sent to a number of different stations. The Westinghouse company has also completely left the building, and all of its large machinery was returned to its factory as well. The Bell Telephone Company has deserted its pavilion. It is expected that within a couple of weeks all of the few foreign exhibits now remaining will be removed.

In Machinery Hall the Westinghouse company, which did not start until very late to remove its big generators, is now

getting them out rapidly. These are also being returned to Pittsburgh to be overhauled. Two of the direct connected engines and dynamos are going from there to Baltimore and two others to Boston.

All of the other electric machinery in the power plant has been removed except the Standard arc dynamo and the two small Westinghouse incandescen machines, which are still in use. Most of the engines are also out, except those driving the dynamos mentioned and also parts of some of the largest ones. A few boilers are still kept. The piping of the plant is nearly all removed, except, of course, that which is in use. This belongs to the Exposition and is being measured up, sorted to sizes and lengths and piled up in the annex to be sold. The wiring is also being removed with rapidity. Work was begun on the wiring in the subway only shortly before the first of the month and is now nearly all removed. The duct wiring of the arc work is also mostly out of the ground. The arc and power wire is the property of the New York Safety Wire and Cable Company, and is to be returned to them. The incandescent wiring belongs to the New York Insulated Wire Company, and is being removed by that firm under direction of the Westinghouse company.

It will be some time before the wiring and lamps can be all returned to their makers. The patrol lights will probably be run until February, but the contracts for the machinery expire on the first of that month.

After the disastrous fire which broke out on the grounds on the night of Jan. 8 the scene at the Exposition presents rather a desolate appearance. The magnificent peristyle, Casino and Music Hall were burned literally to the ground, but the damage done to the Manufactures Building was not as great as at first thought. A number of the exhibits which had not yet been removed were considerably injured by fire and water, and portions of the building, especially parts of the cornices, were destroyed. It is said that the insurance on the buildings had run out.

The Bell Telephone Company.

To an inquirer about Bell Telephone Company earnings the Boston "Transcript" gives the following figures:

	Net Income.	Year's Increase.	Per cent. gain.
1885.....	\$1,809,996.48	.....	....
1886.....	1,973,350.76	\$163,354.28	9.
1887.....	2,237,608.12	264,257.36	13.3
1888.....	2,136,463.66	198,855.44	8.9
1889.....	2,661,888.69	225,425.13	9.25
1890.....	2,869,418.35	207,529.66	7.8
1891.....	3,126,819.90	257,401.55	8.97
1892.....	3,411,679.78	284,859.88	9.11

It was figured that an increase of 9 per cent. in 1893 would be tantamount to earning some 19 per cent. on the whole \$20,000,000 capital, although all of the new stock did not participate in all of the 1893 dividends. Here is another table of interest:

	Surplus earnings applicable to dividends.	Equal on Stock Per cent.
1885.....	\$1,809,996.48	18.09
1886.....	1,973,350.76	19.73
1887.....	2,237,608.12	20.8
1888.....	2,136,463.66	21.25
1889.....	2,661,888.69	26.72
1890.....	2,869,418.35	28.95
1891.....	3,126,819.90	30.85
1892.....	3,411,679.78	34.49

The following is from a recent compilation of the Boston "Herald".

The present company was organized in May, 1880, with an authorized capital of \$10,000,000, and issued capital of \$6,500,000. This was increased to \$7,350,000 by giving a right to the National Bell Telephone Co.'s shareholders to subscribe for \$800,000 stock at par. From that day until recently subscription privileges at par have been issued, and sundry extra and valuable rights have been given to shareholders. None of these is included here. The National Bell Telephone Company had a capital stock of \$700,000

When it concluded to reorganize as the American Bell, it sold 500 shares in its treasury for \$600 per share to meet its "immediate wants," presumably floating debt. It then gave each shareholder six shares for one and turned the property over to the new company for \$6,500,000, taking pay in stock at par. The first year ended Feb. 28, 1880, and included two months of the National Bell year. In 1884 the fiscal year was changed to the calendar year, and covered but ten months. The total dividend payments and capital at the end of each year have been:

	Dividends.	Capital.
1880-'81.....	\$178,500	\$7,350,000
1881-'82.....	416,500	7,350,000
1882-'83.....	595,000	7,350,000
1883-'84.....	1,051,479	9,602,000
1884.....	1,440,315	9,602,000
1885.....	1,562,236	9,802,100
1886.....	1,568,336	9,802,100
1887.....	1,568,336	9,802,100
1888.....	1,789,878	9,962,100
1889.....	1,838,913	11,303,900
1890.....	2,213,913	12,500,000
1891.....	2,625,000	15,000,000
1892.....	2,919,080	17,500,000
1893.....	*3,337,500	20,000,000
Total.....	\$23,106,096	.....
Average per year.....	1,650,435	11,209,035

*Estimated.

The company began paying extra dividends in 1884. They are included above and in detail have been: 1884, \$288,063; 1885, \$392,044; 1886, \$392,084; 1887, \$392,084; 1888, \$597,726; 1889, \$600,000; 1890, \$750,000; 1891, \$900,000; 1892, \$991,863; 1893, \$1,125,000. The average regular and extra dividend per year has been \$1,650,435. The average capital has been \$11,209,035. The average rate of dividend has been 14.72 per cent.

A Proposed Municipal Electric Lighting Plant.

Paterson, N. J., has recently been giving great attention to the subject of a municipal lighting plant, which is very strongly favored by the Mayor of the city and many of the Council. At a recent meeting of the Board of Aldermen the Mayor made a statement in regard to the probable cost, which is partly in reply to a statement of one John F. Noonan, who said a 600-arc light plant would cost \$560,000, and deteriorate 30 per cent. a year.

The Mayor stated that he had received replies to a communication sent to a number of cities owning their own lighting plants asking about the cost per lamp. The mayor of Allegheny replied that his city had \$200,000 invested in an electric lighting plant which furnished light for 560 arc and 2,000 incandescent lamps; the cost of operation is about \$72 per arc light per year, while Pittsburgh paid \$96 by private contract. The capacity of the Allegheny plant is 620 arc and 3,000 incandescent lamps. The Mayor said that there were 125 cities owning their own lighting plants; of these 23 furnish arc lights at a rate of \$53.04 per light, while 20 cities whose light was furnished by private contract paid \$106.01; it was also stated that Bangor, Me., saved \$100 per light per year.

A prominent engineering firm has made a proposition to the city to erect and maintain an electric light plant of the capacity of 800 lights at a total cost of \$148,800, divided as follows: dynamos and machinery, \$91,800; building, \$8,000; poles, lines and construction, \$44,000; superintendence, \$5,000. It stated that the cost of maintaining the plant for one year would be \$34,400, or at the rate of \$43 per lamp.

Another estimate was presented offering to erect a plant to furnish 600 arc lights at a cost of \$150,000, to be paid for in city bonds bearing interest at 5 per cent., and the parties agreed to run the plant for a year or any portion of the year at the rate of \$50 per arc light.

Electric Traction in Cuba.

The first electric tramway in Cuba is projected for the town of Cienfuegos. The project is now under consideration by the council of the civil government of Santa Clara.

Electricity in the Far East.—III.

BY W. STUART-SMITT.



HERE are also central stations of considerable magnitude in Yokohama, the Hokkaido (Yezo), Kobe, Nagoya, Kumamoto, Nagasaki, and smaller plants in other cities.

Kumamoto is situated in the island of Kiushiu, and was the centre of what was known as the Satsuma rebellion of a few years ago. The castle was one of the strongest of all the old feudal strongholds in Japan. The old buildings, with one exception, were destroyed by fire during that rebellion, but the walls still remain, with the surrounding moat. New buildings have been erected, and the place is now a military post, one of the most important in Japan. The Kumamoto Electric Light Company was organized primarily to supply light to this post, and the government is still the largest customer, though private demand has necessitated putting in an extra dynamo. The plant now contains two Edison dynamos and one Brush alternator, together making about 1,300 lights, but this number is increased by the fact that many 8-c. p. lamps are used in the small houses.

Including private plants in mills, etc., there are perhaps 75,000 lamps connected, many of which are of 8-candle, this power being better suited to the small stores and house rooms. All these 8-c. p. lamps are 50-52 volts, and on the Edison circuits are connected two in series.

Nearly all the foreign machines in Japan are of American make, there being but very few from European countries.

Most of the Japanese men of war and larger merchant steamers have been built in Europe and are fitted with European electric plants, but two gunboats recently built in Japan have Edison marine dynamos, these having been chosen after the visit of the U. S. S. "Charleston" to Japanese waters.

During the big earthquake of two years ago the Yokohama station was badly damaged. Though the centre of the earthquake was two hundred miles from Yokohama, yet the shock there was quite severe. Several earth movements followed each other in regular order, with the result that the big chimney of the electric company swung like an inverted pendulum, the amplitude of the swing increasing with each movement, until finally it broke in the middle and the upper half crashed through the roof. Fortunately it fell in such a manner that only the boiler room was de-



WHAT THE CHINESE THINK THEY ARE COMING TO.

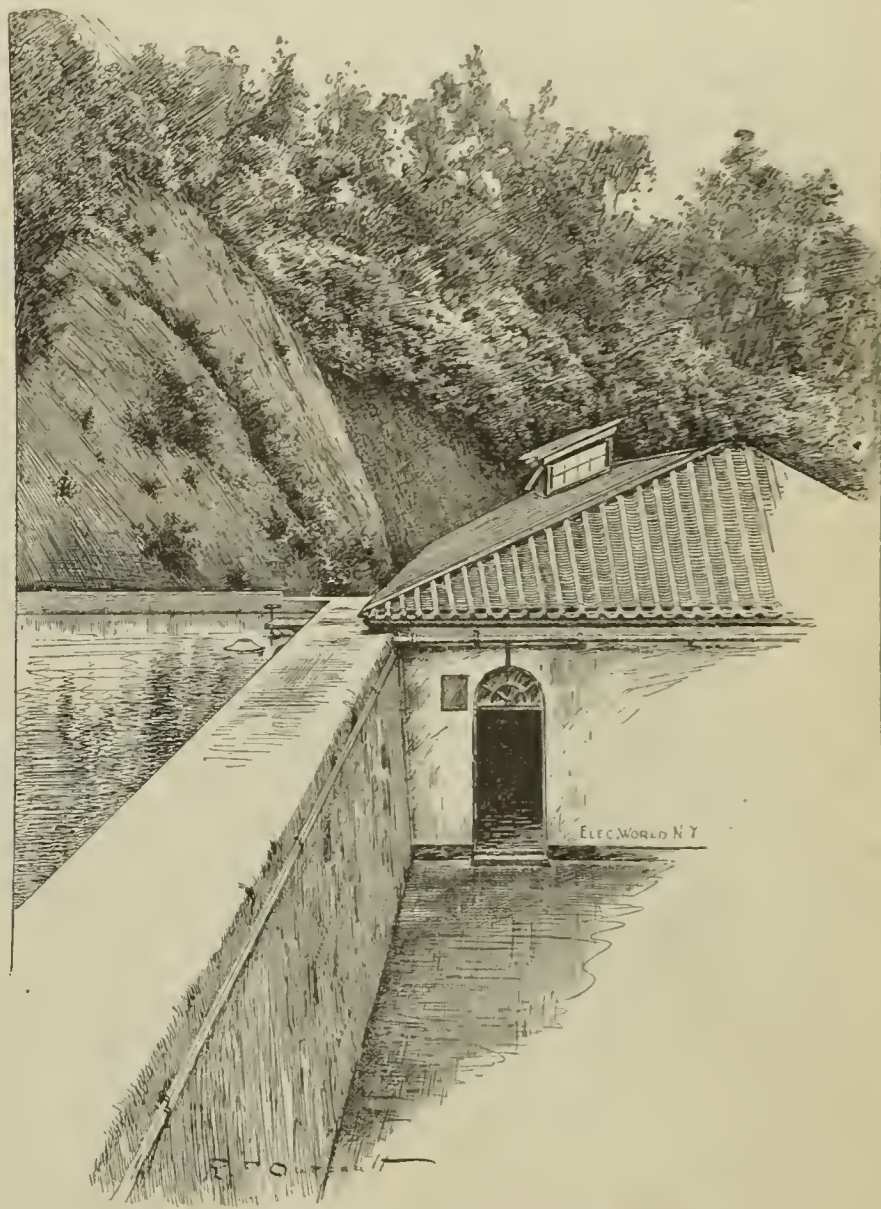
stroyed; the boilers themselves escaped with but slight damage, as they were protected by the base of the chimney. The dynamo room entirely escaped, as did the store rooms, offices, etc. The station stands in the most densely settled part of Yokohama, with houses crowded close against it,

and had the chimney fallen in any other direction the loss of life must have been great; as it was, no one was hurt.

The wisecracks of Yokohama, and, especially the daily press, viewed the ruins, and immediately sent up a great guffaw about the engineering of the Japanese. They said "of course the chimney would not stand; it had *hollow* bricks in it instead of being built of good solid material."

Brick chimneys are dangerous on account of the heavy earthquakes frequently experienced. The loss to the Yokohama company was about 10,000 yen, including the cost of a new brick-lined iron chimney 110 feet high by 6 feet in diameter.

As yet there are no electric railways in Japan, though there is much talk of building them, and many efforts have been made, especially by Mr. Fujioka and the Tokyo Electric Light Company, to have the Tokyo tramways electrically equipped. During an industrial exhibition in Tokyo four



CENTRAL STATION AT HONG KONG.

years ago, the Tokyo Electric Light Company fitted two cars with storage batteries and Sprague motors, and they ran for some time as part of the exhibition, but the good results hoped for were not realized.

The government owns the telephones and refuses permission for a single trolley system, and, of course, storage battery traction was no more successful than in America.

There has been considerable talk of building electric roads in various parts of the country, mainly with the idea of connecting together separated towns and connecting outlying towns with the steam railroads.

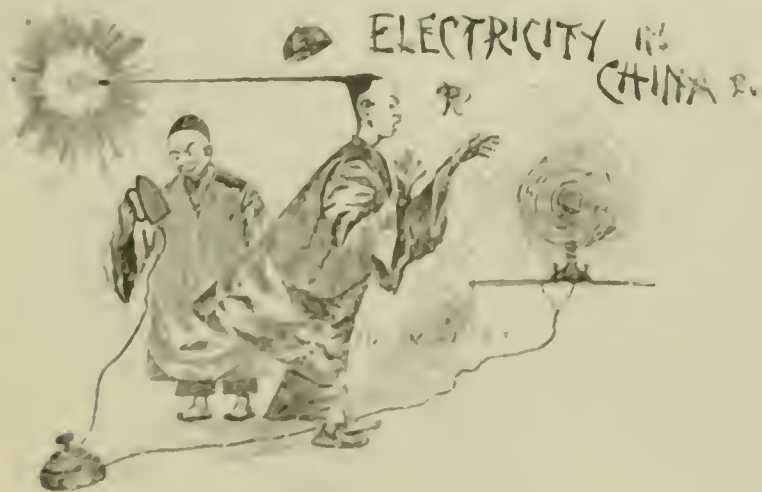
The writer made an estimate for such a road twenty miles long. The gauge was to be 30 inches, and electric locomotives hauling two or three cars were to be used. This same idea was talked of for other places, but after considerable talk had been indulged in the "powers that be" decided that such an arrangement could not be permitted on tramways, that it must be included under the head of railways

and come under the regulations for the government of railways. On this account the enterprises were abandoned, or postponed, until more favorable times. It is certain, however, that several electric roads will be built in the near future. There is abundance of water power in many places, which will surely be utilized for power and lighting purposes.

In mining little has been done toward using electrical machinery, but much has been talked about, and the field for this class of machinery is very promising. Coal mines are very abundant and new deposits are continually being discovered. Copper mines have received considerable development. The largest of these is the Ashiwo mine, and considerable trouble is experienced on account of the acidity of the water, which attacks the pumps, boilers and piping and makes the life very short.

All the telegraph and telephone instruments used in Japan are of native make, nothing of this sort being imported, except an occasional new one to be used as a model to copy. There are several manufacturers of these, the most important being Tanaka & Co., of Tokyo. There are patent laws in Japan, but they are not intended for the protection of the foreigner; on the contrary, Japan is very anxious to be in a position to copy the best that the foreigners devise.

In this, however, they are limited by their mechanical skill, as the finer classes of instruments and machine making are



beyond their powers. They are, however, rapidly improving, and in a few years will be almost entirely independent of foreigners.

Shop keeping in Japan has always been looked down upon, and in the old days the shop keepers were next to the *etas*, the outcast class of the nation; on the contrary, the man who made something was always esteemed as being a very useful member of the nation, the old sword makers being held in particularly high repute. This same feeling is largely dominant to-day, and it is to this feeling that the large extension of manufacture is due. Engineering is the favorite study of the Japanese youth, and many of them are mathematicians of a high order.

In China but little has been done except in Hong Kong and Shanghai, and even in these cities the work has been a very uphill one, owing to the powerful opposition of the gas companies.

Several years ago a couple of Brush arc dynamos were put up in Shanghai for street lighting, but the company had very hard times. After several years of hard struggle they have finally got in good working condition. Two Morley alternators have been put in and the service is rapidly extending. The original Brush machines are driven by an old, poorly governed, long stroke, slow speed engine, belted to a countershaft, and the speed varies so much at different parts of the stroke that instruments in circuit plainly show the variation of current. This plant is exclusively used for lighting in the foreign settlement.

An electric road will probably soon be built, extending from Woosung to Shanghai, a distance of about thirteen miles.

In the factories of the Shanghai Cotton Cloth Spinning Mill Company there are two dynamos furnishing current to about 1,200 lamps; one of these dynamos is Edison and the other English (Kapp direct current). This mill stands on the river bank, but there is so much sediment that the water cannot be used for condensing purposes, so settling ponds were built, from which the circulating pumps draw their water. After leaving the condenser the water passes into a ditch, which winds through the fields and finally discharges into the ponds, again having become entirely cooled during its transit.

In Hong Kong the station is furnished with Brush arc dynamos and Kapp alternators.

Many of the offices in Hong Kong are very dark, and pressure is kept on the wires all the twenty-four hours; but few lamps are connected up, and the price is high—two cents per lamp hour. This company has had to fight strong opposition from the gas companies, and shares are very low (as is also the case in Shanghai), but people are beginning to appreciate the advantages. The strong opposition to these two companies, with the consequent slow progress and bad standing, has had considerable effect in preventing the starting of stations in other parts of China and South Asia.

In Manilla a contract has been let for a plant of 10,000 16-c. p. lamps and 250 arc lamps of 2,000-c. p. each for city and private lighting. The city has contracted with the lighting company for 1,000 20-c. p. incandescent lights and 140 arc lights for twenty years, at \$60,000 per year. The plan of the city lighting was laid off by the writer.

In Canton there is a small plant, consisting of two 750 light Westinghouse alternators. It has been running about two years without a single accident of any kind. But one dynamo is run, the other being held in reserve. Enough 8-candle lamps are connected up to make the total number of lamps run from one dynamo about one thousand. This loads the dynamo up to its full capacity, and no more can be connected up until the station is extended. Mr. Weise, the engineer, will not run the risk of putting a load on both dynamos, because, in order to keep the good will of the Chinese, it is necessary to have unbroken success; so far, he has had no trouble from lamp extinction, and he is in high repute as being a favorite of the gods, but if he should load both dynamos and an accident should happen to one of them so as to cause the shutting off of part of the lights, his reputation as being a good "Joss" man would be gone, or, at least, would be much weakened. His only assistants are raw Chinamen, to whom he has imparted some instruction. He manages to get along very well now, and trusts the plant to their care after starting up for the night.

Westinghouse engines are used, one for each dynamo, and they contribute largely to the success of the plant, as they require so little care. In fact, Mr. Weise says he could not possibly get along with any other type of engine, as it could not be trusted to his Chinamen. In case of accident to the running dynamo they understand how to start up the other, but at the writer's last visit, last spring, this had never been necessary.

The streets are very narrow (as is the case with all Chinese cities), being from, say, six to twelve feet wide, and are filled with hanging wooden signs. Through these signs the wire must twist and turn, because on no account would the Chinamen allow a sign to be moved to make room for the wire, as it would certainly mean bad luck to their business. In many cases the insulation has been strongly reinforced with rubber and tape, to prevent abrasion from the swinging signs.

The poles are simply cross pieces of timber, with the ends secured in holes cut in two opposite houses. The converters are generally screwed to the wall just inside the buildings and out of reach of people standing on the floor.

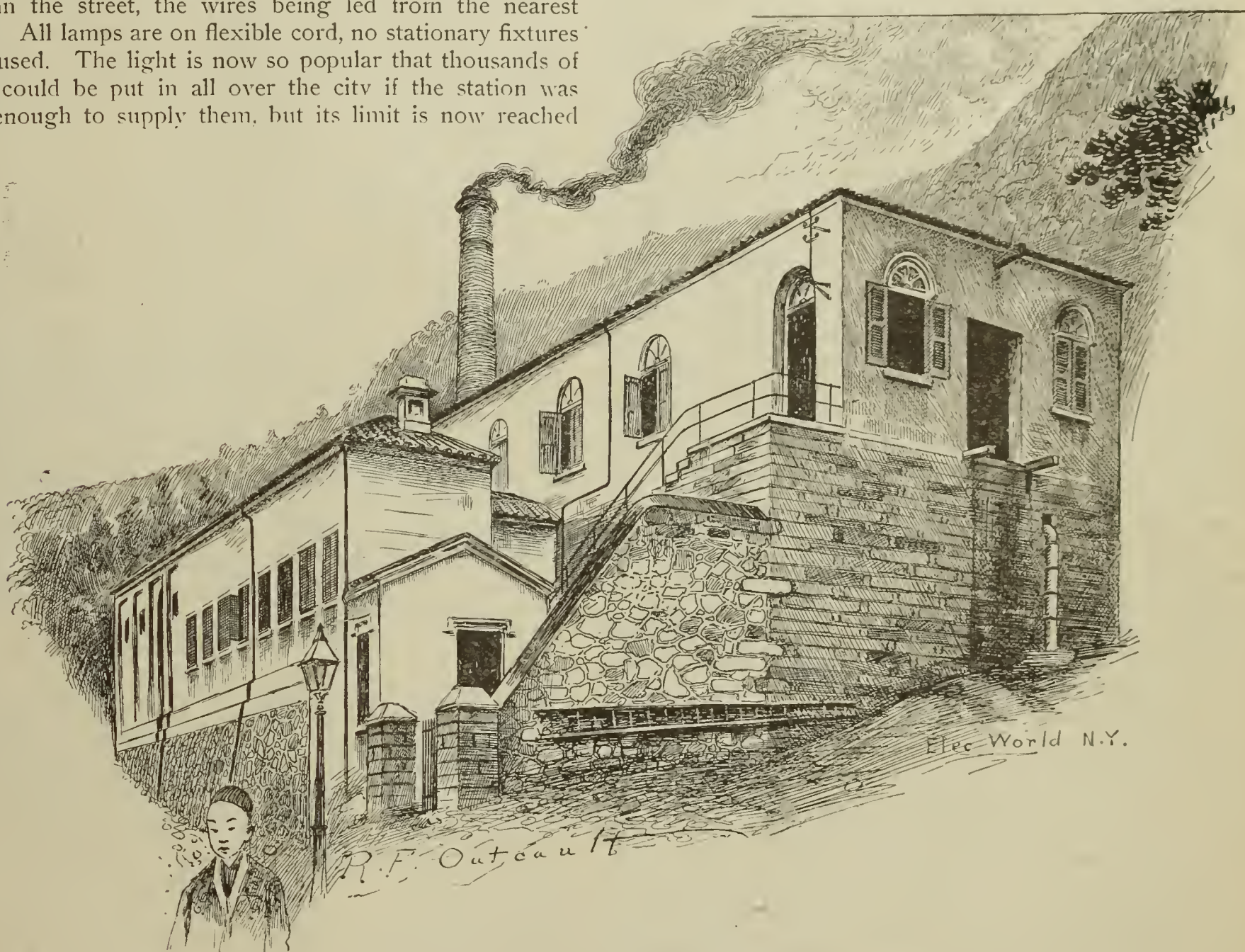
The streets of Canton are divided into sections of a few blocks each, and each section is shut off from all others by heavy gates, that are closed at 9 o'clock in the evening. The populace is so turbulent that for many centuries the authorities have made it a practice to hold all the people of any section responsible for any riot or tumult in that section. The result is that the people have got in the habit of regulating affairs in their section without any reference to the powers that be. Mr. Weise had occasion to see the effect of this in an instance where a store wanted lights, but the wires could not be run, because one man objected to having a hole cut in his house for securing a pole. The man wanting lights informed his neighbors, and a delegation waited on the individual and soon induced him to withdraw his objection.

At first there was considerable objection to the plant being put up, but now it has become very popular, and is used in houses and stores; even fruit and nut stands use them in the street, the wires being led from the nearest house. All lamps are on flexible cord, no stationary fixtures being used. The light is now so popular that thousands of lamps could be put in all over the city if the station was large enough to supply them, but its limit is now reached

small, being but one-half cent per lamp hour. Attempts are being made to start plants in other parts of the Canton province, and Mr. Weise occasionally makes trips about the country, with a small Edison dynamo and Shipman engine, giving exhibitions, which are sure to lead to the establishment of stations.

In Canton two attempts were made to steal the street wires soon after the station was started, but, unfortunately for the thieves, the wires were alive, and though no one was killed, no attempts have since been made. It is inhabited by a bad Joss, that is too powerful for them.

In Korea there are a few telegraph stations, but the service is under the control of the Chinese. The operators are Koreans of the student class, the members of which have a high standing. They wear hats of a peculiar shape, which no one is allowed to wear who has not passed certain rigid examinations.



A VIEW OF THE HONG KONG STATION.

and difficulty is experienced in building a larger one, as the franchise for the entire Canton province is in the hands of one man, and he wants to make too much out of it.

The Chinese are great people to expect private commissions on everything they have a hand in, and the management of the company, one and all, manage to steal something. One man, who has the handling of the money, will hold back needed supplies and wages, another, less fortunate, will go to the station and steal coal and oil, and if there is any objection the engineer is told it is none of his affair. In fact, though the plant is a success from an electrical and mechanical point of view, it is kept running under considerable difficulty.

A large station will, nevertheless, be built before long, as there is so strong a demand for it. The charges are very

Several years ago an Edison plant was put in the palace at Seoul, but with this exception there is no electric lighting in the country. The plant was put in by an engineer who was sent out for the purpose, and the writer's recollection is that he was killed shortly after the plant was finished. Some instructions were given to a Korean who was to act as engineer, but, apparently, he did not become very expert, because soon after being left to himself he burned out the armature, and though there was a spare one, he did not know enough to put it in, and the plant was shut down for a long time.

There is comparatively little money in the country, the common people having none at all. If it becomes known that some one of the common people has saved a little money, the servants of some noble arrest him on some

trumped up charge and he is told that his liberty will be given him when his money is forthcoming. If he is obstinate, he is stripped and whipped daily until he becomes amenable to reason. The Koreans are great believers in the efficacy of the rod, and apply it freely as an antidote for small offenses.

The King, in whose palace the above plant is installed, is a man of large mind and would gladly see his country adopt modern civilization, but Chinese influence is too much for him to surmount.

Alternate Current Working.—II.

BY HARRIS J. RYAN.



THE strength of an alternating current in amperes is numerically equal to that of a continuous current which would cause the same heating effects in thin conductors. Alternating electromotive forces in practical measure are determined by the heating effects of the currents that they establish in thin non-inductive conductors. Consequently, alternating and continuous electromotive forces are identical numerically when the currents that they establish in thin non-conductive conductors produce the same heating effects. The conductor is here specified as non-inductive—one about which the current could not establish a sufficient amount of alternating magnetism to produce an appreciable amount of electromotive force. Electromotive forces thus produced would change the effects of the impressed electromotive force. The conductor is further specified as being thin because in thick conductors carrying alternating currents the current is crowded toward the surface. This effect is caused by the alternating magnetization that the current produces in the interior of the conductor. This magnetization produces electromotive forces that oppose the impressed electromotive force along the interior of the conductor. The current is thus forced to the outer portions of the conductor, with the result that a heavy conductor behaves as though it has a greater resistance for alternating than continuous currents. The rate at which heat is generated in a thin conductor at any instant is equal to $C^2 R$. When R is unity the heat is developed at a rate equal to C^2 . The average rate at which heat is developed with an alternating current is equal to the average value of C^2 . The strength of an alternating current in amperes, then, equals the square root of the mean of the squares of the instantaneous values of the current in amperes, and is called the effective value of the alternating current. The current established at any given instant through a thin non-inductive conductor is equal to the electromotive force at that instant divided by the resistance of the conductor. The heating effects at any instant equal $C^2 R = \frac{E^2}{R}$. When R is unity these heating

effects will equal the square of the electromotive force. The average rate at which heat is produced will be equal to the mean of the square of the instantaneous values of the electromotive force. Consequently, the value of the alternating electromotive force equals the square root of the mean of the squares of the instantaneous values of the electromotive force. This is called the effective value of an alternating electromotive force. The phrase *square root of the mean square* will hereafter be written $\sqrt{\text{mean}^2}$. For any particular form of electromotive force or current the $\sqrt{\text{mean}^2}$ value may be determined in the following manner: A curve of the squares of ordinates of the curve of

electromotive force or current is determined by means of a slide rule, or a table of squares. The area of this curve, obtained by means of a planimeter, divided by the length of the card gives the mean of the squares. The square root of this mean of the squares is the desired effective value of the electromotive force or current. When the maximum value of the curve is taken at unity the $\sqrt{\text{mean}^2}$ of the instantaneous values is equal to the ratio of the effective value to the maximum value of the current, or electromotive force. This operation has been done for the electromotive forces given in the foregoing diagrams, and the ratios obtained are as follows: Ratio of effective value to E_{max} for a rectangular E. M. F. curve = 1; for the E. M. F. curve of the Stanley arc alternator = .73; for the E. M. F. curve of sines = .707, and for the triangular E. M. F. curve = .58. The product of effective E. M. F. and current in any circuit equals the watts therein displayed. This may be seen more clearly from a study of the following expressions: Average $[E_{\text{inst.}} \times C_{\text{inst.}}] = \text{average watts.}$ $E_{\text{inst.}} = C_{\text{inst.}} \times k$, where k is the ratio of $\frac{E_{\text{inst.}}}{C_{\text{inst.}}}$, which is constant at all instants.

$$\text{Average } \frac{E_{\text{inst.}}^2}{k} = \text{average watts.}$$

$$\text{Effective E. M. F.} = E = \sqrt{\text{average } E_{\text{inst.}}^2}$$

$$\frac{E^2}{k} = \frac{\text{average } E_{\text{inst.}}^2}{k} = \text{average watts.}$$

$$E = Ck.$$

$$EC = \text{average watts.}$$

Mr. Steinmetz, in the proceedings of the A. I. E. E., Vol. X., page 548, describes a unique method for determining the effective value of an alternating electromotive force, or current, from the instantaneous values. He plots "the instantaneous values of the alternate wave in polar co-ordinates, i. e., as radii corresponding to the time as angle; the area of the curve represents the sum of squares of values, i. e., the effective value, so that the effective value of an alternate wave can be derived directly by measuring the area of the curve of instantaneous values as polar co-ordinates."

The ratios of $\frac{E_{\text{max.}}}{M_{\text{max.}}}$ were determined for a periodicity of one complete cycle per second. Had they been determined for a periodicity of two complete cycles per second, the ratios would have been doubled, because the areas of the electromotive force cards would have been halved, and the resulting required maximum magnetization halved. The same thing is true of any number of periods per second. It follows then that the product of the periodicity, or number, of complete periods per second into any one of the above ratios will give the ratio of the corresponding maximum electromotive force and maximum magnetization. The electromotive force is multiplied by the number of turns surrounding the alternating magnetization. These facts are condensed into the following expression:

$$\frac{E_{\text{max.}}}{M_{\text{max.}}} = \rho \times l, \text{ where}$$

$E_{\text{max.}}$ = Maximum value of the E. M. F.

$M_{\text{max.}}$ = Maximum value of the magnetization

ρ = Ratio of maximum E. M. F. to maximum magnetization with a periodicity of unity.

$\times$ = Periodicity or frequency.

l = Number of turns.

The following values will be introduced in this expression by substitution for the purpose of putting it into the form in which it is much used in practice:

$B_{\text{max.}}$ = Maximum magnetic density in the magnetic circuit in lines per square centimetre.

a = The cross section of the magnetic circuit in square centimetres.

$$\frac{E_{\max.}}{B_{\max.} a} = \rho \sim t$$

$$B_{\max.} = \frac{E_{\max.}}{a \rho \sim t}$$

For the majority of cases in practice the electro-motive force curve has a sine form when $E_{\max.} = 1.4 E$ and $\rho = 2 \pi$. Substituting these values in the above expression, and remembering that one volt equals 10^8 C. G. S. units of electromotive force, we have for practical purposes

$$B_{\max.} = \frac{E \times 10^8}{1.4 \pi a \sim t}$$

The application of this formula is illustrated in the following example: The object is to determine the magnetic flux that must be established through it, and the number of turns that should surround the lug of an alternator armature. The type of armature is similar to that illustrated in Fig. 9:

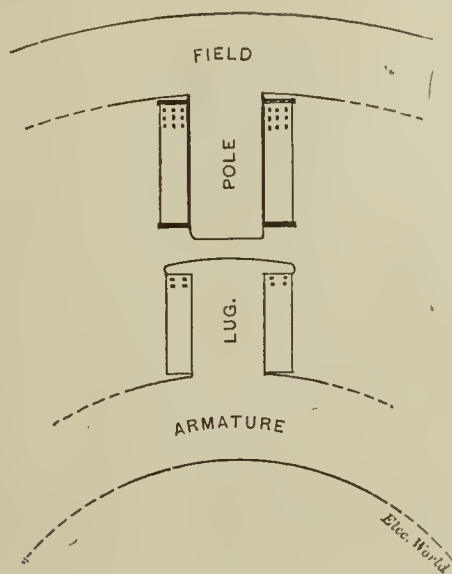


FIG. 9.

The lug is twelve inches long and two inches wide. It passes a north pole one hundred times per second, so that the periodicity of the developed electro-motive force is one hundred. The coil must develop one hundred volt.

$$a = 12 \times 2 \times 2.54^2 = \text{sq. cms.}$$

These values are substituted in the above formula, and we get

$$B_{\max.} t = \frac{10^8 \times 10^8}{1.4 \pi 154 \times 100} = 147,000.$$

It was determined that undue heating in the iron of the lug would not occur with the use of a magnetic density of $B_{\max.} = 3,000$. Therefore, the necessary number of turns in the coil surrounding the lug must be

$$t = \frac{147,000}{3,000} = 49.$$

(To be continued.)

After-Glow in Exhausted Bulbs.

BY H. M. MARTIN AND W. H. PALMER, JR.

Having failed to note in any communication on the subject of the phosphorescence of exhausted bulbs in a field of high potential and frequency any mention of what, for want of a better name, may be called the "after-glow," we are led to believe that a brief description of this phenomenon may be of general interest.

If an exhausted bulb having a sealed-in electrode be held in the hand and approached to a terminal of an induction coil giving moderately high potential and frequency, the whole interior of the bulb will be permeated by a phosphorescent glow; if, now, the bulb be slowly withdrawn from the field of excitation, the degree of luminosity will gradually diminish till a point is reached beyond which the intensity of the glow, now greatly attenuated, is practically unaffected

by any further increase in distance from the terminal. It is this glow, entirely independent for its perpetuation of the field in which the bulb was charged, and continuing, we believe, until electrical equilibrium has been established between the rarefied gas and the electrode of the bulb, that we have called the "after-glow." That it is thus independent of the field of excitation may be proved by shutting off, after the "after-glow" has been established, the exciting current of the induction coil, when the glow will be entirely unaffected and continue, practically, for the same length of time as when the coil is in action. When the glow has become almost imperceptible it may often be stimulated into renewed life by shifting the position of the fingers on the surface of the bulb. After this has been done and the glow has again died away, a single bright flash may be obtained by touching with one finger the projecting end of the sealed-in electrode. That the hand of the experimenter is a factor in these effects may be shown by laying the glowing bulb on a table; the glow, though not extinguished, becomes very faint, especially if no object of capacity be near. The bright flash may still be obtained by again picking up the bulb and discharging as explained. We have repeatedly charged a bulb, shut off the primary current from the coil, carried the bulb to a remote part of the house, laid it on a table, and after picking it up again, obtained a flash on discharging that could be seen some yards away. Lack of apparatus has prevented us from following up these experiments, which are now some months old, but they are valuable, at least, as additional and ocular proof of the electrostatic origin of the "Tesla bulb effects."

Rapid Transit in Boston.

Mayor Mathews, of Boston, in his inaugural address, dwelt particularly upon the subject of rapid transit. Referring to the proposed subway for street railway purposes, he said that action was taken in the belief that a subway could be so constructed under Tremont and connecting streets as to accommodate all the railway tracks now entering that thoroughfare from the south and west; that the patrons of the street railway system could in this way be furnished with quicker transportation and more convenient waiting places than is possible under existing conditions; that the surface of Tremont street should be restored to the exclusive use of foot passengers, carriages and teams forever; that the rentals for the use of the subway would probably be sufficient to cover the interest on bonds to be issued under the act, and to provide a sinking fund for their payment at maturity, and that the State Legislature and the city government of 1894 would be prompt to take such action in the premises as may be necessary to secure these ends. The subway, if built, will be the property of the city, and is to be leased on public account at a rental to be fixed by the board of railroad commissioners.

The mayor said that he would at once appoint, subject to confirmation by the board of aldermen, the three members of the subway commission; and trusted that the character of the gentlemen selected will be taken as a guarantee that this great project will either be carried out in such manner as most to benefit the public and within the appropriations that may be granted in advance, or not at all.

The Reporter's Lot.

City Editor: "The street is all excitement. An electric light wire has blocked traffic, and no one knows whether it is a live wire or not."

Editor: "Detail two reporters to go to the wire immediately—one to feel of it and the other to write up the result." —"New York Weekly."

Problems for Inventors in Incandescent Lighting—II.

BY DR. L. K. BOHM.



THE proper candle power of the lamp is another question to be solved. Opinions as to the most advantageous number of the candles have differed. The 16-c. p. lamp has been regarded as the standard, but some prefer a large and very brilliant light, while others hold that by subdivision of the light a more uniform illumination is effected, since the light is inversely proportional to the square of the distance. Two 8-c. p. lamps give, according to this, a more uniformly illuminated space than one 16-c. p. lamp. Such have been in use for some time, especially in England, but if they are not heated up fully to the required incandescence then these filaments look like red wires, and complaints in this direction were quite frequent. Only slight changes in the voltage bring about very noticeable differences in the candle power with low candle power lamps. The 16-c. p. lamps also lose by continued use, and 32, 50 and 100 c. p. lamps lose the more rapidly the higher the candle power is. One hundred candle power lamps, especially on the multiple arc system, lose tremendously after a limited use.

The present generation is accustomed to comfort and luxury. This has been particularly the case with light. If we consider that up to a few decades ago candles and oil lamps were the best means for illumination, and how dim these lights were, and see now the clear lights and their number in our houses, we must come to the conclusion that, regarding light, we have grown more luxurious than in anything else. Therefore, a 16-c. p. lamp will not answer in the future, especially when the lamps do not maintain their original candle power. In my opinion, a 25-c. p. lamp will be the thing of the future, and as high candle power lamps with carbon filaments decrease rather too rapidly in their candle power, we have to look for filaments made of other substances than carbon, or containing at least other substances. There is no doubt that a composition will be discovered from which filaments can be manufactured that maintain their candle power more uniformly than carbon filaments even in lamps of higher candle power.

The vacuum in carefully manufactured lamps is very good; it cannot be improved upon for practical purposes. For scientific investigations, much higher vacua can be produced in single instances. For manufacturing lamps the evacuation may, however, be cheapened by improved devices.

Inventions of the above described character would not be independent, they would constitute only improvements on the Edison lamp and could not be manufactured without the consent of the proprietors of the Edison patent, but as stated above, such inventions would be of lasting value even after the expiration of the fundamental patent, and therefore inventors should work in this direction. The majority of inventors have at present only one object in mind, that is, to produce an independent lamp for the period the fundamental patent runs, and I believe that after the expiration of that patent most of them will return to the all-glass closed chamber, with perhaps one exception, which will be described further down.

Experimenters trying to produce independent lamps have recently been very active. Most of them experimented with cements, by means of which two or more parts constituting the lamp chamber might be joined perfectly air tight, thus avoiding the all glass closed chamber united by the fusion of the glass. These cements are numerous, some are silicious, some are non-silicious; others are of organic origin; some are composed of organic and inorganic matter. In the

patent to W. E. Nickerson and E. E. Cary, Aug. 12, 1893, is described a seal of fusible cement of resin chemically combined with lime. The patent to W. E. Nickerson, Nov. 18, 1893, covers a resinous body made flexible and adhesive by fat, solid at ordinary temperature.

A vitreous composition has been patented by Lodyguine, June 7, 1893. This seal is for the leading-in wires, and is composed of glass or vitreous composition containing a composition of boron. The patent to Paul Scharf of Aug. 20, 1892, describes an incandescent lamp having two tubular bearings metallized, the wires soldered to the metallized bearings of the surfaces and a metallic cap soldered to the outer metallized surfaces of the bearings. Another lamp of Nickerson and Cary (U. S. patent, Sept. 16, 1893) has a plug consisting of two layers, one comparatively hard and infusible, located near the filament, and one comparatively soft and fusible, located upon and outside the hard layer. In the new de Khotinsky lamp a chemically prepared organic compound is employed for uniting a glass cap to the neck.

Some of the above described lamps have been put on the market, but in my opinion none with such success as the lamp possessing the all-glass closed chamber.

The Westinghouse stopper lamp, patents to L. K. Bohm, 1881-1882, consists entirely of glass, but the neck of the lamp and the stopper are ground together. This lamp had originally a hollow stopper, with platinum wires sealed in, while it is made at present with a solid stopper and pretty heavy iron wires. Lamps with heavy iron wires are, in all probability, not all perfectly air tight, but if manufactured as originally patented they certainly will hold the vacuum as well as an all-glass closed chamber united by the fusion of the glass. Some time ago two of these lamps from the old American Company, which were in the possession of a New Brunswick college, were tested and found to be perfectly air tight with a good vacuum in them, although they had been manufactured prior to 1883. This lamp is separable, the stopper can be taken out and the new filaments inserted. As filaments are manufactured very cheaply, this lamp may still have a great future when the processes of exhausting lamps are cheapened, because all the other parts of the lamp can be used over again.

Another field for inventors in incandescent lighting is the electric meter,* but to enter the subject would lead too far for this article.

National Electric Light Association.

The Trunk Line Association has granted the rate of a fare and a third on the certificate plan to Washington and return during the period of the convention, namely, Feb. 27, 28 and March 1. The various other passenger associations have the matter under advisement, and will, in all probability, render their decision in the near future.

Wind Power.

M. de Nansouty suggests that users of wind power might find it an advantage to surround the "atmospheric turbines" by strong towers, for directing the wind by nozzles, as water is lead to a Pelton wheel.

Electric Launches.

An electric boat 150 feet long, 25 feet wide and nine feet deep, with five feet draught, and driven by twin screws, is to be put on Seneca Lake, and is to be used for commercial purposes.

* There is up to date no reliable direct reading electric meter in use.

Is Telephonic Induction Electrostatic or Electromagnetic?

BY F. W. DUNBAR.



THE almost universal verdict has been that the disturbances on telephonic lines known as "cross talk," or "cross induction," are due to the electrostatic induction of one circuit upon another.

Without attempting to review the articles previously published upon this subject, I wish to present the subject in the light of some experimental results obtained by myself some time ago bearing directly upon this question, and hope that more competent mathematicians will take up the discussion and settle in a definite manner a question which may soon have an important bearing upon telephonic transmission.

Whatever the cause of the effect may be, there is little chance for a difference of opinion concerning the effect itself. Whenever a telephonic, or variable, current of any nature is transmitted over one of a number of parallel circuits, whether these circuits be overhead wires or cable conductors, each of the remaining circuits will be disturbed by an induced current of the same nature as the disturbing current. The strength of this induced current is some function of the distance separating the disturbed and disturbing circuits, and decreases with an increase in this distance. The distribution of the current upon the disturbed circuit is governed by the conductivity and capacity of that circuit, as has been so thoroughly pointed out by Mr. J. J. Carty.

These disturbances can be decreased and rendered negligible by making the algebraic sum of the distances between the disturbed and disturbing wires equal to zero—that is, by either spiralling the two conductors of each circuit about each other, as is practiced in cable construction, or by transposing at definite intervals the two conductors of either one or both circuits, as practiced in overhead construction.

This indicates that the disturbance is due to the unsymmetrical relation of the two circuits, but whether it is caused by the electrostatic induction of the one circuit upon the other, due to the variation in potential of the disturbing circuit and varying with the specific inductive capacity of the dielectric, or whether it is caused by the electro-magnetic induction of the one circuit upon the other, due to the variation of the current in the disturbing circuit and varying with the magnetic inductivity of the dielectric, is still an open question.

As it is practically impossible to eliminate the effects of one of these actions without sensibly affecting the other, and as a vast amount of experimental work has been done in this direction with a conclusion in favor of the electrostatic action, I will only attempt to show by data obtained on actual telephone lines and cables the probable magnitude of the two actions.

It is well known that the mutual capacity of the two sides of a circuit is the effective capacity in regard to telephonic or other alternating current transmission. But this statement is far from meaning that this capacity is independent of the capacity "to ground." A more accurate statement of the fact would be that the effective capacity is the series capacity "to ground" of each conductor, plus the direct capacity through the air of the one conductor to the other.

This is shown by diagram in Fig. 1. Fig. 2 shows the relation when the capacity of one of the conductors is taken to ground, the other wire being grounded as per practice.

From this we see that the mutual capacity of one wire upon another must exceed 50 per cent. of either alone to "ground," for the capacity of two similar condensers in series is one-half the capacity of either alone.

Letting a represent the capacity to ground of either conductor alone, and b the direct capacity of the one wire to the other, then in the first case the capacity will be $\frac{a}{2} + b$ and in the second case $a + \frac{b}{2}$. Thus the mutual capacity exceeds 50 per cent. of either alone to ground by $\frac{b}{2}$.

Figs. 3 and 4 indicate the same conditions with three wires in the field, and in general when a represents the capacity to ground of one of a group of similar conductors and includes the direct, or air, capacity to all other conductors save the one to which its mutual capacity is to be



FIGS. 1, 2, 3 AND 4.

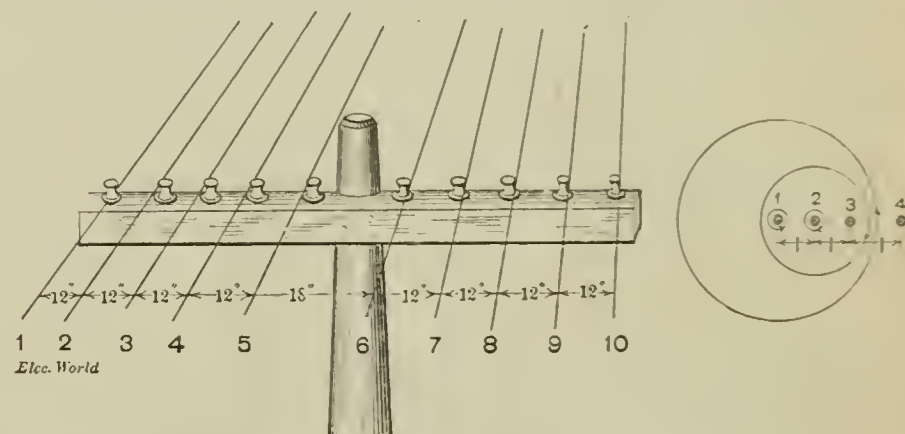
measured, and b represents the direct capacity to this conductor, then the mutual capacity of these two conductors will exceed 50 per cent. of the capacity of either to ground by an amount equal to $\frac{b}{2}$. It is apparent that an increase in the number of wires increases the capacity to ground and the mutual capacity correspondingly.

Below are given the results of some actual measurements made upon existing lines representing the present development of telephonic line construction.

The capacities were taken with all other wires grounded and with the customary ten seconds electrification. The needle was heavy enough to secure the full discharge.

The wires were No. 12 (N. B. S. G.), and their relative positions are shown by Fig. 5.

The results are given in groups of two, for transpositions



FIGS. 5 AND 6.

were present, and the results for each individual wire were really the mean values of two.

TABLE I.

No. of Wire.	Capacity in mfd. per mile.			
	One Wire alone to ground. All others grounded.	One wire to its mate (mutual cap.) All others grounded.	Excess of mutual capacity over 50 per cent. of cap. to gr.	Ditto in per cent.
1				
2	.0157	.00840	.00155	11.
3				
4	.0152	.00855	.00005	0.
5				
6	.0151	.00835	.00005	4.
7				
8	.0145	.00855	.00130	0.
9				
10	.0136	.00850	.00170	13.
Average.	.0145	.00847	.00123	8.5

The above results are the mean results obtained on two sections of line 43.5 and 75 miles in length.

Table II. gives the observed values of the mutual capacity of two wires not necessarily mates, and upon the section 43.5

miles in length. As before the results are the mean values of each group of two:

TABLE II.

No. of wire.	Mutual capacity in mfd. per pole (42 ft. in.)		
	Mutual capacity All other wires to 1.	Excess over 50 per cent. of the average of each cable to its ground (Approximately series capacity.)	Diff. in per cent.
1 on 2	.71	.001	11.
1 on 3	.61	.001	7.
1 on 5	.43	.001	1.
1 on 7	.33	.001	1.
1 on 10	.22	.001	1.6

These results indicate a marked increase in the capacity to ground as we approach the centre of the cross-arm, and a marked decrease in the excess of the mutual capacity over 50 per cent. of the capacity to ground, by the same change.

The increase in the capacity to ground of the wires as they approach the centre of the arm may be partially explained by their closer proximity to the pole and to their more central position in reference to the other wires. But this explains in no degree the decrease in the excess of the mutual capacity of one wire to its mate. The increased separation of 5 and 6 (18") would account for a small portion of this decrease on those particular wires. But we should naturally expect the value of the excess over 50 per cent. to remain constant and equal to $\frac{h}{2}$ (one-half of the direct air capacity of one wire to its mate).

This value of h may be approximately calculated from the formula

$$C = \frac{Area}{4\pi t} \left[1 - \frac{1}{2} \left(\frac{1}{R_1} + \frac{1}{R_2} \right) + \dots \right]$$

where t = distance in centimetres, and R_1 and R_2 the radii of curvature in centimetres; in this case equal and of opposite sign, thence $c = \frac{\pi 0.26}{4\pi 30} = .0022$ F. S. U. per centimetre.

Reducing to microfarads per mile we have

$$.0022 \times 10^9 \times 10^6 \times 161,000 = .0043 \text{ microfarads per mile.}$$

and $\frac{h}{2} = .0022$ microfarads, a value but one-third the lowest value obtained experimentally.

We may also readily calculate the approximate increase in capacity due to the influence of the wires themselves.

Thus calling the capacity of a freely suspended wire distant from all other wires a , we have for the capacity to ground of

$$\begin{aligned} 1, 2, 9 \text{ or } 10 & (a + 3.2 h) = (a + .00139) \text{ microfarads per mile.} \\ 3, 4, 7 \text{ or } 8 & (a + 3.1 h) = (a + .00136) \text{ microfarads per mile.} \\ 5 \text{ or } 6 & (a + 3.0 h) = (a + .00134) \text{ microfarads per mile.} \end{aligned}$$

This only accounts for a small fraction of the increase in capacity, as we approach the centre of the arm.

The capacity of a freely suspended wire at a distance of h centimetres above the earth is given by

$$a = \frac{1}{2 \log \frac{4h}{d}}$$

where d is the diameter of the wire in centimetres. For the particular case under discussion

$$a = \frac{1}{2 \log \frac{3.600}{.26}} = .0522 \text{ F. S. U. per centimetre}$$

Reducing to microfarads per mile

$$a = \frac{.0522 \times 10^9 \times 10^6 \times 161,000}{(28.8 + 10)^2} = .0122 \text{ microfarads per mile;}$$

therefore, neglecting the effect of the cross-arms and poles, we should expect a capacity

for 1, 2, 9 or 10 of .0116 microfarads per mile,

for 3, 4, 7 or 8 of .0120 microfarads per mile,

for 5 or 6 of .0119 microfarads per mile,

the discrepancy is

for 1, 2, 9 or 10 .0020 microfarads per mile,

for 3, 4, 7 or 8 .0028 microfarads per mile.

for 5 or 6 .0035 microfarads per mile,

The value of .0035 is certainly a reasonable value for the effect of the poles and cross-arms, but it is scarcely conceivable that this value should decrease to .0020 by approaching the end of the cross-arm; for if the effect were due entirely to the pole the capacity would only be reduced to about .0025 by this change in position, while we know from the constant and controlling position of the cross-arm that the decrease will be far less than that amount.

There is but one obvious explanation of this discrepancy and it also explains the unexpectedly large variation in the excess of the mutual capacity over 50 per cent.

It has many times been noticed that a uniform time of electrification on a line wire is fully as important as in a cable, despite the negligible absorption by the dielectric (air). A reasonable explanation may be advanced when we consider the "bound" charges on the poles and cross-arms.

Owing to the comparatively high resistance of the arms, this charge accumulates slowly, and is especially noticeable on dry cold days, such as prevailed at the date of the tests. For the same reason, the discharge will be retarded, owing to the comparatively slow disappearance of the bound charges on the arms. This would cause an indicated capacity less than the true capacity, and the effect would be greater as the tested wire approached the ends of the cross-arm.

The insulation of the wires themselves frequently exhibit this fact, and Table III. gives the measured insulation of these same wires on one of the dates of test.

TABLE III.

No. of wire.	Insulation in megohms per mile.
1	
2	
3	540
4	360
5	
6	420
7	
8	432
9	
10	570

The error introduced by this partially insulated bound charge will not appear, or rather will be present to a vastly reduced extent, when the mutual capacity of one wire to its mate is measured; for in this case the bound charges are separated by a few inches only and readily recombine, while before they had to traverse a length of cross-arm varying from 5 feet for the end wires, where the error is a maximum, to a few inches on 5 and 6, where the error is a minimum. The pole itself probably causes but little error.

We should then expect that the values of the mutual capacities of one wire on its mate would remain practically constant, increasing slightly toward the centre of the arm, due to the more central position of the wires, and decreasing again on reaching 5 and 6, owing to increased separation.

On examination of the actual values secured, Table I. shows a remarkably close agreement to these values. When, however, we separate the wires whose mutual capacity is to be measured, as in Table II., we see that the effect of the separation of the bound charges again appears, and the apparent mutual capacity decreases slowly with an increasing separation.

(To be continued.)

Laboratory Notes—XIV.

BY LIEUT. F. JARVIS PATTEN.

APPLICATIONS OF MULTIPHASE AND MULTIFREQUENCY CURRENTS.



OME reference has already been made to what was termed "multifrequency currents" for sake of a proper designation. They will be referred to in general terms as independent currents in the same magnetic system, having different frequencies or time periods. As will be seen later on, they are not without some practical application, and as a study of the action of such currents is best made by a simple system of graphical analysis, they will be considered as a sort of sequel to a brief but similar treatment of the action of multiphase currents, which will serve to familiarize the reader with the method as well as to bring out the salient features of multiphase current applications and the peculiar effect of such currents when applied to a single magnetic system.

Were it not for the rotary field effect, so called, there would probably be little practical use for multiphase currents—but the rotary field effect makes a beautiful motor system possible, that not only dispenses with commutators and brushes, but also one that requires no current in the moving part of the machine, and as such takes a long step, at least so far as the theory of the matter is concerned, in advance of direct current machines, with the difficulties of which we are all so familiar. By the term multiphase currents we understand, in general terms, two or more single alternating currents having different instantaneous current values, but the same period, that is, their successive impulses have the same duration but they do not begin and end at the same instant, one starting a plus impulse, say just about as the plus impulse of the other has attained a maximum value, and is beginning to decline in strength. It is this shifting of the effect of one behind the other that determines the phase difference and gives occasion for the name multiphase currents—both are separate independent alternating currents of the simplest form and are in no wise different from single alternating currents except in their combined effect, or the resultant effect of the two operating together in the same magnetic system. They are referred to as biphasic currents when there are only two separate currents, and as triphase currents when there are three used simultaneously. More than three such currents have been used with a view to determining their effect as a further application of multiphase working, but these applications have been very limited, and have served as much as anything to show that biphasic or triphase currents can produce as efficient results as would be derivable from the use of many more. It will therefore serve the purpose here to consider the first mentioned only.

In Fig. 32 are shown the curves of two separate alternate currents assumed for convenience to follow a sine function. These curves serve no other purpose than to represent the instantaneous values of the E. M. F. of both at any particular instant of time with reference to each other. The line $t_0 t_3$ is merely a line of reference, which is taken to represent a certain time interval, during which, as is evident from the figure, one complete wave and a quarter of the current represented by the curve $h h$ takes place. Inasmuch, however, as both currents have the same time period continuously, we find that a wave and a quarter of the current has likewise taken place in the same time interval, the only difference between the two currents represented by the two full curves $h h$ and $v v$ of the figure being that the maxima and minima values of the two currents do not occur at the

same instant of time, but these values are displaced by a certain amount with respect to each other, and this amount of displacement, great or small, determines the phase difference between the two currents. In the diagram the curve, or current, $h h$, is at a maximum value when the other is zero and conversely, having the same time period continuously, they must preserve this relation whether the machine generating both goes fast or slow.

Two separate alternating currents having this relation are commonly called biphasic currents, and are strictly biphasic currents in quadrature, for they might have some other degree of displacement, and they would still be biphasic currents, but not necessarily in quadrature, or having ninety degrees phase difference.

As the degree of phase difference has much to do with results, this point of two currents being in quadrature, or having ninety degrees phase difference, will bear a little further elucidation.

Consider for a moment how such a single alternating current as that indicated by the curve $h h$ would be produced in the simplest way. Any closed coil, or coil connected through two ring contacts to an external closed circuit, would give two pulsations of current, one positive and one negative, during a single revolution when revolved in a single or two-pole field. Thus, starting at the position where the field has zero induction effect upon the moving coil, we should have an increasing and subsequently decreasing E. M. F., and current in the coil during a half revolution thereof, all in one direction and corresponding to the time elapsed during one-half a revolution, all this E. M. F., or current, being in one direction. In the succeeding half revolution the

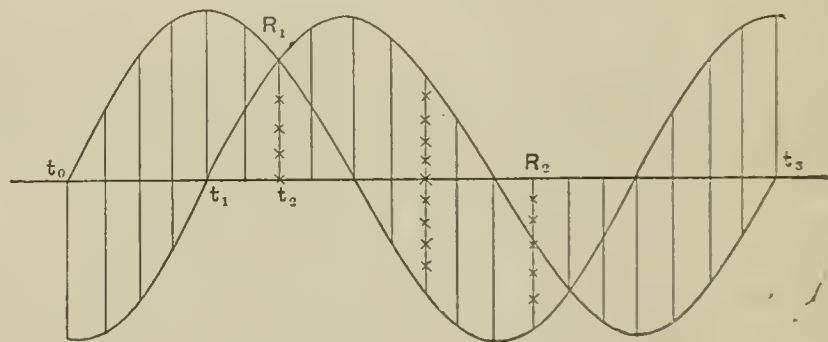


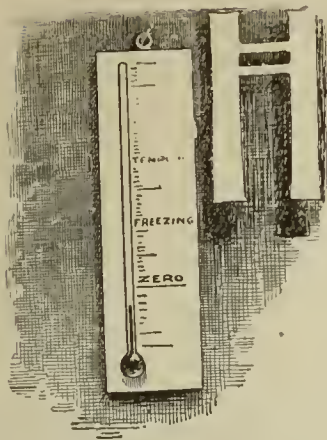
FIG. 32.

same thing would be repeated with the only difference that the E. M. F., or current, would be in the opposite direction; the curve representing this effect during the interval of time elapsed is, therefore, drawn below the time line, or zero line, simply to represent the reverse direction of current flow. Whether the curve representing the current in such a simple case is a true sine curve or not, is immaterial, depending, as it does, upon certain relations of field and coil, it is so represented for convenience and in such form answers the purpose of this explanation. The simplest way then to obtain such a current is to revolve, say, an ordinary Siemens armature, the terminals of which are connected through two rings to a closed external circuit, in a single, or two-pole, magnetic field of constant strength.

If, now, there were another coil identical with the first in every respect, but wound in a plane at right angles to the first and connected through a separate pair of rings to a separate closed external circuit, then this last coil would yield an E. M. F., or current, indicated by the second curve, $v v$, while the first was giving that indicated by $h h$, and these two currents would be properly described as biphasic currents in quadrature; but if the two coils were not placed in planes at right angles to each other, their respective currents would not be in quadrature, and would have some other phase difference, depending on the angle of divergence between the planes of their windings; thus we may have biphasic currents of any degree of phase difference.

A New Method of Preventing Heat Radiation.—II.

BY R. A. FESSENDEN.



OW efficient this means of checking radiation is may be seen from a comparison of curves 3 and 4. In these experiments we see that by simply surrounding the heated box with another one, but 1-4 of an inch from it, we have checked radiation to an extent which could only be accomplished by covering it with a layer of asbestos one and one-quarter inches thick. The ratios between the relative efficiencies would have been still

greater had the inner box been blackened.

Placing the outer box has cut down the radiation about 60 per cent., instead of the theoretical over 66 per cent. How much of this effect is due to the insulation of the air we do not know. The insulating power of the air is great when absolutely prevented from moving; according to calculations made by Lord Rayleigh, based on the value for its coefficient of viscosity, its impartivity is .000054. In practice, however, tests give much larger results, probably on account of the impossibility of keeping down diffusion. From the experiments of Professor Ordway, of the Mass. Inst. of Tech., the value obtained in actual experiment is .0008 (in calories). If we accept this value (and the experiments seem to have been made with great care) of the total increase of moratance found on placing the second box about the first, only about 5 per cent. can be due to the resistance of the air, and the theory may possibly be correct. Whatever the reason of the increase of the resistance to the passage of heat, the results show that it is very decided, and that space for space it is much more effective than any other method known. In addition it has the advantage that the specific heat of such a system is very low, which is not the case when insulating materials are used. In the latter case some time elapses before the asbestos or magnesia coating is warmed up, and attains its steady temperature, and the amount of heat necessary to do this is wasted. This becomes important when, as in electrical cooking, the use of the apparatus is only economical on the condition that it is only in use for the actual time necessary to perform the operation required. In the case of the system of polished surfaces, no large amount is required to give the steady temperature, which is attained almost immediately.

In view of the great advantages to be obtained in checking losses from radiation, it is hoped that this method may be of practical use, not only in electrical work, but also in refrigerating work.

The advantage of using polished surfaces may be seen in another way, which does not depend upon any doubtful theory. The emissivity of a substance is defined as the number of calories lost per second per square centimetre per degree centigrade of difference between the surface and the air. Its value for ordinary temperatures in dry air is about .0001 for a surface which is blackened inside but polished outside. The impartivity of asbestos, as given by reduction from Prof. Ordway's experiments, is about .0008, i. e., a cube one centimetre side will transmit .0008 calories of heat per second when the difference of temperature between its faces is one degree centigrade.

If we have a layer of asbestos adjoining and touching a polished surface, and a source of heat on that side of the asbestos which is furthest away from the polished surface, we have the equation

$$.0008 \div t \times x = .0001 \times y,$$

where t is the thickness of the layer of asbestos, x is the difference of temperature between the sides of the as-

bestos, and y the difference of temperature between the polished surface and the air. In order that the drop of heat potentiality may be the same across the asbestos as across the polished surface, we see that the asbestos must be 8 centimetres thick, or, in other words, that the thickness of 8 centimetres is required to produce the same effect as one polished surface.

Below is a table of emissivities drawn from the results of the experiments described above, and also a list of the impartivities of a few substances reduced from Prof. Ordway's results. All are expressed in calories, centimetres and seconds, with the exception of curves 1, 2 and 3, which are in watts and centimetres. It is believed that curves 1, 2 and 3 are quite accurate, on account of the size of the surfaces taken, i. e., six square feet, and on account of the accuracy of the methods used.

TABLE OF HEAT CONDUCTIVITIES.

Calculated from Prof. Ordway's Results.

Loose wool	About .00015
Hair felt	" .00017
Loose lampblack	" .00016
Carbonate of magnesia.....	" .00022
Fine asbestos	" .0008
Air	" .0008
Sand	" .0010
Best slag wool	" .00022
Paper	" .00025
Asbestos paper wound tight	" .00035

Curve 1 represents the variation of emissivity (in watts) with temperature, of tin polished inside and out. Curve 2, the same for tin polished on the outside and coated with

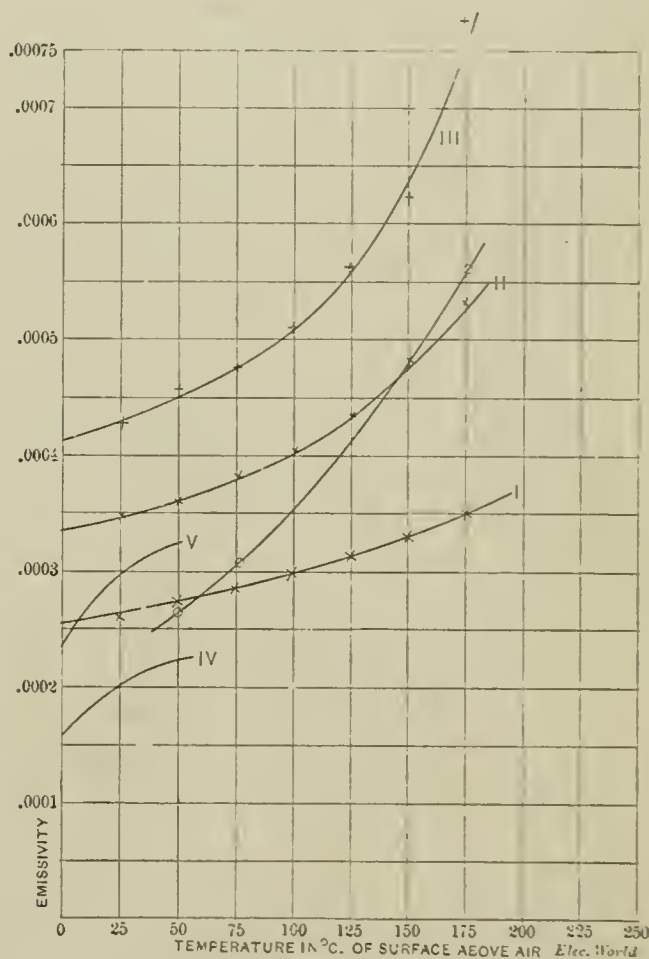


FIG. 2.—CURVES OF EMISSIVITY.

lampblack on the inside. Curve 3, for tin coated both inside and out with lampblack. (The word tin is used in its commercial sense, as meaning tinned iron.)

Curves 5 and 6 are taken for comparison from Everett's C. G. S. units and physical constants, as representing Macfarlane's results for the emissivity, in calories, of polished and blackened copper. The equation given in the book referred to is evidently wrong, and is a horrible example of the effect of fitting equations to curves without taking into account what the general character of the curve must be. It makes the emissivity zero somewhere about 200 degrees C. In the later experiments by Dr. Bottomly, made with the same apparatus, the results give a curve of the same general shape as Nos. 1, 2, and 3. The curve obtained for

the blackened copper ball is given in curve 6. It will be noted that it goes up rather steeply, from which one would suspect an undue amount of convection.

These results are only calculated approximately. In conclusion I would express my thanks to Messrs. Keiper and Fisher for the trouble taken in performing the experiments and in tabulating the results.

Rope Driving.—VI.

By J. J. HARRIS.



THE subject of rope driving may properly be placed under two heads, according to the nature of the material composing the ropes—whether fibrous or metallic. With few exceptions metallic or wire ropes are used almost exclusively on long distance or tele-dynamic transmission, while fibrous ropes are employed for intermediate and comparatively short drives. Among the materials used in this method of power transmission we find manilla rope in much favor in this country, as well as in Great Britain and Germany.

In many cases ropes of cotton are also used, as they are generally softer and more pliable than the ordinary manilla ropes, thus allowing smaller pulleys to be used with less injury to the fibres. In fact, cotton ropes of small diameter have been used for years in cotton machinery bandings over pulleys and under conditions which would wear out a manilla rope in one-third the time. There is also an advantage, in that there is less internal chafing and wear when the rope is bent over a pulley, on account of the smoothness of the fibres and the great elasticity of the yarns.

The fibre of cotton is in itself a single cell, or hair, which grows on the coat of the seed and is thus a unit. These fibres are divided into two classes, constituting what is known as the short and long stapled varieties, in which the length varies from 3-8 inch to 1 3-4 inches. The unit cell, when attached to the seed in the plant, is in the form of an elongated cylinder, but when dried and separated from the plant the walls of the cells collapse; the flattening of the cells is not uniform nor continuous in a straight line, and as a result the fibre assumes the appearance of a twisted ribbon of numerous convolutions, somewhat resembling a corkscrew.

The shape of the fibre is thus well adapted to the work of being twisted into yarns and on account of each fibre being a unit its surface is comparatively smooth; the structure of the fibre permits considerable elongation, and especially in the long stapled varieties, the natural wax on its outer surface acts as a lubricant and permits a freedom of motion between the unit fibres without undue wear.

Thus it will be seen that cotton ropes are particularly well adapted to the transmission of power, in which the rope is constantly undergoing a varying strain, and is subjected to much flexion. The strength of cotton ropes is, however, extremely small,* and although the weight is about one-third less than manilla the actual first cost is from 50 to 75 per cent. greater than for the latter. The working strength of cotton transmission rope may be taken higher, in proportion to its ultimate strength, than is used with manilla, for the latter is weakened by the grease with which it is lubricated, and, moreover, a larger factor must be allowed for wear on account of the character of the manilla fibre, which breaks more easily under bending strains.

As compared with manilla, then, the advantages of cotton ropes of the same diameter are: Greater flexibility, greater elasticity, less internal wear and loss of power due to bending the fibres, and the use of smaller pulleys for a given diameter of rope. Its disadvantages are: Greater first cost, lesser

strength, and, possibly, a greater loss of power due to pulling the ungreased rope out of the groove—in any case this is very small with speeds over 2,000 feet per minute.

In England manilla is now being used very largely, but cotton ropes were formerly preferred to the exclusion of all others for all kinds of driving, but the most probable cause of this was not that cotton was the best or most economical material for the purpose, but that rope driving is most common at cotton factories, and cotton ropes were made in the locality by men who were familiar with the local product and had been for years making spindle and rim bands of small size. When the demand for large sizes arose these rope makers applied themselves to the newer industry and shut out other materials.

In the mills of Dundee and vicinity, and in the North of Ireland, where flax and hemp are worked, we find ropes of hemp, a local product, used entirely.

Rawhide ropes, which are made from 3-8 inch to 2 inches in diameter, are used to a limited extent. Where the stress in the rope is not great and the accompanying slip is small, rawhide works very well, and will last from three to six, and, in some cases, ten years. Under ordinary circumstances, it is not necessary to use any dressing, as sufficient lubrication is furnished by the rope itself; if the rope slips in its groove the leather will be burned and lose its flexibility and also its adhesive qualities to a certain extent. A rawhide rope has very little tendency to rotate on its axis, and for this reason the wear is not uniform, and with a heavy tension it is liable to take the set of the groove in which it runs; this is rather an advantage for a straight drive, where the rope always runs in the same direction, but in those cases where a rope is led on to the pulleys at an angle this will be a disadvantage, as under such conditions the rope often slips and wear is excessive. Where the rope is subject to wet or dampness, rawhide is an excellent material to use, as it is very little affected by dampness.

The cost of rawhide rope will average about six times that of a good quality of manilla transmission rope.

Solid round and square ropes of leather are sometimes used, and steel ropes with leather washers closely threaded on have been tried with considerable success, but the expense of such a rope would necessarily limit its application.

As we have already noted, manilla rope is used very extensively for transmission purposes, but its application has not always met with that success which would follow a more thorough knowledge of its requirements. Inefficient rope drives are erected and run for a few months, or perhaps only days, and are replaced with larger ropes if the sheaves will permit, or, as in many cases, the ropes give way to leather belting and henceforth rope driving is condemned. The true cause is not so much the inefficiency of the ropes as it is the lack of knowledge governing their use and application; in order to obtain a proper conception of this a study of the structure of the rope will be found advantageous. Manilla, or more properly, manilla hemp (abaca) rope, is made from the fibres of the *Musa textilis*, a plant closely allied to the banana, growing near Manilla, in the Philippine Islands. The fibres are a part of the outer covering of the leaf stalk, which attains a length sometimes as great as 15 feet. To obtain fibres of suitable size for manufacturing rope, the leaf stalks are subdivided and in the process of segregation the fibre assumes an appearance somewhat similar to that produced in splitting a piece of wood—it is rough and uneven and more or less splintery throughout its length. These fibres, although in themselves not very large, are composed of very fine and much elongated bast cells, which are held together by an intercellular tissue, or mucilaginous substance, which becomes hard when dry.

Fig. 26 represents a portion of the cross-section of a fibre

* Nyström gives the breaking strength of patented twisted transmission rope at less than one-tenth that of similar manilla rope.

* W. H. Smith, Am. Machinist, January, 1891.

of manilla magnified 400 times; this section is one of several specimens examined and sketched by the writer and may be taken as a fair average of good manilla similar to that from which transmission rope is made. There appears to be about 400 separate cells in this fibre, which measured 0.0066 inch by 0.016 inch, as shown in the outline view, which is magnified 50 times; lengthwise the cells appear, under the microscope, to be composed of a bundle of tubes glued together, and in places the adhering glue can be seen as a jagged protuberance on the surface, where it was separated from the adjoining fibres. The contour of the perimeter of the fibre is also rough, as noted in figure, as it retains the form impressed upon it by the contiguous cells when in the stem. Moreover, the cells are much shorter than the fibres, and although they taper at the ends there are frequent rough projections where the end laps over, or where a cell is separated from the fibre.

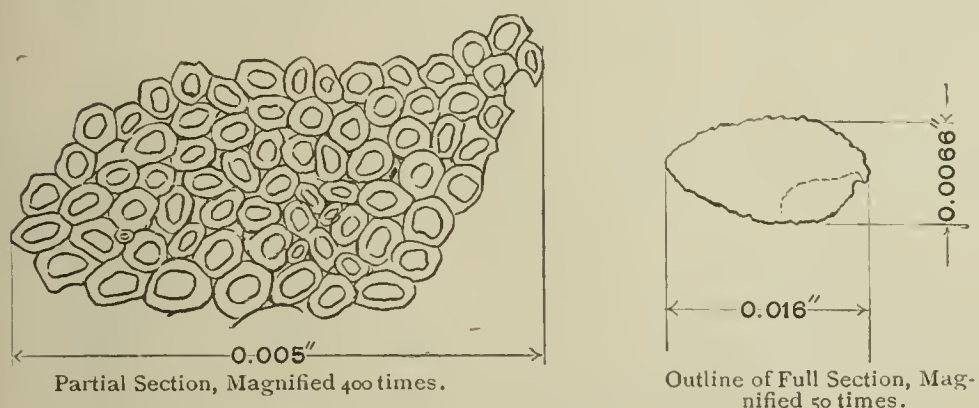


FIG. 26.—CROSS-SECTION OF MANILLA FIBRE.

rated from the fibre. These fibres have great strength in the direction of their length, but are weak transversely;* when made into rope they are compelled, in bending over the sheave, to slide on each other while under pressure from the load. This causes the internal chafing and grinding, which, if not prevented, soon wears out a rope when subjected to bending strain.

In addition to the action of the fibres upon each other, the strands and the yarns of which the strands are composed also slide a small distance upon each other, causing friction, and hence internal wear.

By opening out an old dry rope which has been used over a sheave, a fine powder will be disclosed, showing that where the rope was bent over the sheaves the strands, in sliding on each other, ground some of the fibres to powder. Another reason for this is that by constant flexure the mucilaginous substance which cements the unit cells into congeries, or bundles, cracks and disintegrates. Aside from the external wear which a rope suffers from contact with its sheave, part of which is the differential driving effect; these two are the principal causes of rapid wear in a rope drive, to remedy which we must in the first case lubricate the fibres, and in the second prevent undue flexure of the rope—how this is effected in practice will be seen presently. In manufacturing rope the fibres are first spun into a yarn, this yarn being twisted in a direction called right hand. From 20 to 80 of these yarns,** depending on the size of the rope, are then put together and twisted in the opposite direction, or left hand, into a strand. Three of these strands for a 3-strand, or four for a 4-strand, rope are then twisted together, the twist being again in the right hand direction. It will be noticed that when the strand is twisted it untwists each of the threads, and when the three strands are twisted together into rope it untwists the strands, but again twists up the threads. It is this opposite twist that keeps the rope in its proper form. When a weight is hung on the end of a rope,

the tendency is for the rope to untwist and become longer. In untwisting the rope it will twist the threads up, and the weight will revolve until the strain of the untwisting strands just equals the strain of the threads being twisted tighter. In making a rope it is impossible to make these strains exactly balance each other, and it is this fact that makes it necessary to take out the turns in a new rope—that is, untwist it when it is put at work.

The fibres of manilla which are thus twisted into ropes will average over 6 feet in length, varying from 3 1-2 to 12 feet. If they were long enough the most advantageous method of using them would be to lay the fibres side by side, and secure them at the two ends; each fibre would then bear its own share of the strain, and the strength of the bundle would be that of the sum of the strengths of the separate fibres. As a long rope could not be formed in this way, the ends of the fibres are secured by twisting so as to produce sufficient compression to prevent the fibres from moving upon each other when a strain is applied; but in attaining this amount of compression their strength is greatly reduced; this very compression acts as a constant weight on the fibre and must be deducted therefrom before the available strength can be applied.

The weakening effect produced by twisting varies considerably among the fibres of the same rope according to their distance from the centre or heart of the bundle. If a certain amount of twist be given to a bundle of fibres, the outer ones will be strained more, and will act with less useful effect than those on the inside, which will have to bear the greater part of the strain while the rope is being used. It will therefore be evident that if the fibres were twisted at once into a thick rope the outer fibres would be so much strained as to be of little or no use in contributing to the strength of the rope, but by making the rope as we have indicated by first twisting into yarns, then into strands, and finally combining these into a rope, the strain is more equalized, and the important properties of length and strength are secured without too great a sacrifice of the strength of the individual fibres.

The degree of twist in the rope may be determined by constructing a right-angled triangle, the base of which is the circumference, and the height the length of one turn of the strand measured parallel to the axis. The difference between this height and the hypotenuse is the quantity by which the rope is twisted. The ropemaker's ordinary rule for a three-strand rope is to have one turn to as many inches as are contained in the circumference of the rope; but the degree of twist is variable and more or less dependent upon the judgment of the maker.

Experiments by Reaumur to determine the effect of twist upon a rope showed that a small well-made hemp cord broke in different places with a mean weight of 65 pounds; while the three strands of which it was composed bore 29 1-2, 33 1-2 and 35 pounds respectively, so that the total absolute strength of the strands was 98 pounds, although the average real strength was only 65 pounds, thus showing a loss of strength of 33 per cent.

More recently the test of a small rope showed an average strength of 4,550 pounds, while the aggregate strength of its 72 yarns was 6,480 pounds—each yarn bearing about 90 pounds; thus there is a loss of 1,930 pounds, or about 30 per cent.

(To be continued.)

City and South London Railway Company.

The traffic receipts for the week ending Dec. 17, 1893, are given as £905, which is a decrease of £13 compared with the corresponding period of last year, while the receipts from the end of June were £20,037, which is an increase of £143 over those for the corresponding period of last year.

* The tensile strength of manilla fibres will average over 30,000 pounds per square inch of section.

** A three-strand rope, one inch in diameter, is the key to the sizing of the yarns. Yarns of 20s are of such a size as to require 20 to fill a tube half an inch in diameter, or to make one strand of an inch rope; 26s requires 26 to fill the same size tube and so on.

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BY CARL HERING.

ELECTRO-PHYSICS.

Explanation of the Ferranti Phenomenon.—The "Elek. Zeit.," Dec. 29, abstracts a paper by Dr. Sahulka, of Austria. If the secondary of a transformer is connected to a capacity which is not too great, the ratio of transformation increases and may become greater than that of the windings, while at the same time the primary voltage becomes greater and the primary current smaller; this, he states, is the most curious of the Ferranti phenomena, and he explains it by showing, first, theoretically, and then experimentally, that it is due to the so-called magnetic leakage; the mathematical principle in the abstract is hardly conclusive, as it is not sufficiently complete; in the experimental investigation the transformer was constructed with a cylindrical core, with one coil in the middle and one at the ends; by using the two end ones as primary and the middle as secondary or vice versa, the leakage could be made very small or very great respectively; in the former case the condenser increased the voltage only 1.5 per cent., while in the latter the increase was 18 per cent.; he concludes from this that there is no doubt that if all the magnetic lines generated by the primary cut the secondary, and vice versa, there will be no Ferranti effect.

Duration of a Discharge.—According to the Lond. "Elec. Rev.," Dec. 29, Mr. Mayer estimates that with a striking distance of 8 centimetres, the duration of a single flash from a Holtz machine is less than one-millionth of a second; with shorter distances the flashes are formed of several separate sparks; with a large inductorium, a distance of one millimetre and a Leyden jar of 242 square centimetres surface in circuit, the discharge lasts one-twenty-fourth of a second and is formed of over 720 separate sparks; the latter decreases with increased distances up to between 1 and 2 centimetres, when it is reduced to a single flash.

Dielectrics in Rotating Electric Fields.—In the Digest, July 15, under "Electrostatic Hysteresis," an article by Mr. Arno was abstracted. In the Lond. "Elec.," Dec. 29, an article supplemental to this is abstracted, giving the numerical results of experiments for the values of the constant K , by which the field intensity raised to the 1.6 power must be multiplied to obtain the energy dissipated; this formula is analogous to the Steinmetz formula for magnetic hysteresis, and the results confirm the supposition that the work done in this case is due to electrostatic hysteresis.

Tesla's Researches.—The "Zeit. fur Elek.," Dec. 15, reprints a portion of an address by Prof. Ettingshausen, in which he gives a short description of the life and works of his countryman, Nikola Tesla.

Oscillations in Cylindrical Conductors.—The mathematical article of Mr. Blondin is continued in "La Lum. Elec.," Dec. 23.

Impedance of Mutually Inductive Circuits.—Mr. Rimington's article, mentioned in the Digest last week, is concluded in the Lond. "Elec. Rev.," Dec. 29.

Calculating Alternating Currents.—The article by Mr. Guilbert on a discussion of Mr. Steinmetz's method, is con-

cluded in "La Lum. Elec.," Dec. 23; the method, it is claimed, is not new, but leads to very interesting results.

Conductivity of Flames and Gases.—The Lond. "Elec. Eng.," Dec. 29, abstracts a short article on this subject, showing that there is considerable conduction in some flames and that it increases with the temperature.

Electricity.—The Lond. "Elec. Eng.," Dec. 29, contains the sixth article by Mr. Walker on "What Is Electricity?" Attractions and repulsions of bodies are discussed.

MAGNETISM.

Pull of Magnets.—The serial in "Ind. and Iron," by J. S., is continued in the issue of Dec. 22; it is well worth reading; but scarcely admits of being abstracted. Taking an electro-magnet coil of 100 turns and one ampere, with poles of 1 square centimetre and a keeper of 1 centimetre distant, neglecting leakage and assuming a uniform field, he calculates the field in the air gap by multiplying the ampere turns by 0.4 π lines and dividing by the air gap, giving 62.8 mites per square centimetre; suppose the keeper be allowed to move toward the magnet 1 millimetre, the induction will be 68.7; neglecting hysteresis and Foucault currents, if the coil had been short-circuited at first there would have been an induction current due to 62.8 lines cutting it; if this is done after the movement of 1 millimetre there will evidently be more work done on the circuit; some work has also been done in moving the armature, therefore when a magnet does work on an armature the source of energy has to supply more energy than is needed for the moving of the armature, the surplus being obtainable by short-circuiting the coil. He then discusses, without the use of mathematics, the stored energy, and compares it to water running out of a cistern in which the height diminishes as the water flows out; if the cistern had an outlet of such a shape that the rate of escape of water was proportional to its height, it would follow exactly the same law as the magnet; the work stored in the coil of an electromagnet can be found by finding the power at the beginning of the dying away, taking this as continuing until the field is gone and dividing the result by two; the resistance of the coil cancels out; if it is high, the field dies away quicker but develops a greater power for shorter time.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Capacity of Condensers for Alternating Currents.—The "Elek. Zeit.," Dec. 29, abstracts a paper by Dr. Sahulka, of Austria, in which he shows that the capacity of condensers with solid dielectrics is smaller when used with alternating currents than when measured with continuous currents; the dielectric takes up some energy, part of which is again returned at discharge; for this reason the capacity measured with a continuous current source will be too great both for charging and for discharging, as in either case the quantity passing through the galvanometer will be larger than that due to the true capacity; with alternating currents there is not sufficient time to take up the energy as with continuous currents, and for the same reason less is given out at discharge; for alternating currents the capacity should therefore have a special definition, for which he suggests the re-

reciprocal value of the product of $2 \pi n$ and its inductive resistance, the latter being the quotient of the difference of potential and the current at charging; with a condenser of 1 microfarad, in which paraffine paper was used, the difference was 14 per cent. less for alternating currents; his results also agree approximately with the law of Steinmetz that the work consumed in a condenser is within wide limits proportional to the square of the voltage.

Copper Electrolysis in Vacuo.—The Lond. "Elec.," Dec 29, reprints in abstract a Royal Society paper by Mr. Gannon; a summary of the experimental results is as follows: For neutral solutions of copper sulphate the copper deposit is higher, other conditions being the same, if the voltmeter is under reduced pressure, but the percentage difference is not constant; it is constant and higher than 1 if a little free sulphuric acid is added to the solution under atmospheric pressure; if the acid is added to both, the percentage difference will also be constant; for current densities of over 0.01 ampere per square centimetre of active cathode, there is practically no difference between the two deposits; if the current density is below this, the deposit in vacuo is appreciably higher; for different current densities the curve of deposits is more regular for those in vacuo while below a density of 0.01 it is approximately a straight line. In a paper by Prof. Schuster immediately following this he gives the results of experiments which prove that nearly the whole effect which is observed when copper is immersed in a solution of sulphate of copper or sulphuric acid is due to the presence of oxygen in these solutions.

Resistances and Conductivities of Metals and Alloys at 0° C.—The Lond. "Elec.," Dec. 29, gives a table of lines of different lengths representing the volume specific resistances and conductivities for various metals and alloys based on the determinations of Profs. Dewar and Fleming.

Resistance of the Earth.—"L'Ind. Elec.," Dec. 25, states that Mr. Kallmann has measured the resistance of the earth at Berlin, using about 50 amperes, and finds it to be equal to a mean of $1 \div 3,600$ ohm per metre, if the two contacts form perfect connections with both the water and the gas pipes; when connected to only the water pipes it was $1 \div 2,500$.

Measuring the Efficiency of Dynamos.—The Bul. de la Soc. Belge. Elec.," for June-July, reprints an article by Mr. Bouquet, from "Genie Civil" of October, in which the Swinburne method is described and followed by another, which is claimed to eliminate completely errors inherent in this method and does not neglect any quantities, thus giving a closer approximation. Owing to typographical errors and the omission of important diagrams, the description is not clear, and therefore those interested should refer to the original.

Measurements at Central Stations.—The serial by Dr. Kallmann is concluded in the "Elek. Zeit.," Dec. 29; in it he discusses measurements of currents, resistances and insulation and the construction of instruments based apparently on his differential method.

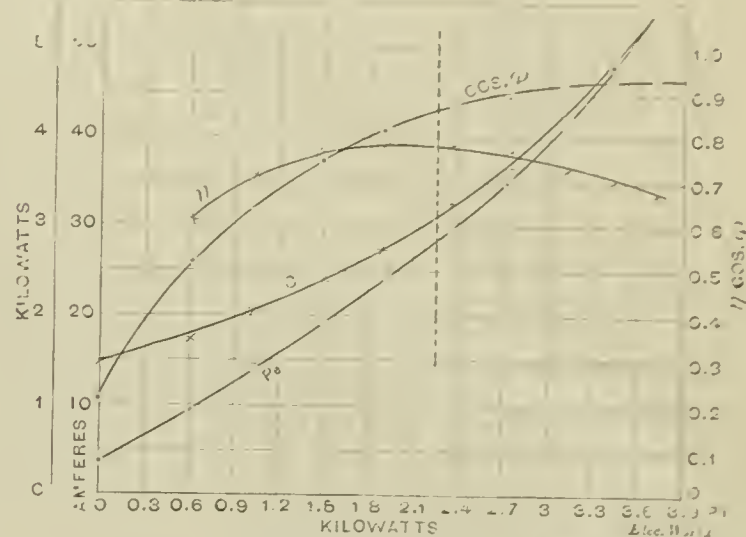
Dynamometry.—In the serial by Mr. Carter in the Lond. "Elec.," Dec. 29, he discusses the measurements of work and power.

Hookham Meter.—The Lond. "Elec.," Dec. 29, gives a very well illustrated description of the present form of this well-known meter, which differs greatly in detail but not in principle from the old form; its construction is simple and robust.

DYNAMOS AND MOTORS.

Experiments with Brown Non-synchronous Motors.—"L'Ind. Elec.," Dec. 25, gives the results of a series of very complete tests made by Mr. Banti in Rome, with a number of Brown motors installed there; three motors were tested

of 3, 1 1-2 and 3-4 h. p.; tables and curves are given, of which the curves for the 3-h. p. motor are reproduced here in the adjoining figure; Pe represents the electrical h. p., Pu the useful, or brake, h. p., C the current $\cos \phi$ the cosine of the angle of lag between the current and potential, and $eff.$ the commercial efficiency in per cent. The weights of the three motors, including the pulleys, are 418, 264 and 154 pounds, respectively, and the number of poles were 6, 4 and 4, respectively. The experiments show, among other things, that the current, when the motor is not loaded, varies between 1-2 and 1-3 of that at full load, but the apparent power is then 3 to 5 times greater than the true power; also



TEST CURVES OF 3-H. P. MOTOR.

that the commercial efficiency of the 3-h. p. motor at full charge is 78 per cent.; no figures are given regarding the starting, that is, between the instant of closing the circuit to the times when synchronism is reached, which is greatly to be regretted. (The article is headed "Non-Synchronous," while the table is headed "Synchronous," but we assume that the first is what is meant and that the motors are probably those described and illustrated in the Digest Sept. 25 and discussed in subsequent abstracts.)

Iron in Armatures.—The "Elek. Zeit.," Dec. 29, contains another article of the series by Mr. Schultz, the present one being on an investigation of the supposed advantages of insulating the iron discs from each other, and on the effect of the thickness of the discs. He constructed four armatures, two with thin plates of 0.5 millimetre (19.69 mils) and two with plates 1 millimetre thick (39.37 mils), in one of each pair the plates were insulated from each other with paper, as usual, while in the other there was no such insulation; the external dimensions of the armature core were the same in all; these were revolved in a field, being driven by an electric motor; the power required for each could be measured accurately; the results of the tests and calculations are given in detail, allowances being made for the different cross-sections of the iron; applying Steinmetz's formula for the loss in a cubic centimetre of iron per period, he comes to the following important conclusions: For armatures, with or without paper, the Foucault currents appear to be quite the same, being even 20 per cent. greater when paper is used; the use of paper, therefore, is absolutely unnecessary; the thickness of the plates has a very important effect on the magnetic losses, the coefficient in connection with the Foucault current factor in that formula being five times as great for the thick plates as the thin ones, that is, the loss due to Foucault currents is five times as great; the rise in temperature of an armature will depend on these losses. In the conclusions he quotes from a former paper (see Digest Aug. 12), in which these conclusions were confirmed by temperature measurements; with or without paper the results were the same, but with the thick plates the rise of temperature during a 2 1-2

hours run was 42 degrees, while with thin ones it was 48 degrees C.

Irregularities in the Action of Dynamos.—Mr. Montpelier in "L'Elec.," Dec. 23, classifies the irregularities in the behavior of dynamos, showing in each case what test to make and what to do in order to correct the faults as quickly as possible.

Unipolar and Non-polar Induction.—A translation of the article mentioned in the Digest Jan. 6 is given in abstract in the Lond. "Elec. Eng.," Dec. 29, in which the illustrations are reproduced.

TRANSFORMERS.

Air-Core Transformers.—Referring to an article on this subject abstracted in the Digest Nov. 25, Mr. Shand, of Lynn, Mass., writes to the Lond. "Elec.," Dec. 29, showing that the phenomenon of increased impedance and decreased current in the primary circuit, observed on closing the secondary circuit under certain conditions, was observed four years ago in the laboratory of Prof. Elihu Thomson; the following experiment was made: The primary of a small Ruhmkorff coil was put in series with nine lamps in multiple and excited with an alternating current; when the secondary circuit was closed through a Geissler tube, or conductor, of high resistance, the lamps fell perceptibly in candle power, showing that the impedance of the primary was apparently increased; when the secondary was closed through a low resistance the lamps brightened as usual.

ARC AND INCANDESCENT LIGHTS.

Photometry of Projectors.—"La Lum. Elec.," Dec. 23, contains an article by Mr. Fery, in which he discusses the question of whether the law of inverse square does, or does not, apply; theoretically, if the rays are parallel it does not, while in practice it does if the objective of the source is taken as the real source. He discusses the case of a lens with the source in back of it, and shows that up to a certain point in front of the lens (the conjugate focus) the rays converge, and this point should be considered as the source; for a crater 5 millimetres in diameter and a lens 1 metre in diameter and 1.5-metre focal distance, this point will be 300 metres distant; the ratio of the intensities with and without the lens will be the proportion of the surface of the lens to that of the crater, which he calls the multiplying factor, and which in the case of the projector at the World's Fair was 90,000; it is a mistake, however, to do as they did at Chicago, to multiply this by the intensity at 1 metre from the arc; by placing the photometer at the lens the intensity would be that of the arc divided by the square of the distance to the lens, which in the case cited gives 1,333 candles in place of 3,000, which it would be if this correction were neglected. He describes a series of experiments which, he states, conform to the theory; the calculated and observed intensities given agree more or less approximately, although their difference is in some cases over 100 per cent.; up to the point mentioned above the intensity is assumed constant, and beyond that the inverse square law is assumed to apply, "taking the lens as the origin of distances." (This statement is probably a typographical error, judging from what preceded.) All that was said about lenses is applicable in the same way to mirrors. The description and several cuts showing the curve of intensities are not as clear as might be desired.

Flashing.—In discussing the suit in this country, the Lond. "Elec. Rev.," Dec. 29, states that a very significant reason for using this process is that the time required to remove the occluded gases during exhaustion is very much less when the filaments have been flashed.

Frosted and Colored Bulbs.—London "Electricity," Dec. 29, contains an article on this subject by Mr. Wirt, in which he describes several methods of frosting and coloring.

Cored Carbon Litigation.—The "Elek. Zeit.," Dec. 29, contains a lengthy communication on this subject.

Franklin's Electric Light.—According to the "Elek. Rundschau," No. 6, an apparatus has lately been discovered in London with which Benjamin Franklin produced an electric light sufficient to read by; the generator was a large glass cylinder rubbed by a brush and the discharge took place between a knob and a point.

TRANSMISSION OF POWER.

Transmission of Power at Niagara Falls.—Prof. Forbes, in a communication to the Lond. "Elec. Eng.," Dec. 29, replies to several criticisms, in which he endeavors to show that there is not the slightest foundation for certain charges which were made; he also defends the action of the company regarding the acceptance and rejection of designs. An abstract of the second day's discussion is given in the Lond. "Elec. Rev.," Dec. 29; the same journal contains a long editorial on this subject; it criticises the action of the company in entrusting the plant to a professor instead of to men having long experience in actual work; regarding artificial loading for parallel coupling, it states that no practical engineer of this day would think of employing such a clumsy device; there are several plans in daily use that are far better; regarding low frequency it states that it does not enable synchronizing motors to be either cheaply or easily made for starting, nor does it affect in any way the parallel working, nor is there the slightest advantage for transforming or for motors; it is emphatically denied that Mordey's alternators do not work perfectly in parallel; belief is expressed that the best frequency for general work is about 60, and that electricians must sooner or later adopt this as one uniform frequency. The same journal also contains a communication from Mr. Mordey regarding the synchronizing power of his alternators; the experiment alluded to by Prof. Forbes was the placing between the two machines of a resistance considerably more than was required to absorb the whole output of one of them; as even under these conditions the machines did not actually break out of step, Mr. Mordey regards the experiment as very satisfactory and as affording a very strong proof of the powerful synchronizing effort.

Transmission of Water-Power.—According to the Lond. "Elec. Eng.," Dec. 29, plans are being made for the transmission of a water power of 12,000 h. p. in Southern India to two towns requiring a line 110 miles in length and to be used for lighting and power purposes; alternating currents are to be used. It mentions another proposed installation in Southern Russia, in which 5,000 h. p. are to be transmitted ninety-three miles.

ELECTRIC RAILWAYS.

Disturbances Produced by Railway Currents.—The "Zeitung Elek.," Dec. 15, publishes the rules, the compliance with which is required by the Austrian Government Telegraph Department in the construction of electric railways, to avoid interference with telegraph and other delicate instruments.

Conduit Road in Budapest.—According to the "Elek. Zeit.," Dec. 29, the present horse lines in that city are to be gradually replaced within three years by the electric conduit road at present in use; the increase will be about forty-two miles; this leaves little doubt that this road is successful.

Railway in Japan.—According to "La Lum. Elec.," Dec. 23, an electric railway is projected in Japan between two cities forty-eight miles apart, the source of power being a waterfall; another project is for a road fifteen miles long, also operated by water power.

Bordeaux Railway.—"L'Ind. Elec.," Dec. 25, contains an illustrated description of the third overhead line in France, which is erected by the T. H. Co.

Lauterbrunnen-Muerren.—“La Nature,” Dec. 23, publishes a well illustrated description of this road, together with a plan and profile.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Charging for Electricity.—In London “Lightning,” Dec. 28, Mr. Madgen discusses the subject and describes the method of Mr. Wright adopted by the Brighton Corporation; it considers that the maximum current taken by the consumer at any time indicates the proportion of capital at the station; for which he is responsible for this maximum rate, for several hours a day, he pays a certain charge, and for any consumption beyond this he pays only half that rate. For this purpose a maximum indicator is required, which is described and illustrated in the article; it consists essentially of a U tube ending at the top in two sealed bulbs, one of which is surrounded by a coil in series with the mains, which warns it, causing the liquid to overflow into the other bulb, where it is retained; the column shortened by the amount which has overflowed indicates the maximum current that has passed; it is reset by tilting the tube.

Operating Costs.—In the “Elek. Zeit,” Dec. 29, a detailed report is given of a station in Vienna, in which accumulators are used, the cost for different items is given in detail and does not admit of being abstracted; regarding the accumulators it may be said that their mean efficiency in watt hours was, for the whole year, 83.1 per cent. as compared with 77 per cent. of the previous year; of all the current generated 54.8 per cent. went into the accumulators.

Low Frequency Currents.—Commenting on the article of Lieut. Patten, in The Electrical World, Dec. 2, the Lond. “Elec. Rev.,” Dec. 29, states that the application of the device for obtaining currents of low frequency is ingenious and novel, and opens a field well worth further investigation, but that it is not easy to see in what way currents of this kind have any special therapeutic value.

Three-phase System.—The “Elek. Rundschau,” No. 6, publishes the first part of an article on the three-phase current, in which are given the formulas for making calculations in such a system.

Accumulator Regulator.—Mr. Leroy, in “L’Elec.,” Dec. 23, describes an apparatus for operating the accumulator switches used in large central stations.

Search Light in Shaft Sinking.—“Electricity,” Dec. 29, describes briefly this application of search lights in a shaft in Scotland.

Central Stations in Great Britain.—The Lond. “Elec. Rev.,” Dec. 29, prints as a supplement a complete list of these stations, with a short description of each.

London.—In “L’Elec.,” Dec. 23, Mr. Hauptman continues his serial on electric lighting in London, describing the stations of the Metropolitan Company; the illustrations include two large folded plates.

Cologne.—In the Lond. “Elec.,” Dec. 29, Mr. Crompton replies to the article mentioned in the Digest last week, showing that the figures, although very good, do not compare well with those of Bradford or Liverpool.

Blackpool.—London “Electricity,” Dec. 22, gives an illustrated description of this station.

Chatsworth.—The English papers give an illustrated description of a small plant at Chatsworth.

WIRES, WIRING AND CONDUITS.

Resistances with Alternating Currents.—In “L’Ind. Elec.,” Dec. 25, E. H. (Mr. Hospitalier) makes some interesting and practical deductions from an inaugural address made by Sir William Thomson as president of the Institution of Electrical Engineers in 1889; these deductions simplify very greatly such calculations. Assuming circular wires, the resistance to alternating currents will be equal to that for direct

currents, multiplied by a factor k , which depends on the frequency and on the diameter; this factor is the same if the product of the frequency and the square of the diameter are the same; on this basis he has calculated the following table, in which the first column represents the frequency in periods per second, multiplied by the square of the diameter in centimetres, for copper having a resistivity of 1,597 C. G. S. units; for any frequency and diameter of wire calculate the figure in the first column, then the corresponding one in the second will be the factor by which the ohmic resistance must be multiplied to obtain the resistance for these alternating currents:

$d^2 f$	k	$d^2 f$	k
0	1.0000	1620	1.8628
20	1.0009	2000	2.0430
80	1.0001	2420	2.2190
180	1.0258	2880	2.3937
320	1.0805	5120	3.0956
500	1.1747	8000	3.7940
720	1.3180	18000	5.5732
980	1.4920	32000	7.3250
1280	1.6778		

If the product of the square of the diameter, multiplied by the frequency, is greater than 32,000, the effective resistance may be obtained with considerable precision in assuming it to be equal to that of a tubular conductor of the same external diameter and a thickness equal to $6.38 \sqrt{T}$ in centimetres, T being the time of one period. For a different specific resistance the numbers in the first column of the table should be changed in proportion to the ratio of the resistivities, that is, as $1,597 \div r$, in which r is the resistivity of the other metal; the magnetic permeability, however, must remain equal to 1; these formulas do not take into consideration a capacity nor mutual induction. A translation of the article is given in the Lond. “Elec. Eng.,” Dec. 29.

Safety Cables for Mines.—The “Bul. de la Soc. Belge. Elec.,” for June-July (just received), contains a description by Mr. Masson of the Cockerill-Jaspar cables, which are claimed to avoid the danger of igniting fire-damp in case of short circuits, faults, etc.; he states having witnessed experiments in which the cables were crushed and cut, the current being broken without the least spark.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Theory of the Shunted Condenser in Automatic Telegraphy.—In the Lond. “Elec. Rev.,” Dec. 29, Mr. Taylor gives a non-mathematical explanation of the increasing speed when this apparatus is placed in series with a receiver; for high speeds of working he shows that a high E. M. F. should be used, but unless some additional means are adopted, it would produce a great deal too much magnetic induction. The action of the condenser is to bring the resistance shunting the condenser automatically into the circuit soon after the commencement of each current; during discharge the condenser acts not only as a short circuit of this resistance, but as an additional battery joined in series with the other; the common statement that the charge and discharge of the condenser overcome, or neutralizes, the back E. M. F. and extra current of the receiver coils, he states, is misleading.

Transatlantic Telephony.—According to the Lond. “Elec. Eng.,” Dec. 29, an attempt was made on Dec. 28 to telephone from St. Martin’s-le-Grand to New York, but it was unsuccessful; no further information is given.

Pacific Cable.—The London journals of Dec. 29 reprint a report of Mr. Sandford Fleming on the proposed routes, in which is included a table of the estimated earnings.

Field Telegraphy.—A translation of the article mentioned in the Digest Sept. 23 is given in “L’Elec.,” Dec. 23, including the illustrations.

Sweden, Norway and Denmark.—Telegraph statistics for the year 1892 and telephone statistics for Sweden are given in the “Jour. Telegraphique,” Dec. 25.

Telephone Statistics in Austria.—Some statistics for the year 1892 are given in the "Zeit fuer Elek.," Dec. 15.

ELECTRO-CHEMISTRY.

Electrolytic Separation at Definite Voltages.—The Lond. "Elec. Rev.," Dec. 29, abstracts an article by Mr. Frendenburg, in which he classifies metals into three groups; those which are not separable, those which are precipitated as peroxides and those appearing in the metallic state on the cathode; the voltage has little influence in the separation of these three groups, but applies chiefly to the separation of the members of the third group; the latter is considered in detail, the proper voltage suitable in each case being given in the original.

Electrolyzer.—The Richardson & Andreoli apparatus are described and illustrated in "La Lum. Elec.," Dec. 23, in the former the granulated material to be treated is carried on a moving belt below an inverted vessel, in which the gases are collected, and which contains the carbon anodes. In the Andreoli apparatus the liquids are made to circulate between numerous vertical plates.

Electrolysis of Fused Salts.—Mr. Andreoli's article is continued in "Ind. and Iron," Dec. 29; he discusses the electrolysis of strontium, lithium, sodium, potassium, chlorates and chlorides, many of the descriptions being chiefly of historical interest.

Pollak Accumulator.—The "Elek. Rundschau," No. 6, publishes a short description of these well-known cells without, however, giving anything not already published.

Silver Plating Industry.—The serial in "Ind. and Iron" is continued in the issue of Dec. 29, in which the subject of wires is discussed.

MISCELLANEOUS.

Electro-Culture.—According to the "Zeit. fuer Elek.," Dec. 15, Mr. William Siemens experimented with the effect of electric light on plants and found the following: The electric light (presumably the arc) acts equally beneficially on the formation of chlorophyl as on the growth of the plants; the plants need no rest during the twenty-four hours, but make greater progress if they are exposed to the sun during the day and the electric light during the night; the electric light increases the development of flowers and fruits, the flowers being more intensely colored and the fruits having a finer odor and aroma; the cost of the light is but slight, if natural forces are at one's disposal.

Electricity of the Skin.—According to London "Electricity," Dec. 29, Prof. Yarchanoff experimented by connecting electrodes applied to the skin at various parts of the body through a galvanometer, "and at such times the various stimuli of the skin—such as light tickling with a brush, heat, cold, a needle prick, sound, light, taste and smell—were noticed, and in all cases a strong deflection of the galvanometre needle was observed. Merely opening the eyes after having had them closed for some time produced a considerable deflection, and mental efforts, like calculation, also had a similar effect." He believes that the source may be due to the decomposition of metals taken in the food.

Electric Light in Surgery.—According to London "Electricity," Dec. 22, it has been noticed that when the eyes are illuminated from behind by an incandescent lamp placed in the mouth, the pupils, seen as blood red apertures, do not contract, a fact which may make this application an important one.

Electric Welding.—In a well-illustrated article in "La Lum. Elec.," Dec. 23, Mr. Richard illustrates and describes a number of apparatus, among them the Lemp regulators, the Suppes method for welding rails, the Angell & Burton multiple system, the Coffin system of the revolving arc, the Mountain system of radiation from the arc, the Krupp arc system and the soldering iron of Tinnerholm.

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C. D. WARNER,

Standard Electric Time Co.

I LIKE THE NEW FORM you have adopted, as I believe it places the matter in a more compact shape and will make a better size for binding purposes. I am pleased with our advertisement, as it appears in this issue, and wish to thank you for the excellent taste you always display in arranging our matter.

Hartford, Conn.

F. G. WATERHOUSE,

Waterhouse, Gamble & Co.

WHAT I THINK of The Electrical World in its present form and condition is the fact that I have this day signed contracts for two advertisement in it, which is the first advertising we have done with this paper for three years.

New York, N. Y.

C. J. FIELD,

Field Engineering Company.

I LIKE THE NEW WORLD very much, and think you have made a big hit in reducing the size. Certainly the electrical fraternity will appreciate it and it should (as I have no doubt

it could) continue to receive their hearty and undivided support. Trusting your labors will be crowned with that success which they merit, I remain, etc.,

Boston, Mass.

WILLIAM N. TITUS,
President Northwestern Land and Coal Company.

I AM GLAD to see that alternating currents are to be treated by Prof. Ryan, so that the ordinary man can grasp the subject and get some idea of them.

New York, N. Y.

CHARLES E. CHAPIN.

A GREAT IMPROVEMENT. We have the new Electrical World and we like the size and get up of it much better, and consider it a great improvement on the old form.

St. Louis, Mo.

J. A. J. SHULTZ,
President Shultz Belting Company.

I WISH TO CONGRATULATE you on the appearance of the first number of The Electrical World in its new form. It is a very handsome and impressive publication, and I am confident you will never regret the change of shape.

New York, N. Y.

DAVID WILLIAMS,
"Iron Age."

THE NEW APPEARANCE of The Electrical World is a great improvement. The paper is concise, to the point, and covers a field more general than any of the other papers we are aware of. With kind wishes for the new year, we remain,

New York, N. Y.

JEROME KIDDER MFG. COMPANY.

AFTER READING YOUR TELEPHONE EDITORIAL we wish there were more papers like The Electrical World. Most of the others seem afraid to speak. We enclose herewith our advertisement and wish we could send you a larger one, for you deserve it.

Mianus, Conn.

PALMER BROTHERS.

WE AWAITED the issuance of this paper with great interest, and certainly could not help being pleased with it. We hear nothing but complimentary remarks regarding this magnificent issue on all sides. Wishing you continued success, etc.

New York, N. Y.

FRANK S. DE RONDE,
The Standard Paint Company.

THE NEW SIZE of The Electrical World is much more convenient than the old one, the reading matter is, as it always has been, arranged with great care and the advertisements make a business-like impression. Of course we will continue our advertisement.

Newark, N. J.

LOUIS HECK,
Stucky & Heck Electrical Manufacturing Company.

I AM VERY MUCH PLEASED with the new size of The Electrical World. The reading contents of the paper are certainly much more attractive and get-at-able. Our "ad" is excellent evidence of the versatility of The Electrical World staff. Altogether I congratulate you upon the change.

Chicago, Ill.

WM. H. MCKINLOCK,
President Metropolitan Electric Company.

A GREAT ADVANCE, both in appearance and in convenience, and certainly reflects great credit on you for progressive ideas and a disposition to keep in the front rank of electric journalism. Wishing you continued success and compliments of the new year, we remain,

THE EMERSON ELECTRIC MANUFACTURING COMPANY,
H. L. PARKER, President.

IT WILL ENHANCE THE VALUE of the journal as one to keep on file for future reference, many fold. The advertisements have generally, if not always, been improved by the new setting, and I esteem it a very great gain in my own case that the advertisements of engineers are brought together into a group.

Vineland, N. J.

WM. A. ANTHONY.

WE SINCERELY CONGRATULATE you on the improved size and shape of The Electrical World. It is very compact, both for reading and filing, as we think everybody will certainly want to do on account of the valuable scientific information it contains. Wishing you the success your energy merits.

New York, N. Y.

R. EDWARDS,
Edwards & Co.

MY PERSONAL CONGRATULATIONS on the new form of your paper. It is a great improvement in every way and will make The Electrical World more popular than ever. It is much more convenient to handle when reading, cuts up the advertising space better (not getting so much matter on a page), and the printing and arrangement of the cuts are excellent.

Brooklyn, N. Y.

J. REMSEN BENNETT,
The E. W. Bliss Company.

YOU HAVE ADVANCED ANOTHER STEP in the general improvement of the journal and the contents of it are in such a get-at-able order that it becomes a pleasure to refer to any particular article or advertisement between its covers. We are much pleased with the appearance of our own advertisement, and only trust that times will so improve as to permit us to feel justified in increasing our space.

Philadelphia, Pa.

HARRY S. SMITH & CO., LTD.

I MUST CONGRATULATE you on the handsome issue of The Electrical World of the 6th of January; also the interesting reading matter contained therein. The new size and appearance is a great improvement over last year's issues. The advertisement we have inserted on page 20 makes a very nice display, and undoubtedly will lead to many valuable inquiries, etc.

New York, N. Y.

EDWARD B. WYMAN,
Central Electric Heating Company.

THE ELECTRICAL REVIEW would prefer to congratulate its enterprising contemporary, but candor compels us to state that we do not believe the change to be a happy one. High class publications, such as "Harper's," "Leslie's," "Scientific American," "Western Electrician," "American Machinist," and the "Electrical Review," have won pronounced and recognized success in the field just deserted by The World. So sensitive is the public in all things that concern its reading and advertising patronage, that an abrupt change, unless a conspicuous advance, is seldom greeted with favor.

—The Electrical Review.

ALTHOUGH SOMEWHAT BELATED, the last issue of The Electrical World—the first in the new form of reduced pages—was of conspicuous excellence and one reflecting credit on all taking part in the work of producing it. The World in its new shape was awaited with much interest by the electrical fraternity, and the expressions of praise were many and cordial. The "Western Electrician" extends its congratulations on the 100-page issue. An interesting feature of the paper was a comparison of the advertisements published in The World, "Engineer" and "Review," much to the advantage of the first named.

—Western Electrician.

THE NEW ISSUE of The Electrical World, dated Jan. 6, is the start of the twentieth year in this progressive paper. There is a change in size, bringing it down to a more readable form, while the paper is much thicker in volume. The first number promises great things for the future. It is replete with illustrations. Some idea of the field which has been covered by the weekly digest of electrical literature may be had from the fact that in the past eleven months since it was started there were published in this department over 2,000 abstracts and references, which required the careful reading of over 800 issues of journals, of which about two-thirds were in foreign languages. The subscription of this paper is low, and, owing to the more convenient form, it will gain even more patrons than it now has. The Electrical World, in an editorial, gives a comparison between 1883 and 1894. The most conclusive argument showing popularity with the trade is the advertising patronage. The number of advertisements in the pioneer issue of 1883 was 63, and they occupied 430 inches of space, while in this issue the number is 320 advertisements, and they occupy 2,549 inches of space, a gain in eleven years of over 500 per cent.

—N. Y. Times.

Why He Does Not Like It.

In response to your inquiry of Jan. 6 asking me how I like *The Electrical World* in its new form, I wish to say I do not like it for the following reasons:

The paper it is printed on is too good for regular use. Now, for instance, I am in the shop, and my hands are oily and dirty, and it is so clean and smooth I dare not touch it. If it were on common paper I would have no such scruples.

In the second place, I placed my card in the advertising column, and now it takes me half my time to answer the inquiries it brought, so I have to work harder, and I do not like hard work.

In the third place, there is too much to the paper; it has so many interesting things in it that it takes all my spare time to digest its contents, and consequently I have no time to read the other journals that come to my office.

Also, I do not like it for the reason that by its growing corpulency it denotes prosperity to its owners, and as I am of a jealous disposition and like not my fellow man, nor to see any one make money unless I am making more than they are, I naturally do not like it, and I know there are a good many others who do not like it for this same reason.

Excuse my being so very candid in my criticism, but as you asked for my opinion I have given it in an honest, straightforward manner and trust you will not take offence at my plain speaking.

New York, Jan. 9, 1894.

FRANK M. ASHLEY.

An Automatic Warehouse Telephone.

A new warehouse telephone has just been placed upon the market by the well-known telephone and electrical manufacturing firm of T. W. Ness & Co., Montreal. The special feature of this new instrument, which is the invention of Mr. T. W. Ness, and has been patented in Canada, the United States and other countries, is an automatic switch return, by means of which the switch is brought back automatically to



NESS TELEPHONE

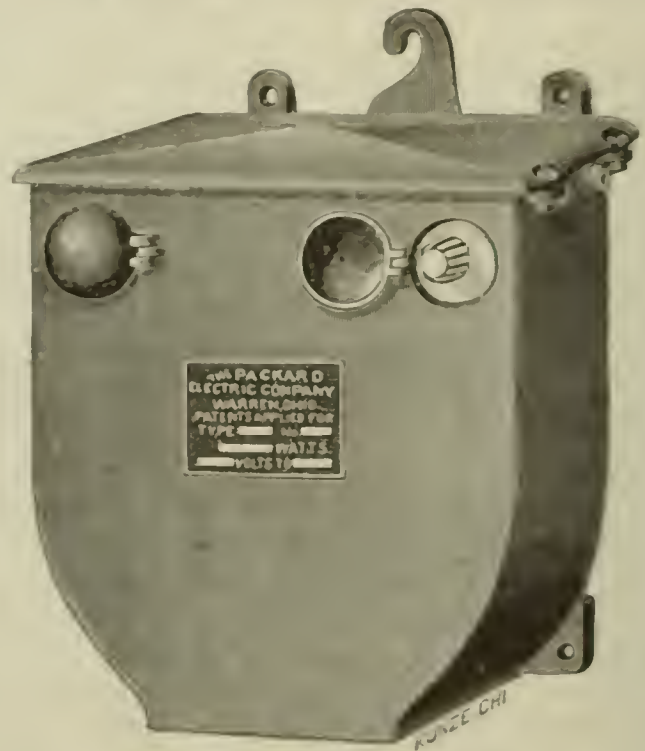
its normal point after conversation is finished. Those who are familiar with the old system, in which connection is made by inserting a plug in a socket corresponding with the line desired, which plug requires to be withdrawn after through talking, but is constantly overlooked, or the old style of switch, which requires to be returned by hand to its normal point, will at once see and appreciate the value of this new invention.

The automatic switch, receiver hook and bell are combined in the centre box. This automatic system is particularly suitable for connecting the different departments of factories, warehouses, offices, banks, colleges, etc., and it will be observed that no central office for making the different connections is required. Each instrument in a series has switch points corresponding or connecting with each of the other instruments, so that any one telephone can call up, or be called up, by any other by simply turning the switch lever around to the point corresponding with the instrument desired, and at the same time "ringing up," which is done by pressing the lever down upon the outer ring, shown below the switch points; this causes the bell of the instrument

required to ring. After conversation is finished, the hanging up of the receiver causes the switch lever to return automatically to its own point, thus leaving the telephone in position to be called up by any other instrument. When desired, the instruments can be so arranged that only certain ones in a series can call up certain others, instead of having the whole system interchangeable. In ringing up, only the bell of the instrument required sounds, so none of the others are disturbed, and conversation is at the same time private. In a series of, say, eight instruments, 1 and 3, 2 and 4, 5 and 6, might converse at the same time, without interfering with one another.

A New Transformer.

In the transformer which we illustrate, manufactured by the New York and Ohio Company, Warren, O., an attempt has been made to incorporate all of the improvements of the



AN IMPROVED TRANSFORMER.

past few years in transformer construction, and at the same time to avoid the mistakes which have naturally been made in many cases in attempting to secure desirable but hitherto unattained results. The efforts of the manufacturers from the start have been to produce, not a transformer that can be easily repaired, but one that will not require such repairs, and hence in which the feature of cheap repairs ceases to be of any value. Severe tests covering this point have shown almost conclusively that the Packard transformer, by which name it is known, cannot be burned out under anywhere near normal conditions. The importance of attaining the result is evident, providing, of course, that no sacrifice has been made in other directions. It will be readily believed that no such sacrifice has been necessary, as perfect insulation does not conflict in any way with high efficiency or perfect regulation, but is rather an assistance to it. Careful tests, extending over a considerable period of time, have besides demonstrated the attainment of the highest results as regards efficiency and regulation.

By reference to the cut of the transformer it will be observed that in mechanical construction it is neat and compact, showing that careful consideration has been given to general detail. The fusing arrangement is convenient and complete; throwing back the two round covers or lids shown in the cut discloses two porcelain plugs, which carry the transformer fuses, which can be withdrawn and re-fused or another plug inserted almost instantly without the use of any tools or the least danger to the operator.

In the construction of the coils the only theoretically correct form has been followed, that is the circular, or ring, form,

and care has been taken to proportion the windings so that the best possible results will be secured. The point in which the superiority of the Packard transformer undoubtedly lies, however, is in the insulation of the transformer coils. By a new system of insulating transformer windings the manufacturers have been able to make a transformer that cannot burn out under ordinary conditions.

In the manufacture of the transformer every detail of the work is done only by experienced, expert help, and no expense is spared to make a perfect machine in every respect. The fact that the transformer, as its name indicates, is manufactured entirely under the personal supervision of Messrs. J. W. & W. D. Packard, the manufacturers of the celebrated Packard lamp, is a sufficient guarantee that nothing is spared to make every transformer that leaves the factory as perfect as money, long experience and skilled labor can make it.

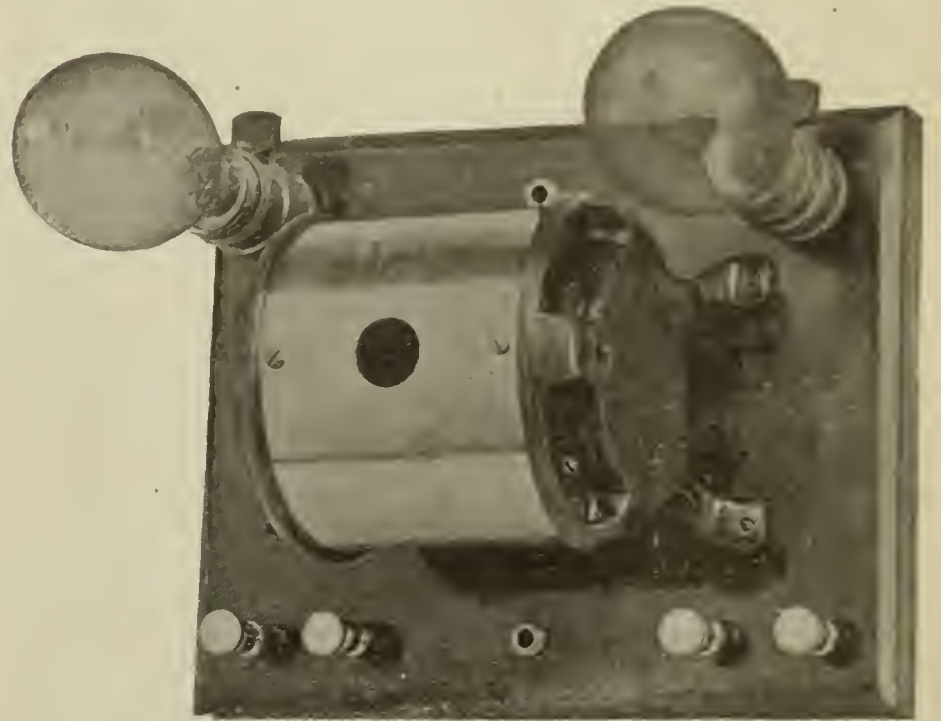
Acoustic Synchronizer for Alternating Machines.

With the great use of alternating current machines and with our modern ideas of central station practice, it is frequently desirable to run alternators—single-phased and poly-phased—in parallel. Although alternators have not hitherto been run in parallel as a general thing on this side, the practice is not infrequent in Europe, where it has been made the subject of much study. The operation of alternators in parallel is, however, receiving more attention here, and a device to indicate in the most delicate, yet effective manner, the exact point of synchronism in speed and coincidence of phase of two alternators has become a necessity. The requirement is met by the acoustic synchronizer, which the General Electric Company has recently brought out. It consists merely of a cylindrical iron case with an aperture in the side, each end being closed by flexible diaphragms, each of which has opposite its centre, the pole of an electromagnet. In using this device one of the magnets is connected in circuit through a transformer, with each of the machines to be run in synchronism. The current is then turned into the magnet coils, and the diaphragms emit a loud, clear note. As the machines approach synchronism the notes from the

two machines should be thrown in. So sensitive and distinct is the indication of approach of synchronism, that it is possible to throw two machines together with hardly a quiver upon the ammeter in actual circuit.

The immense superiority of this acoustic apparatus over the old phase lamp device cannot be disputed. It is much more sensitive, indicating distinctly the small differences from synchronism, which the phase lamp fails to detect.

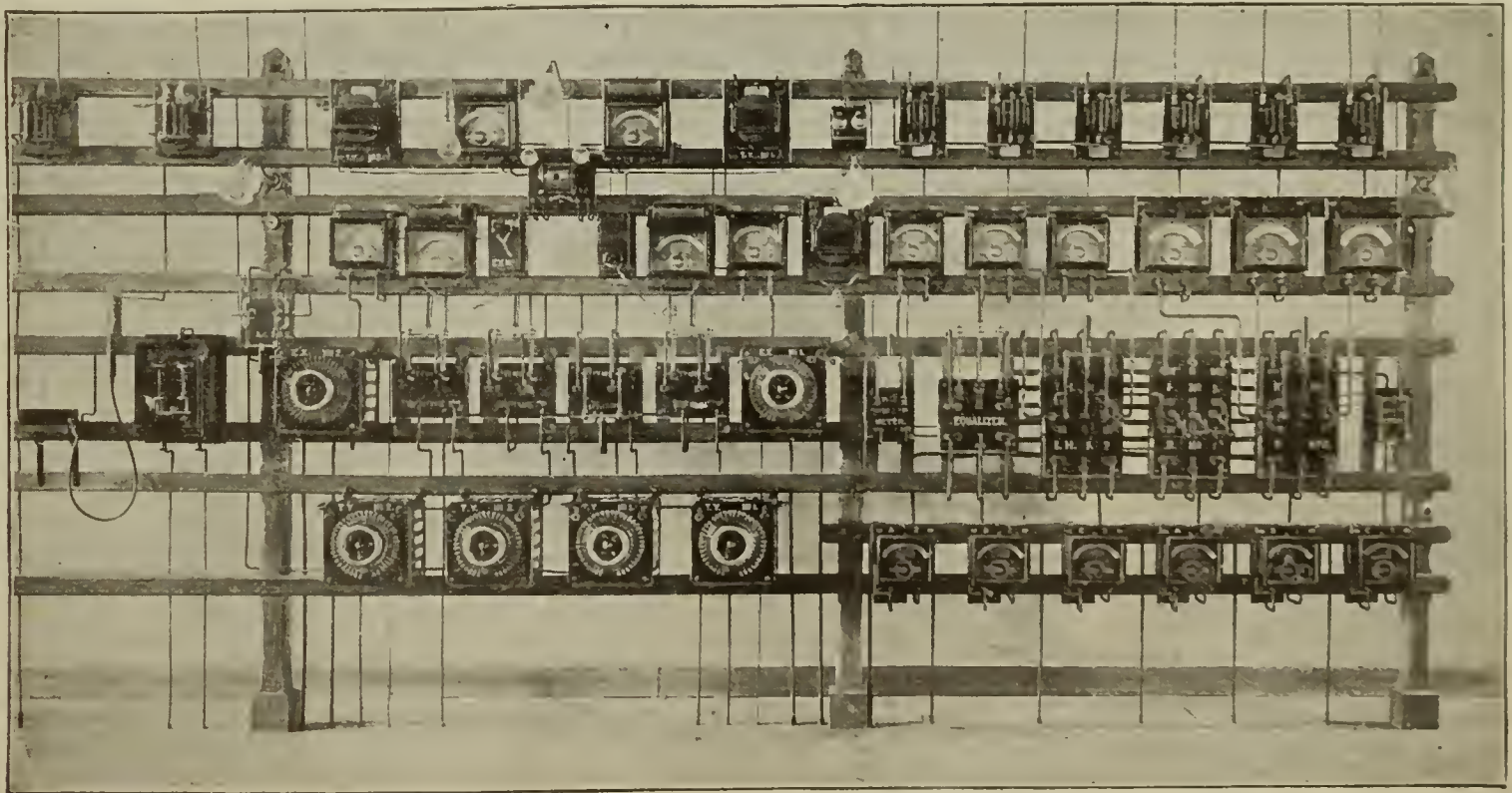
The synchronizer was shown by the General Electric Com-



ACOUSTIC SYNCHRONIZER.

pany in its power and mining department at the Chicago Exposition, where it attracted considerable attention, especially from foreign electricians. When it was shown to Prof. Von Helmholtz and its operation explained, he expressed himself delighted. It was a development in his own field of acoustics and showed how electricity and acoustics could work together for scientific benefit.

In our issue of Dec. 2, 1893, we described fully the three-



SWITCHBOARD IN THE REDLANDS STATION.

diaphragms approach closer in period and begin that loud, periodic sound, known in music as beats. As the two machines more nearly approach synchronous speed the beats grow slower and slower until finally the diaphragms fall into unison, and each gives out the same low, clear note. At this moment, which is sharply marked, the switch connecting the

phase power transmission plant installed by the General Electric Company, at Redlands, Cal. We are now able to show the switchboard fitted up with its different regulating and controlling apparatus. The synchronizer, which the irreverent Californians have labelled the "growler," is shown in the upper left-hand portion of the board.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, Jan. 13, 1904.

THE ELECTRICAL STOCK MARKET has experienced another week of comparative dullness and light trading. Though one of the electric stocks was active on particular days, and advanced several points, the other electrical stocks, both listed and unlisted, remained stationary with no transactions. Purchasers of industrial securities are still holding off until the financial situation becomes more settled. The report in Wall Street that the New York banks would furnish no more gold for export, leaving all drains to be made on the Sub-Treasury, and the expected bond issue at Washington, makes the money market very uncertain. Everyone looks for a turn in the tide but it does not seem to come.

GENERAL ELECTRIC STOCK closed several points higher today than it did a week ago, and the stock is probably at present stronger than it has been for two weeks. As most of the industrials made slight advances, General Electric did also, but the greatest gain was made on receipt of the news of Judge Shipman's decision favorable to the General Electric Company, and against the Novak lamp. This shows what an effect patent litigation has in Wall Street. This decision is a sort of prop in the company's fast falling monopoly in the lamp business and the stock profited thereby. Another thing which gave the security a little boom, was good news from Boston. It was that the annual report of the General Electric Company would show a reduction of the floating debt, including indorsed bills receivable, of from \$12,000,000 to \$1,000,000, and also by the removal of the general offices from New York to Schenectady, there would be a saving of \$40,000 in taxes. These are sweeping figures and of course must at present be relegated to current rumor. But the removal of the offices to Schenectady, and the present economical ways of the company, certainly put the concern in a better attitude. That commercial houses are still sceptical of its finances is shown by a story current in Wall Street that R. G. Dunn & Company had made inquiries into the General Electric Company's affairs and had then refused to rate them. This report will as yet have to be spoken of as gossip. When the annual report of the company is made public and the policy and management of the concern is shown to be on a thoroughly business basis, the stock may recover from its low figure. It is now quoted at 36½.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES, of Boston, have declared a dividend of 6 per cent. on the preferred shares, payable Feb. 1. The payment will be made at the office of the Old Colony Trust Company by the transfer agent to holders of record at the close of business Jan. 18. The transfer books close from Jan. 19 to Feb. 1. As this concern is the trust formed to underwrite and liquidate the General Electric Company's floating debt, it has apparently made enough money out of the transaction to declare a dividend.

ALL OTHER ELECTRICAL SECURITIES have not made any changes during the week and the prospects are not bright for immediate trading in them.

ELECTRICAL STOCKS.

	Per	Hid.	Asked
Bruck 11½ New York	50	50	10
Current Electrical Works	10	2	3
Cleveland General Electric Co	—	85	90
East River Electric Light	100	—	95
Electric Co. & Supply Co., pref	15	15	16
" " " " " "	15	15	17½
Edison Electric 11 New York	100	96	99
" " " " " "	100	101	101
Edison Electric 11 Brooklyn	100	99	102
" " " " Boston	100	115	120
" " " " Chicago	100	220	240
" " " " Philadelphia	100	120	125
Edison Electric Light of Europe	—	25	5
" " " " " "	—	20	8
" " " " " "	—	5	12
Fort Wayne Electric	—	5	9
General Electric Company	100	30 ½	30 ½
" " " " " "	—	21	22
Interior Electric and Ice Co	100	75	85
Metropolitan Electric	—	—	60
Westinghouse Consolidated	50	41	45
" " " " " "	50	34	34 ½
Western Union Telegraph	—	84 ½	84 ½

New Incorporations.

THE NEW YORK STATE ELECTRIC COMPANY, Canisteo, N. Y., capital stock \$25,000, has been formed to manufacture electrical supplies. C. House, M. Ekstromer, and Peter Hallen, Canisteo, N. Y., are the incorporators.

THE OAKLAND RAILROAD COMPANY, San Francisco, Cal., capital stock \$2,500,000, has been formed to build and operate a railroad between Oakland and Berkeley, by electricity, or some other means. C. F. Crocker, H. E. Huntington, C. E. Green, F. S. Doty, San Francisco; and S. T. Gage, Oakland, Cal., are the promoters.

INTER-URBAN ELECTRIC RAILWAY COMPANY, La Salle, Ill., capital stock \$250,000, has been formed to purchase, con-

struct and operate street and inter-urban railways, with all the appliances and appurtenances incident to or connected therewith, including the power in connection with the railway to purchase and construct electric light and power plants. C. W. Palmer, R. M. Gardner and M. C. Van Fleet are the promoters.

Special Correspondence.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 71, Hathaway Building, 120 Atlantic Ave.,
Boston, Mass., Jan. 13, 1904.

THE MASSACHUSETTS MUTUAL FIRE INSURANCE COMPANY'S new Board of Directors have organized with Chas. B. Cummings as president and treasurer, and John M. Corbett as secretary.

THE BOSTON COMMON COUNCIL has passed an order that a joint special committee be appointed to consider and report on the subject of having all electrical wires and cables operated underground in the city.

MUNICIPAL ELECTRICITY.—Representative Hathaway, of Brockton, has a bill which he will ask the Legislature to enact to authorize cities and towns to establish and operate electric light and gas plants. The bill provides that the cost shall not exceed 5 per cent. of the valuation of towns, and 2½ per cent. of that of cities. The question of the municipalities engaging in the business is to be submitted to the vote of the people. The proposed new law is different from the present one in that the gas or electricity may be used for heat and power as well as for light.

Pittsburgh Notes.

PITTSBURGH, Jan. 13, 1904.

THE MONONGAHELA ELECTRIC LIGHT AND POWER COMPANY, of Homestead, Pa., has gone into the hands of a receiver. Mr. S. A. Duncan was yesterday appointed receiver upon petitions of the company to the court to prevent a sale and consequent sacrifice of the company's assets by creditors pushing their claims.

THE STANDARD UNDERGROUND CABLE COMPANY, of this city, a few days ago declared its regular quarterly dividend of 1½ per cent. and at the same time gave out a report as to the operations of the company during last year. According to this it appears that orders were taken amounting to \$628,000. At the beginning of the year unfilled orders to the amount of \$100,000 were on hand, which brings the business up to \$728,000. The net earnings of the year are estimated at \$130,000, which is 12 per cent. on the capital stock, and an increase over the earnings of 1892 of \$40,000. The annual meeting of the company will take place some time this month.

IN THESE DAYS of general depression it is gratifying to note the constantly increasing business of the Westinghouse Electric and Manufacturing Company. While the output of the company for last November was \$500,000, for December it was \$550,000. The company has on hand a large number of unfilled orders which will keep the works running to their full capacity, and a considerable night force will be put on immediately to keep the large tools in operation on the Niagara Falls contract, and in the manufacture of other large generators for which the company has received orders.

THE WESTINGHOUSE MACHINE COMPANY held an adjourned annual meeting last Tuesday, and the following directors were elected: George Westinghouse, Jr., H. H. Westinghouse, John Caldwell, E. E. Keller and D. E. Jackman. Upon organization of the board, the following officers were elected: George Westinghouse, Jr., president; E. E. Keller, vice-president and general manager; D. E. Jackman, secretary and treasurer. Mr. E. E. Keller is the gentleman who was formerly connected with the Westinghouse Electric and Manufacturing Company, and it was he who had charge of the work the company did at the World's Fair. It is understood that in the future the Machine Company and the Electric Company will give especial attention to the manufacture of combined dynamos and engines. A complete line of new dynamos for D. C. and A. C., it is said, have already been designed for the various sizes of compound engines manufactured by the Machine Company.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 71, Hathaway Building, Chicago, Jan. 13, 1904.

THE METROPOLITAN ELECTRIC COMPANY is moving into its new building, 186-188 Fifth Avenue, Chicago, Ill., where it will have ample store and office facilities, besides warerooms, and is

putting in a large line of staple goods to enable them to take care of all orders without delay.

GEORGE G. CARTER & CO., No. 1,563 Monadnock Block, has recently obtained a large order for Habirshaw wires and cables from Louis K. Comstock, to be used in the electric installation in the Champlain Building, now erecting at the corner of State and Madison streets, Chicago. The Habirshaw wire used in this building will be specially prepared for plaster work. The company has also recently received a large order for incandescent lamps from a large plant in the East, and feels that the prospects for business are brightening, although its business thus far has not warranted any complaint, notwithstanding the prevailing depression.

News of the Week.

Electric Light and Power.

TRENTON, NEB., is discussing the electric light.

ENFIELD, N. H., is talking of putting in electric lights.

BAKER CITY, ORE., is considering the question of granting an electric light franchise.

ELKHART, IND.—The Council recommends that the city establish a municipal electric lighting plant.

READING, PA.—The Police Committee has been authorized to call for bids for lighting the streets and City Hall.

EVERETT, MASS.—A resolution has been adopted in favor of establishing an electric light plant by the city of Everett.

KEARNY, N. J., has sent a bill to the Legislature empowering the township to issue bonds for an electric lighting plant.

EAST ORANGE, N. J.—The East Orange Township Committee calls for bids for electric street lighting for a period of ten years.

JOPLIN, MO.—The present street lighting contract has expired, and the Council will now let the contract for a five-year period.

THE SAN MARCOS (TEX.) ELECTRIC LIGHT AND POWER COMPANY will increase its capital to \$20,000 for improvements.

WILLIAMSPORT, IND., is to have the electric light soon. H. P. Hill & Co., of Evansville, has been awarded the contract.

HERMANN, MO.—Messrs. Herzog, Kropp, Graf and Wenzel are interested in a projected town lighting plant.

MORRIS PLAINS, N. J.—The electric light will be introduced in the hospital here and at Trenton.

BUFFALO, N. Y.—The General Electric Company, now on Court street, proposes to build a large plant on Wilkeson street.

LAUREL, MD.—The Laurel Electric Light Company proposes to change its motive power from steam to water power.

FAYETTE, IOWA.—The Town Council will soon take definite action in the matter of the proposed electric lighting plant.

SCHENECTADY, N. Y.—The contract for lighting the city has been awarded to the Schenectady Illuminating Company.

DALTON, MASS.—The Northampton, Mass., "Herald," is authority for the statement that an electric plant will be built in Dalton in the spring.

JERSEY CITY, N. J.—The Hudson County Board of Freeholders has adopted plans and specifications for the proposed electric light station at Snake Hill.

EVERETT, MASS.—At the last regular meeting of the Mayor and Aldermen a resolution was adopted in favor of establishing a municipal electric light plant.

THE CARO (MICH.) ELECTRIC LIGHT WORKS are in the market for more alternating dynamo capacity, one voltmeter and general supplies from time to time.

BATAVIA, N. Y.—The Consolidated Gas and Electric Light Company is considering the feasibility of establishing a motor circuit when its light contract with the village expires.

MILWAUKEE, WIS.—Captain Pabst has been granted an electric light franchise in the Second, Third, Fourth and Seventh Wards.

ELKHART, IND.—The City Council has passed the following resolution: "That it is the sense of the Council that the city should own and operate its own electric light plant."

ALEXANDRIA, VA.—There is trouble with the plant of the street lighting system, and the general opinion seems to be that a new engine is necessary.

BATAVIA, N. Y.—Official proposals have been called for by the Trustees of Batavia for furnishing an electric lighting plant, dynamos, etc., to be received until 8 p. m. on Jan. 24.

ARCHBALD, PA.—The Borough of Archbald will enter into a contract with the Crescent Electric Company for lighting the streets of the borough by electricity.

COLLINGSWOOD, N. J.—The Collingswood Water and Light Company is the possessor of a lighting franchise and is desirous of putting electric lights into the borough as soon as expedient.

ANNAPOLIS, MD.—The City Clerk has been directed to call for bids for lighting the city for three or five years with electric light and gas.

GEORGETOWN, TEX.—Plans and specifications have been prepared for the proposed municipal electric lighting plant by Wm. P. Rounds, and bids will soon be called for.

SHICKSHINNY, LUZERNE COUNTY, PA.—Residents of Shickshinny will vote in February the matter of issuing bonds to the amount of \$8,000 to pay for an electric light plant.

DES MOINES, IOWA.—Sealed proposals will be received to Jan. 23 by the Board of Public Works for lighting the streets and alleys for one year with 200 or more arc lights. R. S. Finkbine and R. L. Chase are the Board of Public Works.

MORRIS PLAINS, N. J.—The Board of Managers of the Trenton and Morris Plains Hospital have decided to place electric lighting plants in the hospitals in place of the present gasoline system.

IOWA CITY, IOWA.—The contract for lighting the city for the next five years has been awarded to the Iowa City Electric Light Company. The contract provides for 35 lights instead of 15 as formerly.

GERMANTOWN, PA.—Residents of Chestnut Hill want electric lights. It is contended that were a good man to take hold of the project, enough capitalists could be induced to enter into the scheme to form a stock company and erect a plant.

RICHMOND, IND.—The proposed municipal plant was voted down and a ten-year contract awarded to the Richmond Light, Heat and Power Company, composed of Dayton, Ohio, capitalists. The general sentiment is against this action of the Council.

THE LOUISIANA (MO.) ELECTRIC LIGHT COMPANY has passed into the hands of the Carbon Light Company, of which B. S. Reynolds is superintendent. Extensive improvements are being made, including a 170-h. p. Porter-Allen engine, and additional dynamos and a battery of new boilers.

THE HEALDSBURG ELECTRIC LIGHT AND POWER COMPANY, San Francisco, Cal., capital stock \$25,000, has been formed to construct electric plants, etc.; A. H. Babcock, B. R. Babcock, D. H. Ward, J. T. Ward, and A. S. Ward, Oakland, Cal., are interested.

DETROIT, MICH.—Sealed proposals will be received to Jan. 30 for labor and materials for necessary engines, boilers, dynamos, etc., for the proposed public lighting plant, as per specifications on file in the office of the Public Lighting Commission. Will. F. Conant, 511 Hammond Building, is secretary.

PATERSON, N. J.—The proposed \$300,000 electric lighting plant, to be operated by the authorities of Paterson, is meeting with strong opposition from prominent citizens. The Hon. George A. Hobart, president of the Passaic Water Company, is leader of the opposition.

LINWOOD, OHIO.—Sealed proposals will be received to Jan. 23 by the Board of Waterworks and Electric Light Trustees of Linwood for the erection of the primary feeders for the incandescent light system for the village, as per details to be had at the office of George Hornung, 30 East 4th street, Cincinnati, Ohio.

OMAHA, NEB.—The Omaha "Bee" reports that \$50,000 will be spent for improvements by the Electric Light, Heat and Power Company. The improvements will be new boilers and engines and incandescent dynamos, a power circuit, and the replacing of many of the old lines.

TOWSON, MD.—James McEvoy, William Lanahan, John A. Worley, William S. Paca and John Paca, have filed a certificate with the County Clerk for incorporation of the Suburban Electric Light and Power Company, of Baltimore County, to furnish light, heat and power.

MEADVILLE, PA.—A resolution has been adopted authorizing the authorities to engage an expert electrician to inspect and report on the condition of the city's electric lighting plant. The city clerk has been authorized to call for bids for repairing the electric lighting dynamo.

PLAINFIELD, N. J.—After some discussion in the matter of electric lighting contracts, for which the local Plainfield electric company and the Edison Electric Light Company are bidding, it was decided to refer the matter to the Committee on Fire, Water and Lamps.

GENEVA, N. Y.—The electric light station at Geneva is now in the hands of the new company. The street railway is an assured fact, as the Brush Company is under contract to furnish engine, boiler, dynamo, switchboard and four cars. Work will begin as soon as the frost is out of the ground.

AUGUSTA, GA., is desirous of having a large electric power plant installed to furnish power, from its excellent waterfalls, all over the city, to shops and factories. There is an electric power plant in operation, but its charges for power are \$60 per h. p. per annum. With a specially built electric power plant, the cheap water-power should enable electric power to be furnished at less than \$25 per h. p. per annum.

THE AUDUBON, IA., "Republican" says that the electric light plant in that city is a paying institution, and a net profit every

month is being appropriated to the payment of the debt. This plant is owned by the city and was put in operation about two years ago. The fact that it is paying a good profit over and above expenses is sufficient evidence that it is best for corporations to own and operate their own electric light plants.

SAVANNAH, GA.—The Brush Electric Light and Power Company, of Savannah, Ga., held their annual stockholders' meeting on Jan. 11. President S. P. Hamilton and all the old directors were re-elected, and three new directors added: Messrs. J. S. Collins, W. K. Wilkinson, and W. W. Mackall, which increases the Board to twelve in number. The company is in excellent condition and is soon to make some changes and additions to its plant. It is intended to consolidate the station and apparatus of the former People's Light and Power Company (which was united with the Brush Company several months ago) with the Brush Company's station, making one central lighting and power plant.

CLEVELAND, OHIO.—A committee of the City Council has recommended that the Corporation Counsel be instructed to draft a bill to be submitted to the Legislature requesting authority for the city to issue bonds in the sum not exceeding \$750,000, for the purpose of establishing a public electric light plant. This is the result of an investigation of alleged overcharges by the local electric lighting company. The committee further finds from the evidence submitted by expert electricians, that were the plant constructed under the latest improved methods, electricity could easily be furnished to the consumers at the price of 7 cents per thousand watt hours; but that the General Electric Light Company's plant is constructed in such manner that a reasonable and fair price would be 9 cents per thousand watt-hours, which price it recommends they be permitted by ordinance to charge. Testimony of expert electricians leads the committee to conclude that it would be possible and proper for the city, at a cost of \$600,000 or \$750,000 at the most, to erect a plant which would supply arc lights upon every street intersection in the city and about 15,000 incandescent lights, at a cost of 7 cents per thousand watt-hours to the city and consumers, and pay such dividends upon the investment as to make the plant pay for itself in fifteen to twenty years.

The Electric Railway.

POMONA, CAL.—A franchise has been granted C. G. Baldwin to construct an electric railway to China and Ontario.

BABYLON, L. I., N. Y.—A company is being formed to connect Babylon with Brentwood and other nearby places.

PORTSMOUTH, OHIO.—The City Council has sold the electric light plant to the Portsmouth Street Railway Company.

PHILADELPHIA, PA.—The directors of the Hestonville Railway Company have decided to trolley the road at a cost of \$1,200,000.

ORLANDO, FLA.—R. E. Green is interested in the proposed electric road to be built by the Orlando Street Railway Company.

SALT LAKE CITY, UTAH.—The City Council has granted a franchise to H. M. McCartney for an electric or cable street car line.

BURLINGTON, VT.—An electric road to connect Hinesburg and Burlington, Vt., by way of Shelburne, is being talked of in that section.

SUNBURY, PA.—The electric line of the Sunbury and Northumberland Street Railroad Company is to be extended to East Sunbury.

HYDE PARK, MASS.—It is stated on good authority that the West End Electric Street Railway lines will extend in the spring to Mount Hope.

BENTON HARBOR, MICH.—C. P. Wright, president of the new Lake Shore electric railway, is securing right of way from St. Joseph to Stevensville.

LOS ANGELES, CAL.—E. L. Clark, of the Consolidated Street Railway Company, states that work will soon be commenced on the proposed line to Pasadena.

WHITE PLAINS, N. Y.—The following are the committee in the matter of the proposed electric railway: Christopher Harmon, John T. Rehill, and E. B. Long.

NEW ORLEANS, LA.—The St. Charles Street Railway Company has applied for authority to make certain extensions to its line and to use electricity as a motive power.

HOMESTEAD, PA.—J. C. Whittle, of Beaver Falls, Pa., president of the proposed Homestead Street Railway Company, states that work will begin about the 1st of April.

BINGHAMTON, N. Y.—The Binghamton Street Railway Company will extend its line from Floral avenue to the Catholic cemetery, about one mile, at a cost of \$10,000.

ATLANTA, GA.—The Lithia Springs Railway Company, of Lithia Springs, in Douglas County, has secured the \$300,000 necessary for the construction and equipment of the road.

MOUNDVILLE, W. VA.—The surveying of the Benwood-

Moundville Street Railway line has been completed. W. C. Smith & Son, of Wheeling, W. Va., have charge of the work.

CAMDEN, N. J.—The trustees of the E. C. Knight estate have granted the application of the Camden Horse Railway Company for right of way for its proposed trolley through "Knight Park."

PITTSBURG, PA.—The Mayor's veto of the proposed charter for the Pittsburg and Mansfield Street Railway Company, has been sustained in Common Council by the narrow majority of one vote.

CHARLESTON, S. C.—It is stated on the best of authority that the City Railway is to be sold to a syndicate of Eastern capitalists, who will convert it into an electric line and extend and improve it.

WEST CHESTER, PA.—S. M. Patterson, president of the Pennsylvania Traction Company, announces officially that work on the new electric railway from Harrisburg to Philadelphia will be begun in the spring.

HARRISBURG, PA.—The Harrisburg "Call" contains mention of the proposed electric railway between there and Marysville, but no names are mentioned in connection therewith and no definite steps have been taken.

DAVENPORT, IOWA.—Electrician Fredericks, of the D. & R. I. Street Railway Company, has made specifications for the equipment of the bridge line with electricity, and they will be sent to Washington for approval.

NEW BEDFORD, MASS.—The Railroad Commissioner has granted permission to the Union Street Railway Company, of New Bedford, to issue \$350,000 additional stock and \$350,000 in bonds for use in building its proposed line.

WASHINGTON, D. C.—Vice-President Schoepf, of the Eckington and Belt Line Railroad, who is also interested in the proposed Baltimore and Washington electric road, states that the work on the latter road will commence at once.

LOOKOUT MOUNTAIN, at Chattanooga, Tenn.—Is to have another inclined cable railway to its summit. The new one is to run direct to the Lookout Inn. This means increased traffic for the connecting electric car lines to Chattanooga.

SOUTH NORWALK, CONN.—The Horse Railroad Company is before the Selectmen with a petition asking for approval of its proposed action to equip the Winnipauk branch with electricity. No opposition appeared, so the petition was granted.

BRIDGETON, N. J.—At a meeting held in Bridgeton a strong sentiment was manifested in favor of the proposed Bridgeton, Cedarville and Port Norris Railway Company, and there seems to be no doubt of the early commencement of work on the road.

MORRISVILLE, N. J.—The Morrisville Borough Council is now considering a petition from the Morrisville and Trenton Electric Road for a franchise for an electric road to be run as an extension of the lines of the Trenton Passenger Railway Company.

ATLANTA, GA.—A petition has been filed in the Federal Court of Atlanta, Ga., praying that a receiver be appointed for the Atlanta Consolidated Street Railway Company. The petition will be given a hearing on the 19th of January, at New Orleans, La.

ATTLEBORO, MASS.—Owing to the complicated condition of the affairs of the Attleboro, North Attleboro and Wrentham Street Railroad, President Peter Nerney has resigned, and has also tendered his resignation as a director of the Interstate Railroad.

THE NORTHWESTERN ELEVATED RAILWAY will, it is believed, undoubtedly use electricity as a motive power. From hints dropped here and there it is understood that a middle rail below the level of the wheel rails will be used to carry the electric current to connect with the motor car.

HARTFORD, CONN.—The Hartford "Telegram" states that no answer has yet been made by the company in the matter of equipping the four city lines with the trolley system, but it is reported that the Street Railway Company has met the proposition of the Common Council with a counter proposition.

CHARLOTTESVILLE, Va.—The City Council has granted the Piedmont Construction and Improvement Company a franchise to use some of the principal streets for an electric or cable railway. The members of the company have not yet been published. The franchise gives them 90 days in which to commence work.

MOHNSVILLE, PA.—It is expected that work will be commenced within two weeks on the proposed Mohnsville and Adamstown Street Railway Company. Among those interested are ex-Senator E. Billingsfelt, of Adamstown; George W. Keim, of Reading; H. C. Meen, of Adamstown, and Isaac Spatz, of Mohnsville.

BURLINGTON, VT.—A scheme is being pushed for an electric road from Burlington to Hinesburg and Shelburne, and a meeting was held at the residence of E. N. Sanctuary, of Hinesburg, Vt., at which the Hon. Isaiah Dow, of Hinesburg, presided, and it is almost certain that the road will be built.

ROME, GA.—The Electric Street Railway Company is in the hands of a temporary receiver, Mr. John H. Reynolds being appointed. The trouble seems to be dissension among the stockholders, of whom there are only four. A hearing on the application for a permanent receiver will be given on the 15th of January.

NEW HAVEN, CONN.—The Springfield "Republican" is the

authority for the statement that the New York, New Haven and Hartford Railroad will build the proposed electric road here and color is given to the statement by the fact that Superintendent Curtis and Engineer Spencer have been in Conway looking over the ground.

RICHLAND, VA.—Mr. Parrish, of Goochland, Va., has introduced into the Virginia Senate a bill to incorporate the Virginia Electric Railway Company, with power to erect electric plants and operate electric railroads in Richmond, Norfolk and other cities in the State.

SAVANNAH, GA.—The consolidation of the entire electric street railway interests of Savannah is probable. Mr. J. N. Harriman, of New York, who is largely interested in the combined City and Suburban and Coast Line Street Railways, has been in Savannah on a recent visit, where he held an extended conference with Mr. J. S. Collins, president of the Savannah Electric Railway Company. Mr. Harriman states that he and Mr. Collins are both willing to consolidate their two roads. Combination seems to be the word in Savannah.

MALDEN, MASS., has passed the West End order, a matter which has occupied more attention of the 1893 Board than any other question of the year. The order gives the West End road permission to use electricity as a motive power on all its lines in Malden, from the Everett to the Medford boundaries, on Main, Pleasant, and Ferry streets. There are a large number of conditions, the principal one being a 5-cent fare from any point in Malden to Scollay square, Boston. Assurance was given the committee that the West End road would accept the conditions at once and rush the equipment as fast as possible.

Personal.

JOHN D. CRIMMINS, from his connection with New York and

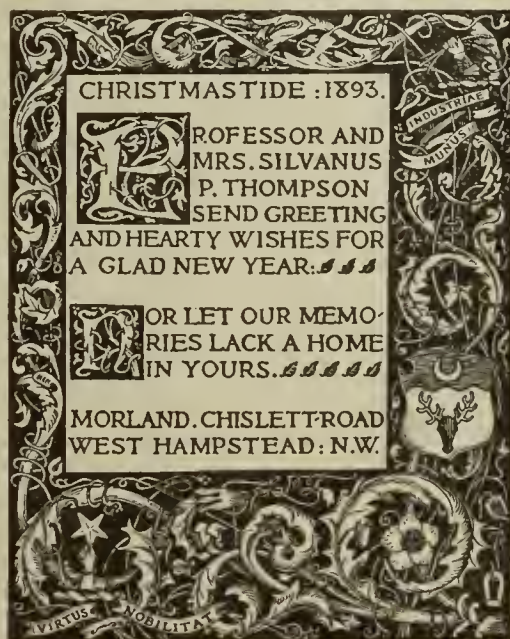


New Jersey electric traction enterprises and far-reaching plans for further extensions into the same field, has become an important auxiliary to the electrical industry, upon which his marked energy and broad views are already beginning to make a decided impression. Although Mr. Crimmins has not yet reached his fiftieth year, he has already a record of achievements that few men have attained in a long lifetime. As a contractor he has erected more than 400 buildings in New York, including the Lenox Lyceum, and helped build the aqueduct; he has served as a Park Commissioner for five years, is a member of the Real Estate

Exchange and Chamber of Commerce, a trustee of two banks, president of a land and improvement company, trustee of several charitable and religious societies—and the father of fourteen children. Mr. Crimmins' entry into the electric railway field has been recent, and it is rumored that the idea of the \$50,000 prize offered by the Metropolitan Traction Company for an economical street railway system originated with him.

PROF. SILVANUS P. THOMPSON, whose name is so familiar in this country, and whose face, we are happy to say, is not unknown to Americans, has given renewed evidence of his versatility by sending to his many friends the graceful New Year's greeting which is here reproduced. In combining a pretty idea with a bit of artistic design, Professor Thompson has been especially happy and has chosen a very effective way of placing himself in touch with his wide circle of acquaintances. We feel that we are not alone in returning to Professor and Mrs. Thompson the compliments of the season, and assuring them that there is little danger that their "memories lack a home in ours."

MR. HORACE R. WEMPLE and Miss Nellie L. Pope, daughter of Mr. Ralph W. Pope, secretary of the American Institute of Electrical Engineers, are to be married on Jan. 23 at Christ Church, Elizabeth, N. J. Their many friends will join us in extending to the young couple our best wishes for their future happiness.



Legal Notes.

CONTRACTS FOR STREET LIGHTING.—The lighting of streets by electric arc lights placed above the intersections of streets is not "street work," within the statute providing that in the erection of public buildings, and in all street and sewer work, it shall be done by contract let after notice by publication. (Electric Light and Power Company v. City of San Bernardino, Supreme Court of California, 34 Pac. Rep., 819.)

INJUNCTION AGAINST INFRINGEMENT OF TELEPHONE PATENT.—The Bell telephone patent, No. 186,787, is infringed by a machine which is perhaps a decided improvement in the addition of a second magnet, giving greater intensity and energy, but which does not change the operation of the parts. The fact that a patent is about to expire is no reason for refusing an injunction against an infringer who has invested his money in the business in the fact of repeated adjudications sustaining the patent. (American Bell Telephone Company v. Brown Telephone and Telegraph Company, Circuit Court, N.D. Ill., 58 Fed. Rep., 409.)

Miscellaneous Notes.

A GENEROUS CONTRIBUTION.—The Westinghouse interests of Pittsburg have donated \$10,000 to the relief fund for the unemployed in that vicinity. In addition, Mr. George Westinghouse, jr., has personally made liberal donations for the relief of families in distress at Wilmerding.

PROF. EDWIN J. HOUSTON, D.D., says the Philadelphia "Inquirer," has long been active in church work as a lay preacher, and recently delivered an address, non-sectarian in character, to the pupils of Girard College. He received his degree as a Doctor of Divinity in May last at Princeton.

DR. COTTON, who claims to have been the first person who ever applied electricity to the propulsion of cars, will give a lecture on Jan. 16, at the Church of the Messiah, Brooklyn, on the "Magnetic Telegraph," to be followed by various chemical and philosophical experiments and an exhibition of a circular road and electric engine, the one originally exhibited in 1847.

A USEFUL ALARM.—Superintendent Robinson, of the Whitman Electric Company, of Hingham, Mass., has an arrangement in his room by which a slight deflection or dying down of the brilliancy of the lights over town will ring a bell to awaken him from sleep. If anything happens at the station, the man in charge by turning down the lights an instant can ring Mr. Robinson's bell.

THE ELECTRIC LAMP IN MEDICAL USE.—Prof. Julius Friedenwald, at the Baltimore City Hospital, recently demonstrated to a class of medical students the use of the incandescent lamp for diagnosing diseases of the stomach. A quart of water was introduced into a patient's stomach, which distended it and at the same time floated a small incandescent lamp that had been swallowed. The light could be plainly seen through the abdominal wall and outlined the stomach.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS will hold its eighty-third meeting at headquarters, 12 West 31st street, New York City, on Wednesday, Jan. 17, at 8 o'clock, p.m. A paper will be presented by Louis Bell, Ph.D., of Boston, on "Practical Properties of Polyphase Apparatus." By direction of Council, the last report of the Committee on Units and Standards, will be presented for discussion, in which is proposed the provisional adoption of the terms, "gilbert," "weber," "oersted," and "gauss." The full report will be found on page 662 of the December "Transactions." The January issue of the "Transactions" will not be published until after the next meeting. Advance copies of Dr. Bell's paper will, if possible, be mailed upon application to the Secretary.

THE MASSACHUSETTS STREET RAILWAY ASSOCIATION held its regular monthly meeting and dinner at Young's Hotel, Boston, on Thursday evening, the 4th inst. The special subject for discussion was, "Electric Motors; Care of and Maintenance During Winter." Mr. Robert C. Brown, of the West End Railway Company, taking the lead in the discussion, followed by Mr. E. C. Foster, general manager of the Lynn and Boston Railroad Company; P. F. Sullivan, manager of the Lowell Street Railway Company, and Mr. E. P. Shaw, of the Haverhill and Amesbury Company, much valuable practical information being given. The subject of "Electric Heating," was also discussed briefly, Mr. Jas. F. Shaw taking the initiative and presenting the claims of the New England Heater. There was a good attendance of members, much to the gratification of President Cunningham and Secretary Butler, both of whom are doing excellent service in endeavoring to arouse a deep interest in these monthly meetings.

THE NORTHWESTERN ELECTRICAL ASSOCIATION will be in session at the Hotel Pfister, Milwaukee, Wis., commencing Jan. 17, 1894, at 2 p. m., and continuing three days. The original intention was to continue the meeting for two days, but the warm-hearted Milwaukee electricians have prevailed upon the Association to remain in session one day longer to allow the members time to visit the places of interest in the city. The Milwaukee Street Railway Company has generously placed at the dis-

posal of the Association a sufficient number of cars to convey the members to all points accessible by its lines. Among the proposed places to be visited are the Milwaukee Street Railway Company's new shops, which are perfect models, the power house of the Allis Company, the Pabst Brewing Company, the Edison Power Station, the Siemens & Halske Power Station, and the Badger Illuminating Station. On the evening of the second day a banquet will be given at the Hotel Pfister. Toasts will be responded to by prominent men in the profession, and a general good time is promised.

Trade and Industrial Notes

THE FOREST CITY ELECTRIC WORKS, Geneva, Ohio, after several months' idleness, resumed with a small force last week.

JOSE ELIGIO MOSQUERO, importer of electrical supplies and apparatus, Havana, Cuba, has removed from 114 O'Reilly street to 114 Ohio street.

THE STANDARD ELECTRIC TIME COMPANY, of New Haven, Conn., has shipped to San Francisco one of its electric tower clocks, which is to be placed in the Art Emporium at the Midwinter Fair.

ATLANTA, GA. Mr. Howard E. W. Palmer, general manager of the Southern office of the General Electric Company, has been elected director-general of the International and Southern States Exposition, to be held in Atlanta, Ga., in 1895.

THE NEW JERSEY LAMP AND BRONZE WORKS, New Brunswick, N. J., have issued a new catalogue of chandeliers, brackets, and hall lights, designed by a famous artist of France. Copies may be had upon application by the electrical trade.

H. P. HILL & CO., electrical contractors, No. 12 Arcade, Evansville, Ind., have just completed the installation of a city plant at Cammerton, Ind., and started out the new year by receiving a contract to put in a city plant at Williamsport, Ind.

THE MCGAHEY BROTHERS' FOUNDRY AND MACHINE WORKS, Elkton, Md., will build a new type of engine, for which Mr. Calvert R. McGahey has just been granted letters patent. A new type of balanced valve and automatic cut-off are the features.

THE UTICA ELECTRICAL MANUFACTURING AND SUPPLY COMPANY, Utica, N. Y., has elected the following officers: W. E. Lewis, president; W. H. Cloher, jr., vice-president; and M. Jesse Brayton, secretary and treasurer. R. D. Baldwin and F. S. Ferris are the additional directors.

THE L. J. WING AND COMPANY will hold its annual meeting of shareholders for the election of directors to serve for the ensuing year and for such other business as may be brought before it at the office of the company, 243 Washington street, Jersey City, New Jersey, on Thursday, Jan. 18, 1894, at 1:30 p. m.

THE KEYSTONE ELECTRIC COMPANY, of Erie, Pa., held its annual election on Jan. 3, and elected directors as follows: Hon. J. F. Downing, Carson J. Sturgeon, Captain George Platt, J. W. Leach and J. C. Sturgeon. The directors will organize on Thursday evening. The plant is being operated full time and with a good strong force.

THE HINE & ROBERTSON COMPANY, 57 Cortlandt street, New York, by consolidation with the New York Indicator and Specialty Company, now control the "Improved Straight Line" and the "Robertson-Thompson" indicators. These instruments are now used by some of the largest concerns in the country, with most satisfactory results.

THE R. THOMAS & SON'S COMPANY, East Liverpool, Ohio, has issued a catalogue of electrical porcelain, comprising 36 large lithographed pages. The list of porcelain electric fittings made by this enterprising firm is surprisingly large, and includes almost every imaginable shape of this material that can be used in the electrical industry.

CALENDARS—A. & J. M. Anderson, Brown Electric Company, Pettengill, Andrews Company, and Ziegler Brothers, Boston. The Commercial Cable Company and Direct United States Cable Company, New York, and J. W. Parker & Company, Philadelphia, have issued neat and artistic calendars, one of which may even be called surprisingly unique.

THE THOMSON ELECTRIC WELDING COMPANY, Lynn, Mass., has received some very good orders lately for welding dynamos from Western firms, which are to be built immediately. Recently the American Projectile Company shipped two carloads of the 50-pounder standard shells, 1,500 shells in all, about 75,000 pounds in weight, to the Brooklyn Navy Yard, where they will be distributed to the battleships of the American navy.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., reports great progress with the Packard Transformer. Two orders of nearly 1,000 lights capacity each, is the record for the past week in addition to numerous smaller orders in the past few weeks, aggregating over 1,000 lights. Reports from customers show a very high efficiency coupled with clear regulation and generally satisfactory results.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin,

Conn., are putting the roof on a building for the United States Government at Fort Wadsworth, N. Y. The building is 41 feet wide and 231 feet long, the roof being made entirely of iron—iron trusses covered with corrugated iron. The new works of the Stanley Electric Manufacturing Company, at Pittsfield, Mass., will be built entirely of iron by the same company.

T. W. NESS & CO., Montreal, Can., have been manufacturing main line and warehouse telephones for a number of years. The large number of testimonial letters submitted from leading business houses speak well regarding the satisfaction its instruments are giving. It is understood that the firm contemplates establishing a branch in the United States, for the manufacture of its various lines of telephones.

THE PAGE BELTING COMPANY, Concord, N. H., has had reproduced the diploma of highest award which it received at the World's Fair exhibit, as well as facsimiles of the two medals also awarded to it. These will be found interesting as souvenirs of the Exposition as well as for their artistic merits, the facsimiles of the medals particularly so in view of the controversy just started in regard to them.

CHARLES A. SCHIEREN & CO., 45 Cliff street, New York, have just furnished a 55-inch perforated electric belt, three-ply, for the Lindell Street Railway Company, St. Louis, Mo., length about 150 feet. They think business is picking up somewhat in the electric line, and there seems to be increased demand for their perforated electric belting. Perforations are found to prevent air cushions and hence are more noiseless and can be run with greater slack upon the pulleys.

THE INTERIOR CONDUIT AND INSULATION COMPANY, 44 Broad street, New York, has issued a catalogue of Lundell motors and dynamos, which is in every respect one of the most artistic and handsome trade pamphlets ever issued by any firm. The cuts of the various machines are in keeping with the typographical and artistic execution of the catalogue, and form another illustration of the unrivalled excellence of the work of Bartlett & Co., the engravers.

THE COWLES ELECTRIC SMELTING AND ALUMINUM COMPANY, of Lockport, N. Y., writes to say that there is no truth in the rumor of a consolidation between it and the Pittsburg Reduction Company. It adds that no negotiations of the kind are even pending and that the Cowles Company has no intention of moving its plant to Niagara Falls. The works at Lockport are still in operation and the company is prepared to furnish aluminum and its different alloys as heretofore.

QUEEN & CO., INCORPORATED, Philadelphia, have a line of very good commercial ammeters and voltmeters in the "magnetic vane" type, which they have manufactured in large quantities for several years. These instruments are designed for light and power plants, and when placed on a switchboard, will indicate current or potential all day long. They are mounted in handsome cases, to present an attractive exterior, and are dust-proof as also weather proof; at least as much so as possible, with first class switchboard instruments.

F. R. CHINNOCK has taken a pleasant office in the Central Building, 143 Liberty street, New York City, room 618, where he would be pleased to see his many friends and former customers. Mr. Chinnock will hereafter do a general electrical contracting business for the installation of complete electric and steam plants, and also act as consulting, electrical and mechanical engineer. He has started in with his usual vim and vigor, and will undoubtedly meet with his former success, as he has already several large contracts booked.

ALBERT AND J. M. ANDERSON, 289 A street, Boston, Mass., have issued a handsomely printed circular showing a few forms of Aetna railway insulators and line material in general use. A facsimile is included of a very complimentary letter from Mr. F. S. Pearson, late chief engineer of the West End Road, as follows: "I would say that the Brooklyn City Railroad Company, of Brooklyn, and the West End Street Railway Company, of Boston, have used this material in large quantities, in fact, almost exclusively for the last two years, and, so far as I have been able to see, it has given good satisfaction in every particular. I have no hesitation in recommending this line material."

JAMES HUNTER MACHINE COMPANY, of North Adams, Mass., announces to the trade that on account of increasing competition and a tendency toward lower prices, as well as to facilitate the delivery of goods, it has decided to handle exclusively and sell directly, all goods of its manufacture, which were formerly sold throughout New England and the Middle States by H. N. Bates & Co., of Boston, Mass. These goods comprise the well-known Hunter patent friction clutch pulleys and cut-off couplings, as well as power transmission machinery of every description. The company's complete new plant, equipped with all modern machinery, enables it to handle large orders and maintain a uniform high standard of excellence. It constantly keeps in stock a large line of shafting, pulleys, hangers, etc., and can fill orders at short notice. The Boston office of the company, in the Bell Telephone building, corner Milk and Oliver streets, is in charge of Mr. Richard H. Hill, a mechanical engineer of thorough training and wide experience.

THE ANSONIA ELECTRIC COMPANY announces that after

careful consideration the directors have decided to withdraw their offer of compromise made to the creditors some months since, of paying 60 cents on a dollar, and give as the reason for this decision the following: The proposition was not accepted promptly by all the creditors, and on account of this the concern has almost entirely lost the benefit of the fall trade, which in the electrical supply business is altogether the best of the year. If the compromise had been accepted at once when made, the directors believe that it could have been successfully carried out. In addition to the above, the business has become to a considerable extent disorganized in Chicago, for the reason that the assignee, by orders of the court, has been obliged to conduct the business within quite narrow limits; so that at the present time the Chicago branch is not in nearly as good shape to continue as a going business as it was at the time the proposition was first made. The directors are now considering, in the interest of a proposed reorganization, the matter of making another offer to the creditors, and if, as hoped, some financial assistance outside of the company is obtained, another proposition will be laid before the creditors. This will of necessity be lower, but it is hoped to make it in the shape of a cash offer.

THE HIGHAM ELECTRIC COMPANY, 431 Shawmut avenue, Boston, will soon place on the market an arc light system which promises to give interesting and important results. Prof. Hooper, of Tuft's College, reports as follows on its commercial features: "The system possesses some remarkable advantages over all other systems. I have found that with fully developed (not hissing) arcs the stability of current is maintained entirely by the action of the regulator; that 50 per cent. above the working current the 'characteristic' of the dynamo does not begin to droop; that the field magnets were far below the degree of saturation

that other arc light dynamos demand; that the reaction of the armature is small, being comparable with that of 'constant potential' (incandescent) rather than arc light dynamos; that there is no destructive sparking at the brushes, either at full load or on short circuit; that at full load the resistance of the dynamo is only about 5 per cent. of that of the whole circuit; that the losses due to hysteresis, eddy currents, windage and friction of the brushes and bearings, is only about another 5 per cent. of the full load; that sections of the field magnet coils were cut in and out of circuit by the regulator without perceptible sparking at the sectional commutator; this is largely due to the small amount of wire on the field, the amount being several times less than is on other arc light machines; I feel that I can fully substantiate the claims made by the owners of this system, that they have a commercially successful arc dynamo which can be manufactured at far less cost than other arc dynamos, and at the same time, will have a commercial efficiency in the neighborhood of 15 per cent. higher than the best arc dynamos of the present day; the system is unique; being a complete departure in its mode of regulating and 'stabling' the current from all other systems of arc lighting."

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED JAN. 2, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

11,389. Reissue. ELECTRIC CONNECTION; H. Sanche, Detroit, Mich. Application filed June 20, 1892. The combination of a binding post, superposed telescopically engaged terminals, wires passed through the terminals and coiled between the same and a binder screwed down on the binding post in engagement with the adjacent terminal.

11,397. Reissue. ELECTRICAL CONNECTION; H. Sanche, Detroit, Mich. Application filed June 20, 1892. The combination of a perforated terminal piece provided with a shank, a companion piece engaged therewith, and a wire passed through the perforation in the terminal piece and coiled around its shank.

511,758. ELECTRIC MOTOR; W. A. Crocus, Chicago, Ill. Application filed Oct. 11, 1892. This comprises a field magnet consisting of sheet metal plates extending in parallel planes, a field coil extending around the plates, holes in the plates, bolts extending through the plates, and a nut adapted to fit on each end of the bolts to hold the plates together and at the same time form a guard for the field coil.

511,763. TROLLEY; W. F. Duncker, Steelton, Pa. Application filed Aug. 26, 1893. A trolley having a pulley and provided at opposite sides of the same with separate outwardly tapering conical bodies provided with spiral grooves.

511,787. SELF-CLOSING TELEGRAPH KEY; H. E. Moss, Kansas City, Mo. Application filed Aug. 21, 1893. This comprises a spring-actuating rod, one end of which is provided with an insulated handle for contact with the thumb, while the other is adapted to be held by the spring in circuit, and a slotted guide sleeve carried by the key lever through which the rod operates.

511,791. AMMETER AND VOLTMETER; J. Perry and C. E. Holland, Application filed April 6, 1893. In a measuring instrument, such as described, the combination with a magnifying spring, a lever, a piece of soft iron, a coil, and index-hand, of a regulating spring attached to a lever, and means for adjusting the tension of the regulating spring. (See illustration.)

511,821. STORAGE BATTERY SYSTEM OF DISTRIBUTION; J. Trumphy, Hagen, Germany. Application filed Aug. 1, 1893. The combination of a motor, a shaft actuating a suitable switch for including a greater or less number of cells of battery in circuit, an electromagnetic clutch adapted to connect the shaft and motor, and means for maintaining the circuit, said clutch continuous during a predetermined movement of the switch.

511,822. STORAGE BATTERY SYSTEM OF DISTRIBUTION; J. Trumphy, Hagen, Germany. Application filed Aug. 1, 1893. In a circuit changer, the combination of a supported circular conducting rail, contacts mounted thereon, but insulated therefrom, a contact-brush bridging the rail and contacts, and an arm carrying the contact-brush mounted on a spindle.

511,824. TROLLEY MECHANISM FOR ELECTRICALLY PROPELLED VEHICLES; C. H. Veeder, Lynn, Mass. Application filed Nov. 23, 1892. A trolley having an insulated wire inclosed in its pole, and extending from the trolley-wheel to insulated connections contained in its standard.

511,853. TROLLEY WIRE SUPPORT; C. T. Lee, Boston, Mass.

Application filed April 15, 1893. The combination of metallic strips temporarily soldered to the ear, and of sufficient length to be bent around the conductor to hold it by the ear while permanently secured thereto.

511,862. ELECTRIC LOCOMOTIVE FOR ELEVATED TRACKS; C. H. Roberts, Nantwell, Ohio. Application filed Oct. 29, 1891. A suspended track beam provided with upper and lower track rails, in combination with upper trucks whose wheels engage the upper track rails, and lower trucks suspended from the trucks by longitudinally yielding hanger rods.

511,866. ELECTRIC ALARM FOR CANE FEEDERS; A. F. Slingerup, New Orleans, La. Application filed April 28, 1893. The combination of an endless carrier, a movable magnet mounted in juxtaposition to the carrier, and a circuit changer operated through the movement of the magnet.

511,873. ELECTRIC CIRCUIT CONTROLLER; R. Callender, Brantford, Can. Application filed April 24, 1893. A normally open circuit including a magnet having a reed armature adapted to vibrate for a determined period on a single closure of the circuit, in combination with means whereby a second circuit is closed by the reed armature at the termination of its vibratory period.

511,874. TELEPHONE EXCHANGE SYSTEM; R. Callender, Brantford, Can. Application filed March 12, 1893. An automatic telephone exchange, comprising telephone lines, signal storing mechanism, signal distributing mechanism and means for thereby uniting the lines in individual pairs.

511,875. TELEPHONE EXCHANGE SYSTEM; R. Callender, Brantford, Can. Application filed Aug. 13, 1892. A series of telephone lines each connected by two branch wires to two independent circuit breakers adapted to break the circuits of all the lines save the signalling line, in combination with electromagnetic means for controlling the movement of both circuit breakers.

511,882. TELEPHONE TRANSMITTER; S. C. Drew, Boston, Mass. Application filed Jan. 23, 1893. This comprises a diaphragm and a resistant electrode adapted to be placed in circuit, combined with a magnet arranged to be directly influenced by the vibrations of the diaphragm, and by its changes in form act upon and vary the resistance interposed by the electrode in the circuit.

511,883. REGISTERING APPARATUS FOR TELEPHONES; A. R. Duperu, San Francisco, Cal. Application filed Nov. 17, 1892. The combination of two telephones, the line wires permanently connecting the same, a recorder located at one of the telephones in the circuit of the line wires, a double contact switch key interposed in the line circuit for throwing an auxiliary current into the line, the auxiliary being closed by the shifting of the switch key.

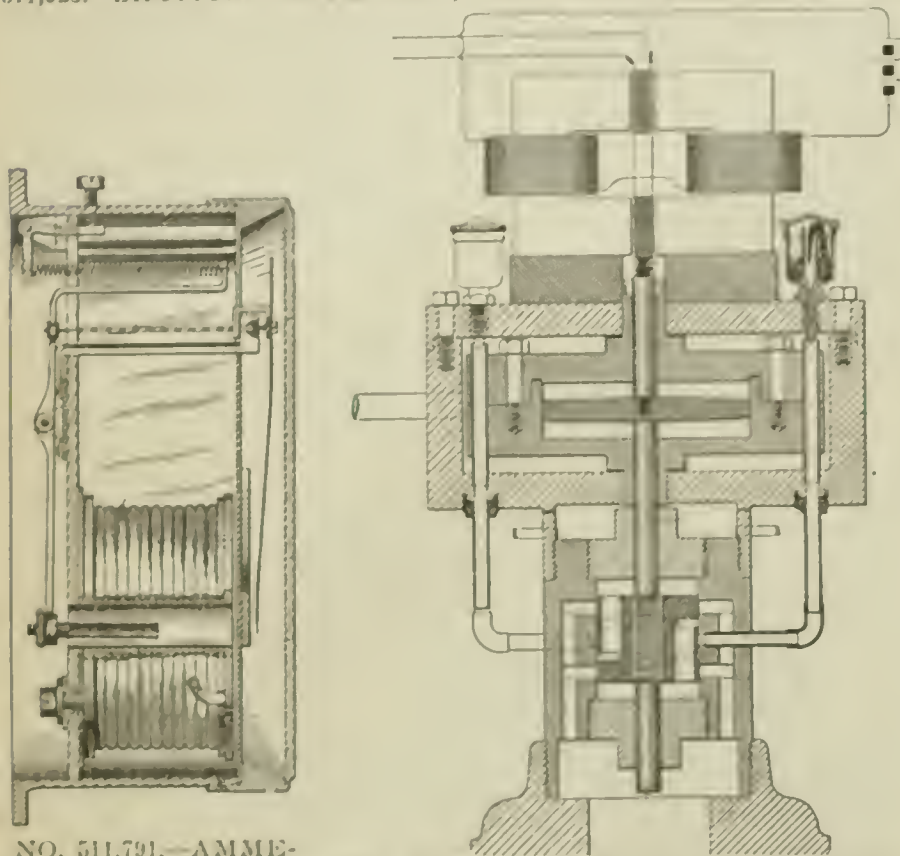
511,889. ELECTRIC SWITCH; J. L. Hinds, Syracuse, N. Y. Application filed May 16, 1892. This comprises a terminal support fixed to a base plate having a bearing opening and arms extending outwardly from the walls of the opening, a terminal mounted in the bearing opening, a clamp for drawing the arms together and securing the terminal to its support and an electric wire secured to the terminal.

511,915. ELECTRICAL TRANSMISSION OF POWER; N. Tesla, New York, N. Y. Application filed May 15, 1888. The method

of operating electromagnetic motors having an independent energizing circuit, which consists in passing an alternating current through one of the energizing circuits and inducing by such current the current in the other energizing circuit of the motor.

511,916. **ELECTRIC GENERATOR**; N. Tesla, New York, N. Y. Application filed Aug. 19, 1893. The combination with a piston of a moving conductor of an electric generator in direct mechanical connection therewith. (See illustration.)

511,928. **SECTION INSULATOR**; H. M. Brockbank, Brooklyn,



NO. 511,791.—AMMETER AND VOLT-METER.

NO. 511,916.—ELECTRIC GENERATOR.

N. Y. Application filed Aug. 21, 1893. The combination of a strengthening strap secured to the insulator by a bolt, the bolt being provided at each end with a nut having an eye for the attachment of the span wires.

511,941. **TROLLEY CATCHER**; G. E. Gay and J. H. Parsons, Augusta, Me. Application filed Feb. 28, 1893. The combination of a disc having projections on one side and rigidly attached to a shaft, winding springs, a casing adapted to revolve on the shaft and a dog adapter to engage with the projection on the disc.

511,953. **PUSH BUTTON**; C. D. Hunking, New York, N. Y. Application filed Jan. 6, 1893. This comprises the circuit terminals a transparent opening, a pivoted index needle in or below the same, and a magnet in the circuit of the terminals to operate the needle.

511,946. **ELECTRIC CLOCK**; F. L. Gregory, Niagara Falls, N. Y. Application filed April 19, 1892. The combination of a vibratory clock actuating lever carrying long radius projection and a shorter radius projection, and an electrical terminal, the switch having an arm and detent rim, and a pivotally supported switch-lock having an arm.

511,988. **ELECTRIC LOCOMOTIVE**; E. M. Bentley, Boston, Mass. Application filed Oct. 24, 1891. This comprises a motor supported on a frame journaled on the axles of the car, the armature of the motor having a gear-wheel engaging with a pinion and journaled on a hollow bearing loosely surrounding the axle, and a flexible or yielding coupling between the gear-wheel and the axle.

512,027. **REGULATOR FOR CONTINUOUS CURRENT ARC LIGHT CIRCUITS**; D. Higham, Boston, Mass. Application filed May 14, 1892. The combination of a current controlling device with means for producing in a branch circuit current waves differing in phase from current waves in the main circuit and adapted to act upon the controlling device to render stable and to regulate the main current.

512,050. **ELECTRICALLY CONTROLLED RAILWAY SIGNAL**, F. McBrien, Newark, N. J. Application filed July 23, 1893. In a block system, the combination of a magnet in each block circuit adapted to be closed by the passage of wheels through the end of the block, a short circuit around the magnet controlled by a relay, and a track circuit governing the relay, whereby the short circuit remains closed while a train is in the block.

512,051. **ELECTRICALLY CONTROLLED RAILWAY SIGNAL**, F. McBrien, Newark, N. J. Application filed Sept. 25, 1893. In a railway signal, a mechanically operated signal set by a passing train, a releasing magnet for the signal, and a circuit-closer operated by the signal when set to close a circuit containing the releasing magnet, and thereby restore the signal if operated without the presence of the train.

512,055. **CARTRIDGE-SHELL BATTERY**; J. J. Pearson, Brooklyn, N. Y. Application filed Jan. 28, 1893. A battery formed of

an outer protecting shell, a zinc lining, a silver chloride cylinder furnished with a zigzag wire for supporting the silver chloride cylinder, elastic supports for the cylinder which compensate for the expansion and contraction of the shell, electrolytic cylinder placed in the shell and surrounding the silver chloride cylinder, leaving a gas chamber and a seal for closing the end of the battery cell, formed partly of elastic material and partly of inelastic material. (See illustration.)

512,077. **ELECTRICALLY CONTROLLED RAILWAY SIGNAL**; J. Wayland, Newark, N. J. Application filed Oct. 5, 1893. A system comprising a plurality of blocks or sections, an automatic signal for each block, a circuit controller operated by the signal mechanism, a releasing magnet in the circuit controlled thereby, and circuit connections from the sides of the releasing magnet to the track rails.

512,102. **TRANSMISSION OF RAPIDLY ALTERNATING ELECTRIC CURRENTS**; W. H. Eckert, New York, N. Y. Application filed Oct. 11, 1893. This consists in generating a number of rapidly alternating currents and the transmission of such currents over a bimetallic conductor of iron or steel combined with copper.

512,115. **ELECTRIC CURRENT REGULATOR**; A. B. Jones, Cleveland, Ohio. Application filed June 10, 1891. This comprises adjustable magnets, an armature lever, a resistance box, movable conducting disc, the disc being supported by an arm on the armature lever, and an adjusting winding post connected with an arm of the lever.

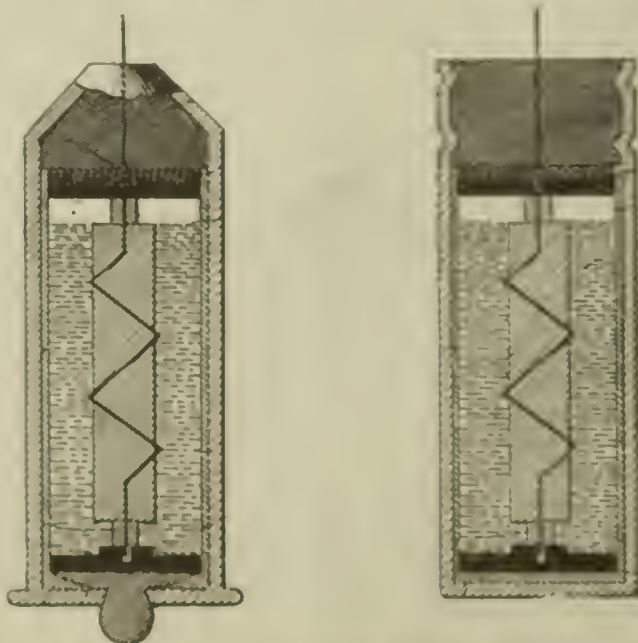
512,146. **WIRE COVERING MACHINE**; W. H. Avis, Toronto, Can. Application filed June 7, 1893. One or more arms carrying bobbins of yarn, in combination with a revolving spindle to which the arms are attached, and a dish containing suitable insulating compound fixed to the revolving spindle, and through which compound the strands to be covered therewith are carried.

512,201. **OVERHEAD TROLLEY WIRE SWITCH**; G. W. MacKenzie, M. B. Sloan, and T. C. Sloan, Beaver, Pa. Application filed Dec. 30, 1892. This comprises two arch pieces connecting the separate ends of the main and branch wires, and bridge pieces pivoted at the ends of the branch wires, and arranged to connect both ends with the main wire.

512,214. **COMPOSITE TELEPHONE AND MULTIPLE TELEGRAPHIC TRANSMISSION**; F. A. Pickernell, Newark, N. J. Application filed Aug. 25, 1893. The combination with the main wire of a double-wire circuit, of a retardation or choking coil in the main circuit, a condenser in an earth branch thereof, a similar coil in the artificial line and a similar condenser in the earth branch thereof.

512,217. **ELECTRIC CALL**; P. M. Randall, Concord, N. H. Application filed May 6, 1893. The combination of a clock, a circuit-closing commutator consisting of an insulating disc with an opening allowing the clock hands to protrude, and a plurality of holes in radially arranged pairs, and a wire passing out through one and back through the other, of each pair of holes, to form commutator bars.

512,227. **REGULATOR FOR DYNAMO ELECTRIC MACHINES**; C. E. Scribner, Chicago, Ill. Application filed Dec. 29, 1887. A



NO. 512,055.—CARTRIDGE SHELL BATTERY.

method of regulating the current supplied to a working circuit, which consists in changing coils of the field magnets from a shunt to a series relation with the working circuit, and vice versa; whereby the strength of the field magnets is changed.

512,250. **ELECTRIC INDICATOR**; A. H. Hoyt, Manchester, N. H. Application filed March 15, 1893. The combination of a pointer and its arbor with a movable bearing piece or presser, a spring arm, and knob, for actuating the same.

512,253. **SECONDARY BATTERY**; W. C. Lockwood, New York, N. Y. Application filed Aug. 6, 1892. A method of constructing electrodes for storage batteries, consisting in depositing metallic tin in a spongy or flocculent state from a solution of chloride of sodium and chloride of tin, by electrolytic action.

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OUR PATENT RECORD.

Hereafter we shall give in our patent record a weekly list of patents which have expired during the preceding week. This feature, we think, will be found of interest by our readers, and especially to inventors, who may have been deterred by the existence of fundamental patents from perfecting improvements.

RAPID TRANSIT FOR NEW YORK.

The proposition of the Wilson syndicate for constructing an underground rapid transit system in New York seems to be an ideal plan, both from a public and engineering standpoint. The underground feature obviates the barbarous desecration of the streets by unsightly structures and the further increase of the intolerable noises, whose continuance with the present elevated system makes it impossible for New York to be favorably compared in an aesthetic sense with any of the great cities of Europe, and renders some of the most desirable parts of the city intolerable for residence besides largely detracting from their business value. As a feature of the Wilson plan is that the cars are to be propelled, lighted and heated by electricity, the electrical fraternity will take a warm interest in the success of the scheme, which might with great benefit be made to take the form of an organized support of the measure before the Legislature and Constitutional Convention. The impetus which the adoption of the scheme would undoubtedly give to electrical traction in general should enlist the direct aid of all those connected with the electrical industries, while the immense benefit to the residents of New York of the adoption of this system over the proposed extension of the elevated railway should cause them to exert their utmost endeavors in its support. With such a method of traction as that proposed, electricity would have an ideal opportunity to make manifest its advantages, and the demonstration would have its effects in many other directions on the hundreds of thousands who would thus daily experience benefit from its use.

THE DESIGN OF ELECTROMAGNETS.

In another column Mr. E. R. Carichoff makes an important addition to our knowledge of the design of electromagnets, which, indeed, may be considered one of the most practical contributions to the subject yet made. Prof. S. P. Thompson and others have pointed out in a more or less general way the principles governing the design of electromagnets for various purposes, but so far as we know, no one had heretofore shown how they were to be applied, as regards the point referred to, to specific cases. By the method given not only may a magnet be exactly designed for a given purpose, but by changing the polar area to satisfy the condition of maximum effect magnets already designed may be made more efficient. The one point of weakness in the method is the necessity of knowing the iron curve, as it would not be practicable to determine this for each case, although with Kennelly's apparatus for this purpose, described in these columns several months ago, it would not be a matter of much difficulty to do so. It would be interesting to have tests made on different commercial irons used in electromagnets in order to determine if the variation is sufficient to affect the method proposed, and to furnish curves from among which the proper one may be selected for a specific case, should the variation exceed an amount which otherwise would render the method described inapplicable.

HEINRICH HERTZ.

By the death of Heinrich Hertz at the early age of thirty-seven years, science has suffered an affliction even greater than through the similarly premature deaths of Pascal and Fresnel. What he had already done for science had come to be regarded as merely a foretaste, and the entire scientific world was confidently relying on the genius of the young German professor for extensions of his researches, even to the final mysteries which nature has so long and carefully guarded from the covetous mind of man. It should be borne in mind that the researches of Hertz have not merely a bearing on the phenomena of electricity and light. The mechanism of molecular physics, which carries with it almost the solution of the problem of the universe itself, was concerned, and therefore the loss through his death is not confined to the scientific world alone, but intimately concerns the entire human race. While thus the master spirit is gone, the field he opened up and the impetus he gave to research remain, and will doubtless be accelerated now that scientific workers are thrown upon their own resources by his untimely death and can no longer rely upon his genius for further extensions. In another column we print a heartfelt tribute of Dr. Oliver Lodge to his late friend and co-worker, which expresses strongly the great esteem in which the charming personal character of Dr. Hertz, in which the modesty of true genius was predominant, was held by those who had the honor of his acquaintance.

PROF. ROWLAND'S SUIT.

The report of the court proceedings in the suit of Prof. Rowland against the Cataract Construction Company, which we print elsewhere, has an interest not usual in legal cases. The testimony gives more of an insight of the genesis of the Niagara plans than has heretofore been permitted, and the side light thrown on the business features of "experting" is also not without interest. From the testimony it would appear that there is a distinction recognized in the "profession" between an "expert" and an "expert witness"—the latter being presumably one whose chief qualification lies in bringing out the strong points of a case and dodging the weak ones rather than in the possession of actual scientific knowledge in regard to the subject matter of a case, which also explains the equivocal professional standing of many so-called experts, and the prejudice becoming attached to the word. The verdict of the court is a recognition of the undoubted value of Prof. Rowland's services to the Niagara project, although, probably on account of the estimate of the plaintiff in his original bill of \$10,000, it does not award anywhere near the amount claimed in the present suit. The claims, however, in regard to originating the main features of the plans adopted for the Niagara transmission are not settled by the verdict, and still remain undecided as far as the public is concerned. The testimony of Prof. Rowland on the one hand and Prof. Forbes and Mr. Rankin on the other are diametrically opposed on some of the most important points. While Prof. Rowland claims credit for settling the question of frequencies, various details of the electrical machinery and transforming apparatus, Prof. Forbes testified that all of the essential features of the plan adopted were determined upon before he had seen Prof. Rowland's report, and the Westinghouse company has claimed that the design of the dynamo originated with their engineers. As the counsel for the defense virtually acknowledged the great value of Prof. Rowland's services aside from any question of priority, no direct effort was made in the suit to bring up this question, but we trust that in view of the claims and counter claims made, both here and in Europe, the Construction Company will feel it but fair to all concerned to authorize the publication of a

history of the Niagara plans from the beginning, and thus set at rest a disagreeable controversy, and also add an exceedingly interesting chapter to engineering literature. The policy of secrecy pursued by the company is at the bottom of much of the suspicion with which its motives have been viewed, and has also resulted in placing some of its professional advisers in an awkward position that a more open policy would have avoided.

RELATIVE COST OF COPPER FOR CONDUCTORS.

The articles elsewhere by Messrs. Bell, Kennelly and Steinmetz form the most important contribution yet made to the subject of the relative cost of conductors in different electrical systems, and may be said to definitely settle a question in regard to which but little information has heretofore existed. Both Kennelly and Steinmetz call attention to an obvious correction to the results calculated in the article upon which they comment, in regard to the additional saving in the two-phased system by having the current density the same in each of the three wires of that system. This introduces a correction of about three per cent. in the results there calculated and brings them into exact conformity with those given by Kapp. The extension of the comparison by both of these writers is interesting. Mr. Kennelly shows that while by a different connection in the three-phased system a saving of 300 per cent. may be obtained on the basis of effective E. M. F., the insulation stress is not changed, which illustrates the worthlessness of comparisons on that basis. Both writers agree that there is no fair basis of comparison, as we have pointed out before, between direct and alternating current systems, and Steinmetz calls attention in addition to the electro-chemical stress of continuous currents, which he states is generally far more severe than the electrostatic stress. As an important complement to the mathematical demonstration is Dr. Bell's account of a practical proof of the saving of copper in the three-phased over the simple alternating system, which will doubtless set the matter at rest in the minds of those who think of mathematics as a mere system for juggling with figures—in which supposition, it may be remarked, they only too often have reason. The criticism of Mr. Steinmetz in regard to our remarks on the importance of line insulation would be perfectly just if the statement referred to were taken in an absolute and not in a comparative sense, as meant, though we now see that it was ambiguously expressed. The idea intended to be conveyed was that until a practical limit of insulation stress was reached, comparisons between alternating current systems based upon insulation stress alone would not be just. That is, the undoubted superiority of the three-phased system in this respect over other present systems would not assume the weight indicated by the ratio expressing it until actual practical difficulties of insulation intervened. With the voltages that have been thus far used, or are now proposed for use, it does not appear that we have approached a limit of insulation that would as yet justify any great weight being given to the additional insulation stress of one system over that of the other, though, of course, when such a practical limit is reached, or when the difficulties of insulation become proportional to the increase of voltage, this factor will assume its full importance.

The Berliner Suit.

We are informed by the attorney for the government that the evidence in support of the bill of charges in the Berliner suit is in, the evidence of the defense nearly in, and that it is the present expectation of the counsel that the evidence on both sides will be completed and the cause ready for hearing before next summer.

Dr. Heinrich Hertz.

The death of Dr. Heinrich Hertz, which took place at Bonn on Jan. 1, robbed the world of one of its most brilliant young scientists. In the thirty-seventh year of his age, with an enviable record for the past, and a genius and energy possessed by but few, he gave promise of achieving even more important results in the future, and of attaining a still greater reputation.

He was the son of Dr. Gustavus Hertz, and was born at Hamburg on the 22d of February, 1857. His primary education was received in a private school, supplemented by one year in the high school. At the age of eighteen he decided to become a civil engineer, and devoted himself to special studies in that direction, but finding that it would require years of work to gain a livelihood from this profession and that the work itself was full of monotonous details, he abandoned the idea, and after serving his time in the army he went to Munich in 1878, where he studied physics under Von Helmholtz. In 1880 he became assistant to that great physicist, and three years later accepted the chair of theoretical physics



HEINRICH HERTZ.

at Kiel. From 1885 to 1889 he was professor of physics in the Technical High School at Karlsruhe, and in 1889 he succeeded the well-known physicist, Clausius, at the University of Bonn, where he remained until his death.

Dr. Hertz had a charming personal character and possessed in a marked degree that modesty which is so often characteristic of true genius.

The investigations of Prof. Hertz were principally in electricity, and his experimental discovery of the relation between light and electricity created a profound sensation in scientific circles. In brief, he proved that the rays of electric force follow the same laws of transmission, reflection and refraction as the rays of light; in fact, that they are only light rays of much greater wave length. Dr. Oliver J. Lodge, who is peculiarly well qualified to pass judgment upon Prof. Hertz's work, has given the following estimate of that scientist in the current number of the London "Electrician":

"Not a student of physical science on the planet but will realize and lament the sad loss conveyed by the message, 'Hertz is dead.' After thirty years of study and preparation, he achieved his great discovery in the comparative quiet and

isolation of Karlsruhe, and now, only a few years later, his work for the human race is over, and he has entered on a new career.

"Ever since he went to Bonn he has been ailing; he was never strong, apparently, as a child, and his friends have long been anxious about him. A little time ago he seemed to be mending, and we heard better accounts; but since the serious winter began he grew worse, and with the incoming of the new year he passed out of our ken, not yet thirty-seven years of age.

"It is not the time to attempt a critical estimate of his work. The greater part of his short life was spent in thorough equipment of himself for the successful quest of the unknown among the most solid and difficult branches of science. Up to the age of twenty-one he studied as an engineer—an admirable training for a physicist, as many can testify. Then he graduated at Berlin, and became assistant to von Helmholtz. Here the writer first made his acquaintance thirteen years ago, when, on calling upon the distinguished professor of physics at the University of Berlin, Hertz did the honors of the laboratory.

"During the years at Berlin he published many investigations and theses of a weighty, not to say ponderous, order, and became known in strictly scientific circles as a learned and rising physicist of whom much might reasonably be expected. In 1885 he became professor at the Technical College at Karlsruhe, and in 1889 he received his call to succeed Clausius in the University of Bonn. But it was during an investigation begun in 1887, at the instance of Prof. von Helmholtz, on some obscure phenomena occurring in induction coil circuits that led him to that brilliant series of experiments which have immortalized his name, and may even be said to have created an epoch in science. July, 1888, saw the publication of the most striking memoir of that series, and at the Bath meeting of the British Association in that same year all the world was advised of the discovery by Fitzgerald, then president of Section A.

"Had it not been for the preparedness of British physicists in this matter Hertz's discovery might have been left to leak out gradually, and be more or less misunderstood for the course of ten or twenty years, as usual. Continental science, was, in fact, by no means ripe for a clear appreciation of these experiments, and even now it is surprising that a Continental philosopher should have thus reaped the fruits of the theoretical seed sown in England. However, so it was; Hertz stepped in before the English physicists, and brilliantly carried off the prize. He was naturally and unaffectedly pleased with the reception of his discovery in England, and his speech on the occasion of the bestowal of the Rumford medal by the Royal Society will long be remembered by those who heard it for its simple-hearted enthusiasm and good feeling. His letters are full of the same sentiment, and there is no doubt that, in addition to being a capable and well-armed investigator, he was also a modest and courteous gentleman. We hoped many times to see him at one of the meetings of the British Association, where he would have been sure of a cordial welcome, but every year he had to excuse himself—once on the ground of military service demanded of him at some autumn manoeuvres. It is strange to remember that such a man, with his rare combination of experimental facility with high mathematical equipment, was regarded by his nation not only in the light of a university teacher, but also as a locomotive unit capable of emitting and receiving bullets. However, this compulsory military service may have conferred upon him some needful relaxation and change of thought, if the discipline was not too trying for his state of health.

"In addition to his physical investigations it may not be generally known that Hertz was also genuinely though not

obtrusively or actively interested in certain modern discoveries in experimental psychology, and he was a corresponding member of the Society for Psychical Research. Some experiences of his in this connection had made a distinct impression upon him, and he was prepared to examine into the possible truth of phenomena such as a short time ago would have been by most men in his position scouted as hopelessly improbable or absurd.

"It would be a mistake to suppose that his best known research is all we owe to him. He made experiments on the time of contact of elastic bodies of certain shapes before they rebounded, and a minor or collateral discovery of his concerning the curious effect of ultra-violet light in promoting electrical discharge has led to a long series of experiments, and seems likely to afford important assistance in the difficult task of disentangling the relations between electricity and matter—the most promising and suggestive branch of modern physical chemistry.

"But the writer does not intend to be drawn into a comment on Hertz's scientific work; he feels too keenly the serious blow which the loss of so young and capable a man entails upon all workers in the same regions of science.

"We have lost the skill and power of work, the trained judgment, the patience and store of learning with which he was endowed; and those that are left must close up the ranks and advance as best they can without the aid of that able and friendly co-worker."

The Meeting of the American Institute of Electrical Engineers.

The eighty-third meeting of the American Institute of Electrical Engineers was held Wednesday evening, Jan. 17, at headquarters, 12 West Thirty-first street, with President Houston in the chair. The paper of the evening was read by Dr. Louis Bell, the subject being "Practical Properties of Polyphase Apparatus." The paper is one of unusual excellence, and with the very able and lively discussion which followed made the meeting one of the most notable in the history of the institute. Such a paper was particularly welcome in view of the great falling off in the character of many of those read during the present Institute year, and as a consequence the attendance was very large, and included an unusual proportion of the more eminent members of the institute, who are only attracted by papers of intrinsic merit.

The paper was compactly written, and though not of inordinate length, contained much information. The principal points considered were the starting and running torques of polyphased motors; relative merits of biphased, triphased and higher phased apparatus, including circuits; also the question of the best frequency, with reference to arc and incandescent lighting, power transmission and the mechanical exigencies of construction of apparatus.

The discussion was of an important character and participated in by Mr. Stanley, who gave a very interesting account of his company's biphased plant in Pittsfield, Mass.; by Mr. Steinmetz, Mr. Crosby, Mr. Darlington, Dr. Pupin and Mr. Mailloux. Profs. Forbes and Rowland, although present, did not join in the discussion.

Mr. Steinmetz is always interesting, but on this occasion he was unusually so. He said that the rotation of a copper disc by a rotary magnetic field produced by stationary electromagnets was described by Arago. In reply to Mr. Stanley's claim for the merits of condensers and his disparagement of synchronous motors, Mr. Steinmetz also said that properly designed synchronous motors had a condenser action of their own, obviating the necessity of separate condensers, and also called attention to the fact that he had made this statement before at an institute meeting. He stated that he had made experiments on the frequency at which flickering was

visible and found that the greater the brilliancy, that is, the higher the temperature, the higher the frequency at which flickering was visible. With the usual brilliancy the flickering at 18 or 20 periods was abominable and at 30 still perceptible. Mr. Crosby said he would like to ask, inasmuch as the personal equation entered largely into the matter of flickering, whether any one else had observed the lights at the same time with substantially the same results. Mr. Steinmetz said that Mr. Eickemeyer was present, also Prof. Forbes and some workmen, and that all arrived at substantially the same conclusion.

After the discussion the report of the Committee on Units and Standards was read, recommending the names Gilbert, Weber and Gauss for C. G. S. units. This was objected to by Messrs. Wolcott, Steinmetz and Mailloux, and finally, on the motion of Mr. Mailloux, the report was laid on the table.

The report of the Committee on Revision of Election Rules was read by the secretary of the institute in the absence of the chairman, Dr. F. Benedict Herzog. It makes certain recommendations requiring that the balloting envelopes emanating from other sources than the secretary's office shall be marked "unofficial," and that the number of votes in nominations shall be placed opposite the name of each candidate on the "general proposal list" accompanying the ballots distributed. This report, which is designed to prevent a recurrence of the disgraceful election tactics employed last year at the annual election, will come up for discussion at a future meeting, and its adoption or rejection will have a vital bearing upon the future prospects of the institute. It is very much to be regretted that action was not taken at the present meeting, in view of the approaching annual election.

The following are the recommendations of the Committee on Units and Standards, signed by Kennelly, Crocker, Geyer and Hamilton:

The provisional adoption of

The term "gilbert" for the C. G. S. unit of magnetomotive force, the same being produced by 0.7958 ampere-turn approximately.

The term "weber" for the C. G. S. magnetic unit of flux, sometimes described as the C. G. S. line of flux.

The term "oersted" for the C. G. S. unit of reluctance.

The term "gauss" for the C. G. S. unit of flux density, or one weber per normal square centimetre.

The committee, it will be remembered, in its previous report, dated June 20, 1891, advocated that the above terms should be accorded to magnitudes in conformity with the "practical" electromagnetic system, and therefore following in natural order and extension from one volt, ohm, ampere, and other units in universal use.

As, however, so important a series of new unit magnitudes could only meet with general recognition and favor under the authorization of an international electrical congress, which authorization has been withheld at the recent congress at Chicago, and since objections have been raised to those magnitudes, your committee considers that the urgent need for names specifying the principal quantities dealt with in magnetic circuits can best be met with general favor by adopting for those names the fundamental unit magnitudes of the International C. G. S. system after the precedents already established in the cases of the C. G. S. units of force and work, entitled respectively the "dyne" and "erg."

At the meeting of council held on Jan. 17 the following associate members were elected:

Comfort A. Adams, Jr., Cambridge, Mass.; U. N. Bethell, New York City; Francis Broadnox, New York City; Joseph Broich, Brooklyn, N. Y.; Sigfried H. Ende, New York City; Thomas Francis Flanagan, Portsmouth, N. H.; Bertram P. Flint, New York City; James Mason Knox, New York City; Wynn Meredith, San Francisco; Max Osterberg, New York City; R. L. Selden, Jr., Deep River, Conn.; George F. Sever, New York City; Charles Henry Smith, Atlanta, Ga.; Sidney Sprout, San Francisco, Cal.; George A. Wardlaw, Oswego, N. Y.

The following associate members were transferred to full membership:

W. L. R. Emmet, New York City; Nathaniel S. Keith, San Francisco, Cal.; Alton D. Adams, Worcester, Mass.; C. E. McCluer, Richmond, Va.; J. P. Jackson, State College, Pa.

Long Distance Transmission with Continuous Currents.

BY FRANK C. PERKINS.



ALTERNATING currents can be successfully used for transmission of power over long distances, as has been clearly demonstrated during the past few years. Some prominent electrical engineers insist that multiphase motors should always be used for long distance transmission. There is, however, no doubt that under certain conditions direct current apparatus may be made to give excellent results.

A very interesting plant has just been completed by Mr. M. Thury, of Geneva, Switzerland. Mr. Thury is electrician for Cie. de l'Industrie Electrique Geneve. At this installation about 400 h. p. is transmitted over a distance of about twenty miles, by means of continuous currents. The potential used on the line is between six and seven thousand volts.

The increasing production of the Biberist paper mills,

After having passed through the turbines of the hydraulic plant of the Frinvilliers mills, the waters of the Suze are collected into a canal and carried through short tunnels to the generating station. The head of water at that place amounts to fourteen metres; and the volume, although varying widely, according to the period of the year, is nearly always sufficient to generate 400 h. p. The generating station is located on the left bank of the river, close to Frinvilliers, and occupies a special building. A 400-h. p. turbine, built by Escher, Wyss et Compagnie, of Zurich, revolves on its vertical shaft at 120 revolutions per minute and drives, by means of bevel wheels and pinions, two dynamos, placed one on each side. These dynamos, built by Compagnie de l'Industrie Electrique Geneve, are six pole generators of the Thury system. The field magnet cores and pole pieces are made entirely of wrought iron; the armature has a Gramme winding and is very carefully insulated. At 275 revolutions per minute these dynamos generate a current of 40 amperes with 3,300 volts. They have been tested at 4,700 volts without affecting the insulation in the least. This would give 9,400 volts when the two machines are connected in series. The regular working potential is, however, but 3,300 volts

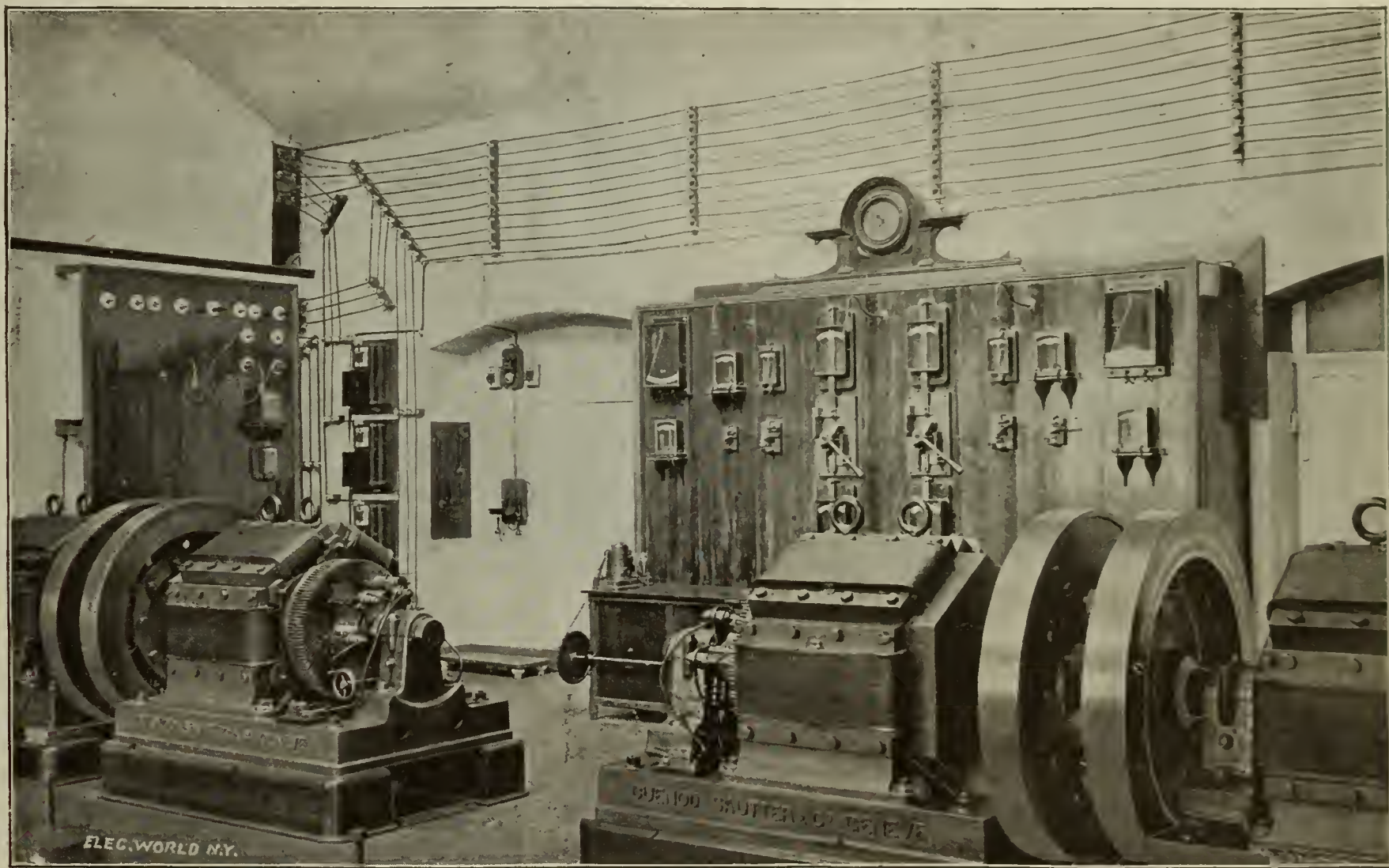


FIG. 1—DIRECT CURRENT TRANSFORMERS.

near Soleure, was such that very soon the available motive power on the spot would be insufficient to carry the machinery required. It was, therefore, necessary to consider how to supply the additional power; and the managers of the works, advised by Prof. Denzler, of the Zurich Polytechnicum, showed much enterprise.

The Ronchatel & Frinvilliers paper mills, near Bienne, are under the same management as the Biberist mills. Their machinery is driven by water power supplied by the Suze; and between the two mills, which are about two-thirds of a mile apart, the head of water available without interfering with the working of the mills was found to be sufficient to develop 400 h. p. as an average all the year round. The distance between Frinvilliers and Biberist is about thirty kilometres, and it was decided to transmit the motive power available by means of electricity.

each, or 6,600 volts in series. They are insulated by means of thick layers of mica, and the bed plates are supported at a certain level above the ground by strong porcelain insulators, as shown in Fig. 2. The commutator is 75 centimetres in diameter, and is formed of 442 segments, or sections, of hard drawn copper, insulated with mica. The current is collected by 18 carbon brushes. The commercial efficiency of these machines, as tested by Prof. Denzler, reaches 93 per cent., while their weight is less than 7 1-2 tons.

They are electrically connected in series, and supply at the generator end of the line a current of 40 amperes at 6,600 volts, with a drop of 600 volts, or 10 per cent., upon the line at full load.

Bare copper conductors are used in the line construction, which are seven millimetres in diameter. The line is entirely aerial and passes through the mountainous country

lying between Frinvilliers and Biberist. From its position, it is very liable to be struck by lightning, and for this reason a number of lightning arresters have been placed on the poles besides those at the generating and receiving stations.

The two motors at the Biberist mills are exactly like the generators in construction and design. They are connected in series on 6,000 volts and deliver about 155 h. p. each at 200 revolutions per minute. The commercial efficiency of the installation from the shaft of the turbine to the motor shafts exceeds 75 per cent. at full load.

Mr. Thury has also installed a plant at Oynax, France, which has been in operation for some time with great success. In this installation direct current transformers are used at the receiving station for reducing the potential from 2,000 volts to 120 volts.

Some of the latest types of machines for this purpose have two armatures and one set of field coils; one armature to receive the current at high potential, being driven as a motor, while the other delivers a much larger current at low potential. Other direct current transformers have two windings on the same armature and one set of field coils.

The machines designed by Mr. Thury for this purpose, shown in Fig. 1, consist practically of a generator and motor with shafts directly connected; two armatures and two separate fields being used. The motor receives the current from

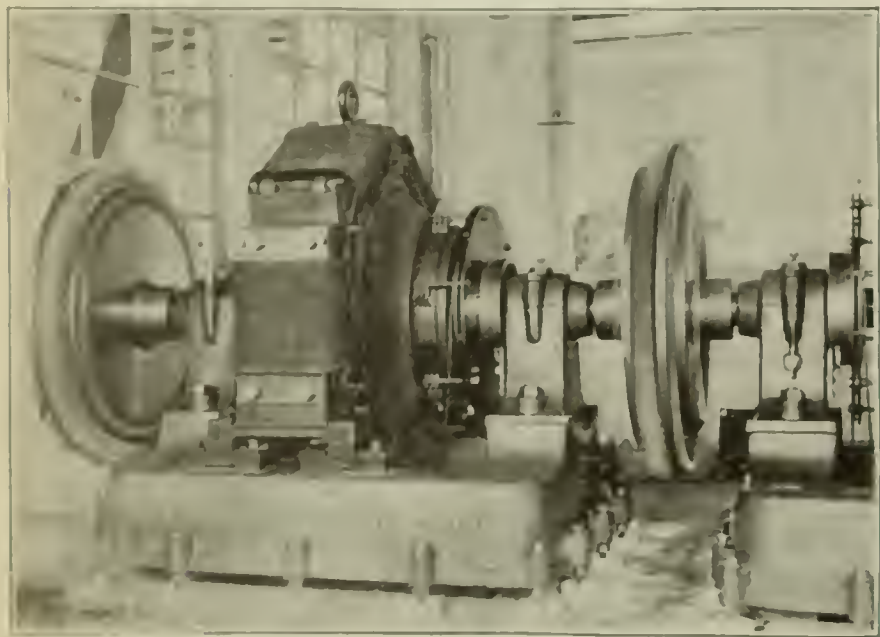


FIG. 2.—MOTOR STATION AT BIBERIST

the line at from 1,800 to 2,000 volts, and drives the generator, which delivers a current of 600 amperes at 120 volts. Each motor develops about 120 h. p.

At the generating station there are two turbines of 150 h. p. each. A generator of 105,000 watts capacity at 2,000 volts is directly connected to each turbine, as shown in Fig. 3.

The distance between the generating and receiving stations is about eight kilometres. A net efficiency of 76.2 per cent. is obtained in this transmission.

The method of connecting the generators to the turbines differs from that at Biberist in that the generator shaft and turbine shaft are directly connected and revolve horizontally, while at Biberist the turbine has a revolving vertical shaft and the generators have horizontal shafts.

A Current Without a Difference in Potential.

In a recent after-dinner chat, the following problem arose: Suppose an air condenser be made of two metallic cylinders or rings, one slightly smaller than the other, and contained inside of it, thus forming the equivalent of the two cylindrical coatings of a Leyden jar. When charged, suppose the outer one to be fixed and the inner one to revolve around its axis; if the charges are contained, or held, in the metal, and

if they remain at rest with respect to each other, that is, if they are independent of the motion of the metal, then, if a current is electricity in motion, there will be a current circulating through the revolving ring, because the charge remains at rest while the ring itself moves; there would then be a current, but there would be no difference of potential between two successive points on the ring, that is, there would appear to be a current without a difference of potential. It might be, however, that the charge in the revolving ring is not held at rest by that in the outside ring, as its path, if it moved together with the metal, would be along equi-potential lines, in other words, it might be like, with gravity, which does not tend to hold a body moving over a horizontal surface. In that case, it seems that the charge must move together with the metal, and, again, if an electric current is electricity in motion, this revolving ring carrying the electricity with it would be the equivalent of a current and would therefore have an effect on a fixed magnetic needle placed near it; it would again be a current without a difference of potential. In this case the effects, if they exist, would probably vary with different velocities of the ring, and it would then be possible to have such a thing as an electric current in which the electricity may be made to travel at any desired velocity. The negative result of such an experiment might at least show that a current is not electricity in

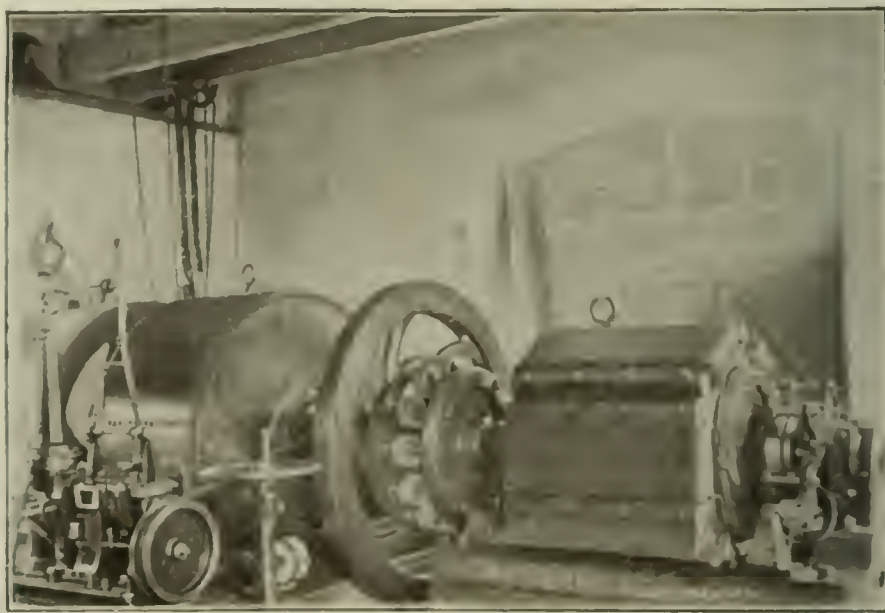


FIG. 3.—GENERATING STATION AT OYNNAX

motion. If the two rings are fixed and a magnetic needle be made to move in the dielectric, between them, around the same axis as that of the rings, it would seem that it should be deflected into a definite position, showing the existence of a magnetic field; this, as was understood from a recent lecture by Prof. Elihu Thomson, might explain the existence of the earth's magnetism, supposing the earth to be one plate of a condenser, the space around the earth forming the other conductor, or plate, of the condenser, the magnetic needle revolving with the surface of the earth, and therefore moving between these two changes.

The University Extension Lectures:

The first of the course of ten lectures on electrical subjects was delivered in the Cooper Institute Building on Monday, Jan. 15, by Mr. C. O. Mailloux, the subject being "Batteries, Primary, Secondary and Thermo." The attendance was so large that almost one hundred persons had to be turned away. Hereafter the large hall in the Cooper Building will be used.

It Is About Time.

It is noteworthy that electric light carbons are now being made in England, says the London "Electrical Engineer."

The Saving of Copper in the Three-Wire, Three-Phase System.

BY DR. LOUIS BELL.

Within the last few months this subject has received attention from nearly every electrician of repute who is in the least interested in alternating work. Up to date the discussion has been entirely on theoretical grounds, and, indeed, this is all that is really necessary, since we may take Ohm's law for granted and the mathematical processes involved in the necessary computations are neither difficult nor complicated. The results which have been reached are in substantial accord on the point that there is in the interconnected or three-wire, three-phase system a saving of 25 per cent. over the copper required, all other conditions being equal, by the single phase or any polyphase system employing a complete circuit per phase. Inasmuch, however, as an experimental demonstration speaks more clearly to the mind of the average man than any amount of theorizing, I have recently performed some experiments for the purpose of satisfying those unfamiliar with mathematics, or stubbornly unwilling to accept mathematical demonstrations, as to the exact facts in the case. The experiments were of the simplest possible character, consisting of the transmission of energy over a three-wire, three-phase line and a single-phase line under conditions that could be most carefully controlled. Four non-inductive lines of equal length were set up leading to a small bank of lamps. The four wires were then arranged two in parallel and single-phase current at 50 cycles per second transmitted over them, the voltage at the dynamo and at the lamps and the amount of energy being carefully noted. This terminated the first part of the demonstration. Next, one of the four lines was removed and the three remaining lines used to transmit three-phased current at 50 cycles to the same bank of lamps connected in the mesh combination. The net result was as follows: With the same initial voltage and the same energy transmitted the same loss of energy was observed with the three-phase system and three wires as had previously been found with the single-phase system and the four wires. In other words, the same amount of energy was transmitted at the same loss with three-quarters the weight of conductor. The agreement with the theoretical saving of 25 per cent. was within one per cent., sufficiently close to render the demonstration complete. Now let us see what this really means; it signifies that by the use of the interconnected three-phase system we can transmit the same energy with the same loss as in the single-phase system, using but three-quarters the amount of copper. Or, it means that with the same amount of copper we can transmit more energy with the same loss, or the same energy at a higher efficiency. So far as the economy of the system is concerned, the interconnected three-phase circuit is equivalent to a rise in voltage of about 15 per cent., without, however, introducing the added strain on the insulation that would be met if the voltage of the generator were actually raised 15 per cent.

To deny the saving in the interconnected three-phase system, therefore, is equivalent to denying an advantage in increased voltage. No matter by what process the amount of copper required to meet given conditions be computed, whether by an assumed drop on the line or by rigid application of Lord Kelvin's law, the fact still remains that the three-phase system has 25 per cent. advantage over the single-phase system in the intrinsic amount of copper required to do the same work. It might be desirable in special cases not to let this saving appear as a decrease in the cross-section of the copper, but to take advantage of it in increased output or in increased efficiency. Whatever the character in which the saving in copper may appear, it is always existent, and although a Jesuitical attempt to conceal it may suppress it in

a certain particular function, it will always appear somewhere and somehow as an absolute saving in the transmission system, just as must be the case with a genuine increase of voltage, and he would indeed stultify himself who would attempt to conceal the advantage of increased voltage in the electrical transmission of power.

Relative Costs of Distribution by Different Electrical Systems With the Same Effective or Maximum E. M. F.

BY A. E. KENNELLY.

In Mr. Weaver's interesting article upon this subject, appearing in *The Electrical World* for Jan. 13, page 48, two of the conclusions reached appear open to some modification.

First. In the deduction by aid of Figs. 5, 6 and 7, that the triphase and diphas systems require equal weights of conductor when equal effective delivery pressures are employed, it is evident that this applies only to the delta triphase system. If the accompanying diagram of a Δ triphase system be exchanged for Fig. 7, the effective pressures, as measured at the lamps, will be the same as before, but the current in each main conductor will be 2 amperes instead of $2\sqrt{3}$.

This arrangement will cause the delivery to the six lamps to be accompanied by a loss in the mains of $3 \times 2 \times 2 = 12$ watts, introducing, therefore, a saving of 75 per cent. in the copper needed for simple alternating current distribution.

On the basis of maximum E. M. F. between conductors this difference between the Δ and Δ varieties of the triphase system does not appear.

Second. There appears to be a flaw, although from a practical point of view an insignificant one, in the result quoted in Mr. Weaver's article for the diphas system. Fig. 6, page 48, represents three equal wires carrying three currents that are not all equal in strength. From the examination of any exaggerated case of this nature, it becomes evident that the purposes of economy can best be served by apportioning the total copper unequally among unequal currents. In this case, suppose each wire to weigh 100 pounds, making 300 pounds total weight. Then it follows arithmetically that the most economical division of this copper gives 87.9 pounds to each outside conductor (resistance 1.138 ohms), and the balance of 124.2 pounds to the return wire (resistance 0.805 ohm). The loss in delivery will now be $2 \times 3 \times 3 \times 1.138 + (3\sqrt{2})^2 \times 0.805 = 34.97$ watts instead of 36, making the relative copper expenditure 291 lbs. instead of 300. This appears to agree with Mr. Kapp's estimate.

Summing up, then, on the basis of Mr. Weaver's results, with the above slight modifications, we have for the relative loss of energy in the same weight of conductor on the different systems, or for the relative expenditure of copper for the same loss in transmission by the different systems:

	On basis of equal	
	Effective E. M. F. at translating device.	Maximum E. M. F. between conductors.
Continuous current (metallic circuit).....	100	100
Simple alternating current (metallic circuit).....	100	200
Diphas with common return wire.....	73	291
Triphase Δ system.....	25	150
Triphase Δ system.....	75	150

To these may be added other well-known systems for the sake of comparison:

	On basis of equal	
	Effective E. M. F. at translating device.	Maximum E. M. F. between conductors.
Continuous current three-wire, allowing 60 per cent. of outside copper to neutral wire.	32.5	...
Five-wire continuous current system, allowing also 60 per cent. of outside copper to inside wires.....	11.9	...

Relative Cost of Copper for Conductors.

BY CHAS. P. STEINMEIZ.



N The Electrical World of Jan. 13

I read a very interesting article by Mr. W. D. Weaver on the copper economy of systems of electrical distribution, to which I would like to add a few remarks, not to dispute any of the numerical results, since obviously scientific results derived by mathematical analysis are proved beyond doubt by the innate exactness of mathematical reasoning, but merely to add a few additional remarks to this question, to which I have given a good deal of attention also.

First, instead of "effective" potential, I should prefer the expression "comparison on the basis of equality of minimum potential," since in this comparison whenever systems are compared having different potentials in their different branches—as the interlinked quarter-phase system—it is the minimum potential which is made the basis of comparison, and, further, because this basis of comparison is of interest and importance only in circuits supplying apparatus which require a definite low potential, i. e., in the low potential incandescent lighting networks.

In this case, of low potential incandescent lighting circuits, still more efficient in copper than the three-phase or quarter-phase system is the old Edison three-wire system, single-phase, or continuous current, which requires only 37.5 per cent. of the copper of the two-wire system if the neutral wire is made of the same cross-section, and 31.3 per cent. if the neutral wire is made of one-half the cross-section of the outside wire. Since by this system the potential of distribution is doubled, and since the amount of copper required in a given system is inversely proportional to the square of the potential, by the use of this system the theoretical amount of copper is reduced to one-fourth, and adding hereto the amount of copper used in the neutral wire gives the above mentioned figures.

With regard to the interlinked quarter-phase system, i. e., the quarter-phase system with common return for both phases, Mr. Weaver considers the case only where three equal wires are used. In this case the current density in the central wires or common return is 41.4 per cent. higher than in the outside wires, and therefore the disposition of the copper is not the most economical. Making the central wire of 41.4 per cent. larger cross-section than the outside, we get the most economical condition and thereby reduce the amount of copper required in the interlinked quarter-phase system in the ratio

$$1 = \frac{3 + 2\sqrt{2}}{6}, \text{ or } 100 \div 97.13.$$

We get then the following table:

LOW POTENTIAL INCANDESCENT LIGHTING CIRCUITS
COMPARISON ON THE BASIS OF EQUALITY OF MINIMUM POTENTIAL IN
THE SYSTEM

To transmit the same power over the same distance with the same loss of power, that is, with the same efficiency, the amounts of copper required are:

2 Wires—Single phase; continuous current.....	100.0
3 Wires—Edison 3-wire, single-phase system, neutral 1-2 cross section.....	31.2
Edison 3-wire, single-phase system, neutral full cross section.....	27.5
Interlinked quarter-phase system.....	72.9
Three-phase system.....	75.0
4 Wires—Four-wire, single phase system, inside wires, 1-2 cross section.....	16.7
Four-wire, single-phase system, inside wires full cross section.....	23.2
Three-phase system, with neutral wire.....	33.3
Independent quarter-phase system.....	100.0

5 Wires—Five-wire, single-phase system, inside wires 1-2 cross section.....	10.9
Five-wire, single-phase system, inside wires full cross section.....	15.6
Independent quarter-phase, with common neutral...	31.3

To compare the different systems in the simplest and most elementary manner, we have to dissolve them in their component systems of equal nature, i. e., in one-wire systems, by considering all the currents as issuing from the generator over the wires to a neutral point or centre of potential, where they neutralize each other.

Then the single-phase system of potential e consists of two one-wire systems of potential $\frac{e}{2}$ each.

The three-phase system of potential e between lines consists of three one-wire systems of potential $\frac{e}{\sqrt{3}}$ each.

Since the amount of copper is inversely proportional to the square of the potential, other things being equal, the amount of copper in the single phase and in the three-phase systems bears the ratio:

$$\left(\frac{e}{\sqrt{3}}\right)^2 \div \left(\frac{e}{2}\right)^2 = 4 \div 3;$$

or the three-phase system requires 75 per cent. of the copper of the single-phase system.

The interlinked quarter-phase system with three equal wires is produced from the independent quarter-phase system with four wires by making one wire the common return of both phases, whereby the loss, and therefore the efficiency, is not changed, and 25 per cent. of the copper is saved, but at the same time the maximum potential increased by 41.4 per cent.

With regard to the comparison of continuous current with the alternating current system on this basis, I beg to differ. While on the basis of the same maximum potential, i. e., the same electrostatic stress, the continuous current requires only 50 per cent. of the copper of the single-phase current, this comparison is not fair and not permissible, since a continuous E. M. F. produces not only an electrostatic stress like the alternating potential, but besides this an electrochemical stress by electrolysis, which is generally by far more severe than the electrostatic stress. It can, therefore, only be misleading to compare continuous current systems on the basis of electrostatic stress with alternating circuits, and is of no practical interest either, since at these high potentials the continuous current is out of competition anyway.

Hence, leaving the continuous current out altogether, we get by a comparison on the basis of maximum potential in the system, as it is proper with regard to the stress on the insulation and danger to life, the following results:

COMPARISON ON THE BASIS OF EQUALITY OF MAXIMUM POTENTIAL IN
THE SYSTEM.

To transmit the same power over the same distance with the same loss of power, that is, with the same efficiency, the amounts of copper required are:

2 Wires—Single-phase system.....	100.0
3 Wires—Three-phase system.....	75.0

$$\text{Interlinked quarter-phase system } \frac{B + 2\sqrt{2}}{4} \times 100 = 145.7$$

Interlinked quarter-phase system, with 3 equal wires..... 150.0 |

4 Wires—Independent quarter-phase system.....	100.0
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Coming now to the editorial remarks that the factor of the line insulation is of no direct importance, since circuits have been worked successfully with 16,000 volts* and the limit of potential not yet reached, I am somewhat astonished at this statement, for, according to this reasoning, it would be inexcusable to throw away large amounts of copper on expensive lines of 3,000 volts, when by merely increasing the

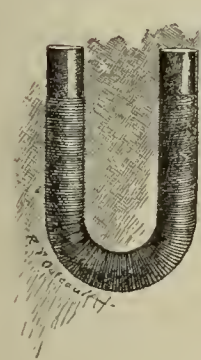
*While such potentials have been used on long-distance lines, it must be understood that practical experience has by no means yet proved such potentials as successful and reliable in the long run.

potential ten fold, 99 per cent. of this copper could be saved. While it is undoubtedly true that potentials of 16,000, or even 25,000, volts can be controlled and insulated successfully, it is just as true, for instance, that in mechanical engineering pressures of 2,000 or 3,000 pounds per square inch have been handled and controlled, and yet nobody in designing a steam engine or a locomotive will think for a moment of using such pressures, though undoubtedly the boilers and engines would become smaller and more efficient thereby.

Hence, while it is possible, theoretically, to insulate for any potential whatever, practically it makes a very great deal of difference whether one has to deal with 2,000 volts or with 20,000 volts, and every increase of potential increases the difficulty of constructing and maintaining the system and reduces its reliability. Therefore, while it is theoretically possible to handle far higher potentials, and perhaps in future such potentials will even be used in practice with complete reliability, still the factor which limits and determines the maximum potential in the system is exclusively the strain on the insulation, so that in high potential circuits the comparison on the basis of equal maximum potential is not only not of secondary importance, but, on the contrary, the fundamental factor which determines the choice of the potential and the reliability of the system.

On the Design of Electromagnets for Specific Duty.

BY E. R. CARICHOFF.



EXIGENCIES demanding the design of an electromagnet to perform a specific duty where maximum efficiency was necessary and no experimenting permitted, the writer made some preliminary calculations, and found that with certain conditions the best results were obtained by reducing the polar area, and with other conditions the best results were obtained by increasing the polar area. After going through the excellent work of S. P. Thompson on the electromagnet and not finding there or elsewhere any formulated statements showing the proper relation that should exist between the magnetic reluctance of the air gap and the iron of the magnet, the writer tabulated a lot of results and finally hit upon the following easy method of determining the relative air gap and iron reluctance in order to get the maximum work out of a given magnet, where work equals initial pull times travel.

The writer offers this with the belief that it is entirely original, although it seems strange that so simple a relation has never been pointed out before.

To explain the method, let us assume, for example, that the curve in Fig. 1, $OEC D$, represents our iron, and OF our air gap characteristic, and that we are working at the point C on said curve. Reduce the polar area A by dA , and suppose that the force is reduced for an instant by $d\mathcal{F}$, so that the induction in the air gap is still $\mathcal{B}$ and that in the iron is reduced by $\Delta \mathcal{B}$. Since a tangent drawn to the curve at C is parallel to the line OF , we see that the force necessary to produce a change $\Delta \mathcal{B}$ in the induction is the same in both iron and air gap. Therefore, if $d\mathcal{F}$ produces in iron a change $\Delta \mathcal{B}$, it can produce $\frac{1}{2} \Delta \mathcal{B}$, say $d\mathcal{B}$ in both.

It is evident that with the above assumptions

$$\frac{\Delta \mathcal{B}}{\mathcal{B}} = \frac{dA}{A} \text{ and } d\mathcal{B} = \frac{1}{2} \mathcal{B} \frac{dA}{A}.$$

With area A and induction $\mathcal{B}$ the pull is proportional to $\mathcal{B}^2 A$.

With the area $(A - dA)$ and the induction $\mathcal{B} + d\mathcal{B}$, we have $(\mathcal{B} + d\mathcal{B})^2 (A - dA)$ proportional to pull.

Then

$$\mathcal{B}^2 A < = > (\mathcal{B} + d\mathcal{B})^2 (A - dA) \quad (1)$$

$$\text{if } \frac{1}{2} \mathcal{B} \frac{dA}{A} < = > d\mathcal{B}.$$

Since for this case $d\mathcal{B} = \frac{1}{2} \mathcal{B} \frac{dA}{A}$ the two sides of the equation are the same and the pull is the same when the polar area is A , and when it is $A - dA$. In the same way it can be shown that the pull is the same where the polar area is A and $A + dA$.

From this we draw the conclusion that when the air gap reluctance is expressed by a line parallel to the tangent drawn at the part of the iron characteristic where we are

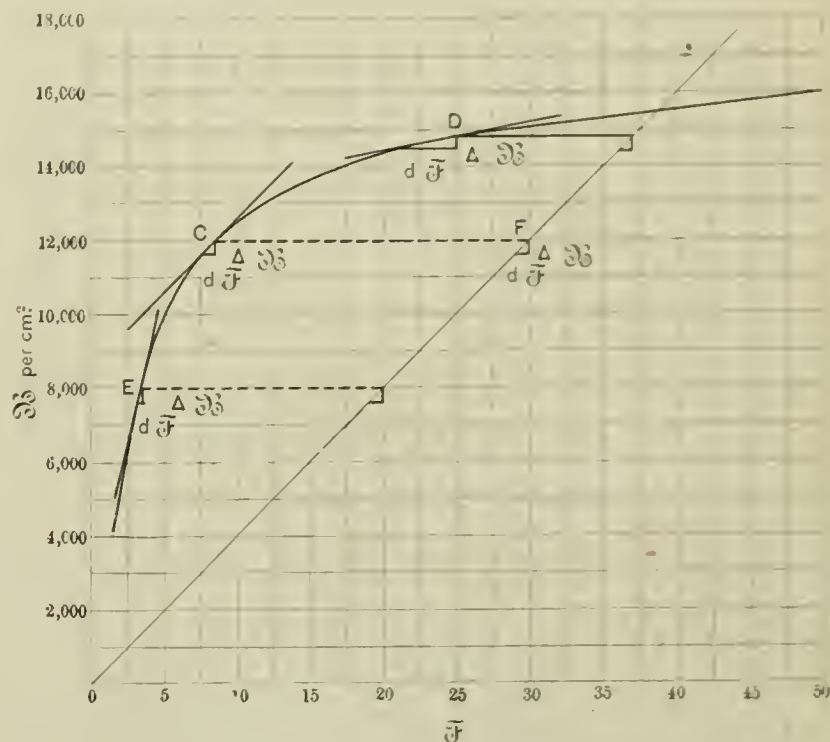


FIG. 1—DESIGN OF ELECTROMAGNETS.

working, there is no gain by either increasing or decreasing the polar area. This is evidently the condition of maximum efficiency, as we shall see from further considerations.

Keep the same characteristics and suppose our ampere turns put us at the point D on the iron curve. Decrease the polar area by dA , and for an instant the force by $d\mathcal{F}$, so that $\mathcal{B}$ is still the induction in the air gap. $d\mathcal{F}$ is now much greater than before necessary to make the change $\Delta \mathcal{B}$, so that it will produce a change in the whole circuit by an amount $d\mathcal{B}$ referred to air gap, where $d\mathcal{B}$ is greater than $\frac{1}{2} \Delta \mathcal{B}$, or greater than $\frac{1}{2} \mathcal{B} \frac{dA}{A}$. This condition makes the right-hand

member of equation (1) greater than the left-hand member, showing that the pull is increased by decreasing the polar area. Increase the polar area by dA , keeping other conditions as above, and equation (1) shows that the pull is decreased. Therefore, if our iron curve shows that $\frac{\Delta \mathcal{B}}{d\mathcal{F}}$

is greater than the same function for the air gap, the air gap reluctance should be increased until the two functions are the same.

Again at the point E we find that $d\mathcal{F}$ is less than in the case first cited, and if the same reasoning is followed it is found that the pull is increased by increasing the polar area.

Instead of increasing or decreasing the polar area, the same results are gotten by shortening or lengthening the air gap. When this is done, so that the function $\frac{\Delta \mathcal{B}}{d\mathcal{F}}$

is the same for iron and air gap, the pull multiplied by the distance is a maximum. This being the case, the best results are obtained by using the proper air gap; and if this distance is not the travel required, a lever can be used to multiply or divide with.

With these principles in view, it is easy to get the most efficient possible arrangement. It is also easy to predetermine a magnet to pull required amounts in more than one point of its travel.

By drawing tangents to all points of the iron curve and lines from the origin parallel to these tangents, and intersecting these by horizontal lines, we get the curve of proper

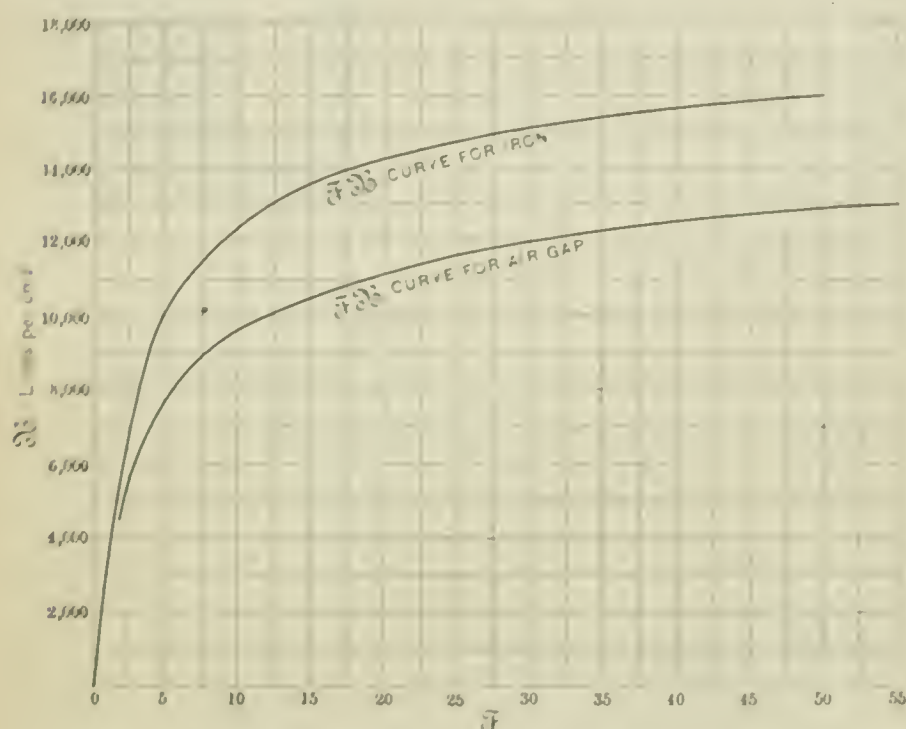


FIG. 2—DESIGN OF ELECTROMAGNETS.

air gap for all points of iron curve cut by said horizontal lines. See Fig. 2.

There are some other curves that materially reduce the labor in designing an electromagnet for a definite work.

To prove that the air gap thus determined gives the maximum amount of work, where work equals initial pull times length of gap, change l by dl ; then

$$\frac{\Delta \mathfrak{B}}{\Delta l} = \frac{dl}{l}.$$

We see that for the point F

$$\frac{d\mathfrak{B}}{\Delta \mathfrak{B}} = \frac{d\mathfrak{B}}{\Delta \mathfrak{B}}, \text{ and } d\mathfrak{B} = \frac{1}{2} \Delta \mathfrak{B},$$

and for points to the right of F ,

$$d\mathfrak{B} > \frac{1}{2} \Delta \mathfrak{B},$$

and for points to left of F ,

$$d\mathfrak{B} < \frac{1}{2} \Delta \mathfrak{B}.$$

In the three cases the work will be proportional respectively to

$$\mathfrak{B}^2 l, \quad (1)$$

$$(\mathfrak{B} - d\mathfrak{B})^2 (l + dl), \quad (2)$$

$$(\mathfrak{B} + d\mathfrak{B})^2 (l - dl), \quad (3)$$

$$(1) - (2) = + \text{ for } d\mathfrak{B} > \frac{1}{2} \mathfrak{B} \frac{dl}{l}$$

$$(1) - (3) = + \text{ for } d\mathfrak{B} < \frac{1}{2} \mathfrak{B} \frac{dl}{l}$$

Calculating the Resistance of Wires for Alternating Currents.

BY CARL HERING.

The French journal "L'Industrie Electrique" for Dec. 25 contains an article in which some practical deductions are made from a table by Lord Kelvin, given in his inaugural address before the Institution of Electrical Engineers in 1889. The object of the deduced table is to enable one to calculate by a very simple computation the effective resistance of circular wires when alternating instead of direct currents are used. It gives the factors by which the ordinary resistance of a wire must be multiplied in order to give its effective resistance for alternating currents. The principle on which

the table is based is described briefly in an abstract of that article contained in The Electrical World's Digest of last week. But as the figures in the first column of the table are for diameters given in centimetres, a reduction must be made if the diameters are given in mils. In order to avoid having to make this reduction, the writer has transformed the first column, so that diameters in mils, that is thousandths of an inch, may be used. The table thus reduced is as follows:

Circular mils × frequency.	k .	Circular mils × frequency.	k .
0	1.0000	198,412,800	1.6778
3,100,200	1.0000	251,116,200	1.8628
12,400,800	1.0001	310,020,000	2.0430
18,291,180	1.0100	375,124,200	2.2190
24,336,570	1.0200	446,428,800	2.3937
27,901,800	1.0258	793,651,200	3.0956
49,603,200	1.0805	1,240,080,000	3.7940
77,505,000	1.1747	2,790,180,000	5.5732
111,607,200	1.3180	4,960,320,000	7.3250
137,958,900	1.4920		

The table is calculated for a specific resistance of 1,597 C. G. S. units.

The increase in resistance referred to depends on the diameter and on the frequency, but is the same when the product of the frequency and the square of the diameter is the same. To use the table, multiply the frequency (in periods per second) by the square of the diameter in mils, that is, by the cross-section in circular mils, and find the number nearest equal to this in the first column, then the corresponding value of k in the second column will give the factor by which the resistance in ohms for direct currents must be multiplied in order to give the effective resistance for alternating currents of that period in cylindrical conductors of that diameter. If the diameter is given in inches instead of mils, divide the numbers in the first column by one million.

To take an example, let the frequency be 125 and the diameter of the wire be 460 mils (No. 0000 B. & S.); squaring the diameter and multiplying by the frequency gives 26,450,000; the nearest number to this, in the first column of the table, is 27,901,800, and the corresponding value of k is 1.0258; if the resistance of this wire is two ohms, the effective resistance for these alternating currents will then be 2.0516 ohms.

For values not found in these columns it is sufficiently accurate to take the nearest one or to interpolate by proportion.

It will be seen from the fourth value, which is interpolated, that, if the frequency is 125, the differences between the two resistances is only 1 per cent. for wires of about 382 mils diameter, which is slightly larger than a No. 00 B. & S. wire. For that frequency and for wires smaller than this, the error in omitting this correction will therefore be less than 1 per cent. The product of the diameter and frequency has also been interpolated for a correction of 2 per cent.

The number of decimal places in the original table has been retained, although in the opinion of the writer it is not necessary to have the values of constants to an accuracy of one-thousandth of one per cent. in dealing with frequencies and diameters, neither of which can be measured and depended upon to anything approaching this degree of accuracy.

Telephone Wires in Norway.

London "Electricity" states that the wire employed for telephonic purposes in Norway, with the exception of Christiania and Bergen, is made of Swedish iron, or steel, and is 2 millimetres in diameter. At Christiania bronze wire of 1.25 millimetres diameter and bimetallic wire (steel and copper) 1.9 millimetres, is also used.

* Interpolated, giving constants for an increase of 1 and 2 per cent

Is Telephonic Induction Electrostatic or Electromagnetic?—II.

BY F. W. DUNBAR.



ACCEPTING the explanation of the discrepancy between the theoretical and observed values as the correct explanation, we are justified in the statement that the actual value of the effective capacity of the conductors during conversation, when the reversals take place far too rapidly to allow the bound charges on the high resistance cross-arms to fully gather and dissipate, will always exceed 50 per cent. of their capacity to ground by a constant amount equal to one-half the direct air capacity between them. And following directly from this the difference in the effective capacity between any two wires upon the pole line is equal to one-half the direct capacity between these two wires.

This gives a value of $(.000055 - .000037 = .000018)$ mfd. per mile for the difference in capacity of 1 on 3 and 4 and a value of $(.000110 - .000055 = .000055)$ mfd. per mile for the difference in capacity of 2 on 3 and 4; making a resulting difference in capacity of 1 and 2 on 3 and 4, when 1 and 2 form the disturbing circuit and 3 and 4 form the disturbed circuit of .000037 mfd. per mile; a value less than 1-3 per cent. of the actual capacity of either conductor to ground. Thus the electrostatic induction between two circuits most favorably situated for maximum cross talk would be practically negligible. But for purposes of comparison we will suppose that the effective capacities in practice are the values secured by experiment, although we know discrepancies exist in these results and that the only obvious and plausible explanation of these discrepancies will reduce the results to their theoretical values within the limits of accuracy of the experiments.

The difference in mutual capacity between circuit (1, 2) and the conductors 3 and 4 (constituting the disturbed circuit) may be at once approximated from the actual observed values recorded in Table II.

Thus the mutual capacity of

+ 1 on 3 =	+ .331
+ 1 on 4 =	+ .324
— 2 on 3 =	— .370
— 2 on 4 =	— .331
	— .039, — .007

giving a resultant difference in capacity of 1 and 2 on 3 and 4 of $-.032$, or $-.00073$ mfd. per mile.

This value, although twenty times the probable actual value, is yet but 5 per cent. of the capacity of either wire to ground.

These wires chosen are evidently those upon which the difference in capacity would be a maximum according to observed values, and are consequently the most favorably situated for possible electrostatic induction.

It may be remarked that had 5 and 6 been chosen for the disturbing circuit the resulting disturbance would be found to be but about 15 per cent. of the disturbance produced by the pair chosen (1 and 2)—a result not at all in accordance with practice, and again indicating a discrepancy between the observed and true results.

The effect of this difference in capacity between the conductors of the disturbing and disturbed circuits will be to induce a current in the disturbed circuit such that the dq at any point (x) will be equal to the product of the potential

of the disturbing circuit e at that point, and this resultant capacity c_0 ,

$$\text{or that } dq = c_0 dx e$$

$$\text{and } di_0 = \frac{d}{dt} (dq) = c_0 \frac{de}{dt} dx.$$

The value of e is given by

$$e = \frac{E}{e^{p^2} \mp 1} \left[e^{p^2 - px} \sin (\omega t - ax) \pm e^{p^2 x} \sin (\omega t + ax) \right]$$

$$\text{hence } \frac{di_0}{dx} = \frac{c_0 E \omega}{e^{p^2} \mp 1} \left[e^{p^2 - px} \cos (\omega t - ax) \pm e^{p^2 x} \cos (\omega t + ax) \right]$$

$$\text{or } i_0 = -\frac{c_0}{c} \frac{E \sqrt{c} \omega}{\sqrt{R^2 + z^2 \omega^2}}$$

$$\left[\frac{e^{p^2 - px} \sin \left(\omega t - ax + \tan^{-1} \frac{p}{a} \right) \pm e^{p^2 x} \sin \left(\omega t + ax + \tan^{-1} \frac{p}{a} \right)}{e^{p^2} \mp 1} \right]$$

where i_0 is the current in the disturbed circuit and c is the capacity to ground of either of the disturbing wires.

$$\text{The expression } -\frac{E \sqrt{c} \omega}{\sqrt{R^2 + z^2 \omega^2}}$$

$$\left[\frac{e^{p^2 - px} \sin \left(\omega t - ax + \tan^{-1} \frac{p}{a} \right) \pm e^{p^2 x} \sin \left(\omega t + ax + \tan^{-1} \frac{p}{a} \right)}{e^{p^2} \mp 1} \right]$$

is the value of the current in the disturbing circuit. The value of the current in the disturbed circuit may then reach a value of $\frac{c_0}{c}$ or 5 per cent. of the disturbing current. But we know that upon two such circuits of any considerable length it is a difficult matter to determine at the receiving end upon which circuit the transmitting is being done.

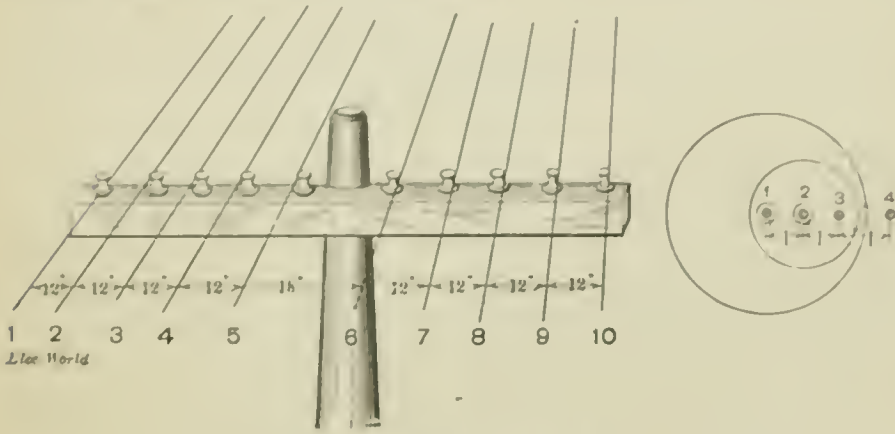
Therefore, upon two circuits most favorably situated for electrostatic induction we have failed to account for the cross-talk. If we had used the theoretical values which, in view of the indications from the experimental results, would seem justifiable, we would have found the disturbing current 300 times greater than the induced current, or that the cross-talk due to the electrostatic induction is negligible.

Up to this point pole lines alone have been discussed. The results of several hundred observations upon the electrostatic capacity of underground cables uniformly indicate that the mutual capacity of any two wires in the cable, which are not directly adjacent, is a practically constant quantity and exceeds 50 per cent. of the capacity to ground by an amount less than 1 per cent., or about the limit of accuracy of the experiments.

The capacity of one wire to its mate, however, varies in different cables from 55 per cent. to 59 per cent. of the capacity to ground, while the capacity of one wire to an adjacent wire, but not its mate, varies from 51 per cent. to 52 per cent. of the capacity to ground. The unexpectedly large excess over 50 per cent. of the mutual capacity of one wire to its mate is undoubtedly due to the compression of the insulation caused by the twisting together of the two wires of each pair. This would of course bring the two wires of each pair unduly near together, and hence increase the direct capacity of one wire to its mate. The slight excess over 50 per cent. of the capacity to ground of one wire to an adjacent one, not its mate, is fully accounted for by the direct capacity of these two wires. But between any two wires not directly adjacent the direct capacity plays such a small part that it can only be detected by experiment with apparatus capable of an accuracy far greater than one per cent. Therefore, the actual observations on the capacity of cables corroborate the statement we felt justified in making from the results of the tests on line wires, i. e., that the difference in

mutual capacity between any two conductors (not adjacent, in cables) is negligible, being less than one per cent. of the capacity to ground on both cable and line conductors. Accepting this statement, the possibility of accounting for cross-talk by electrostatic induction vanishes.

The magnitude of the electromagnetic induction depends upon the number of lines of force produced by the disturbing current, which thread through the disturbed circuit. This value is readily obtainable from the value of the current flux outside a wire between the limits of $3l$ and $2l$ where l is the distance separating the wires (30 cm).



FIGS. 5 AND 6.

Thus, for copper wire in air the current flux linkage between 1 and 3 and 4 will be $2 \log_e \frac{3l}{2l} = .8108$ per unit current in 1, and between 2 and 3 and 4, $2 \log_e \frac{2l}{l} = 1.3862$ per unit current in 2. Therefore, the total or resultant linkage per unit current, or the induction, is .5754 per centimetre, $= \frac{.5754 \times 161,000}{10^9} = .0000925$ henry per mile. Similarly, the inductance in henrys per mile for either 1 or 2 upon its own circuit is 0.00165.

The induced E. M. F. upon the disturbed circuit (3 and 4) is at any point equal to $L_0 \frac{di}{dt}$ where $L_0 = .0000925$ and i = current in the disturbing circuit.

The value of this current at any point, x , and time, t , is

$$i = \frac{E\sqrt{C\omega}}{\sqrt{R^2 + L^2\omega^2}} \left[e^{pt - ax} \sin(\omega t - ax + \tan^{-1} \frac{p}{a}) \pm e^{px} \sin\left(\omega t + ax + \tan^{-1} \frac{p}{a}\right) \right]$$

$$\text{hence } de = L_0 dx \frac{di}{dt} = \frac{L_0 dx E\sqrt{C\omega}}{\sqrt{R^2 + L^2\omega^2}} \left[e^{pt - ax} \cos\left(\omega t - ax + \tan^{-1} \frac{p}{a}\right) \pm e^{px} \cos\left(\omega t + ax + \tan^{-1} \frac{p}{a}\right) \right] \quad (1)$$

$$\text{and } e = \frac{L_0 \omega}{\sqrt{R^2 + L^2\omega^2}} \left[\frac{E}{\omega} \left\{ e^{pt - ax} \sin\left(\omega t - ax + \tan^{-1} \frac{p}{a}\right) \mp e^{px} \sin\left(\omega t + ax + \tan^{-1} \frac{p}{a}\right) \right\} \right] \quad (A)$$

where

L is the inductance of a circuit upon itself in henrys per unit length.

L_0 is the inductance of the disturbing upon the disturbed circuit in henrys per unit length.

C is the capacity of a single conductor to ground in microfarads per unit length.

R is the resistance of a single conductor in ohms per unit length.

$\omega = 2\pi n$ where n = number of alternations per second.

E = maximum positive value of the impressed E. M. F.

i = current, t = time, x = distance, e = potential, e = Napierian base (2.718...)

also $p = \sqrt{C\omega} \sqrt{(R^2 + L^2\omega^2)^{1/2} - L\omega}$,

and $a = \sqrt{C\omega} \sqrt{(R^2 + L^2\omega^2)^{1/2} + L\omega}$.

The expression in the brackets is the expression for the value of the E. M. F. in the disturbing circuit at any time, t , and distance, x , with the exception of the phase which is advanced by $2 \tan^{-1} \frac{p}{a}$, the total induction in the disturbed circuit represented by equation (A) between the limits $x = \frac{l}{2}$ and $x = 0$, is

$$E_0 = \frac{L_0 \omega}{\sqrt{R^2 + L^2\omega^2}} E \sin\left(\omega t + 2 \tan^{-1} \frac{p}{a}\right).$$

This expression is $\frac{L_0 \omega}{\sqrt{R^2 + L^2\omega^2}}$ times as great as the value of the E. M. F. impressed upon the disturbing circuit and is advanced in phase by $2 \tan^{-1} \frac{p}{a}$.

But in the disturbing circuit this E. M. F. is impressed wholly at one point, the origin, while in the disturbed circuit the induction takes place throughout the entire circuit, as represented in equation (1).

The solution for the distribution of current in the disturbed circuit could be found by the same method employed in the solution for the current in the disturbing circuit, using for the value of the impressed E. M. F. that given by equation (A) instead of $E \sin \omega t$; but although this would give us the value of the cross-talk at any point in the circuit, the solution is laborious and an approximation is readily effected.

The values of the coefficient $\frac{L_0 \omega}{\sqrt{R^2 + L^2\omega^2}}$ for the line wires under discussion are

for 160 alternations per second .018

for 320 alternations per second .031

for 640 alternations per second .046

Thus, if the induction on the disturbed circuit took place wholly at the origin, and consequently the current should follow the same law of distribution as upon the disturbing circuit, the cross-talk would be, for 320 alternations per second, .032 times as great as the disturbing current and maintain a constant ratio to it throughout the entire circuit length.

If, however, the induction be assumed to take place entirely at the distant end, the cross-talk would, at the distant end, have a value .031 times as great as the disturbing current at the origin. In practice the current at the origin may be ten or even 100 times the value at the distant end on the disturbing circuit; therefore, in this case the cross-talk might equal or exceed the disturbing current.

The true value, of course, lies somewhere between these two extremes.

Thus, although both the disturbed and disturbing currents decrease with an increase in distance from the origin, the disturbed, or induced, current decreases much more slowly on account of its distributed induced E. M. F., and consequently its ratio to the disturbing current, or the cross-talk, increases with the distance from the origin and with the length of circuit. These results are substantiated by practice, and in themselves form a strong argument against the electrostatic theory, in which, as we have seen, the cross-talk is independent of the distance from the origin and the length of circuit.

The coefficient $\frac{L_0 \omega}{\sqrt{R^2 + L^2\omega^2}}$ shows us that until the rate of alteration is sufficient to render $L\omega$ greatly in excess of R , the cross-talk increases with an increase in pitch. Thus, on the lines under discussion pitch 320 (representing the fundamental of the average female voice) will be heard by cross-

talk 70 per cent. better than pitch 160 (representing the fundamental of the average male voice).

This explains why the female voice is unduly prominent when heard by cross-talk, and also why voices heard by cross-talk are apparently raised in pitch. The effect is especially noticeable in cables where R is greatly in excess of $L\omega$, and consequently the cross-talk varies directly with the pitch.

According to the electrostatic theory the cross-talk, as we have seen, is independent of the rate of alternation, a result substantiated by facts.

These equations have neglected the back influence of the disturbed upon the disturbing circuit, which should be taken into account, as in dealing with the ordinary induction coil, but as the influence of this induction would be simply to reduce the value of the disturbing current and also prevent the cross-talk ever exceeding the disturbing current, its effects have been omitted.

However, we may draw the conclusion that the presence of transpositions upon line wires, besides decreasing the cross-talk, allows the current in the transmitting circuit to attain a higher value than it would were such transpositions absent.

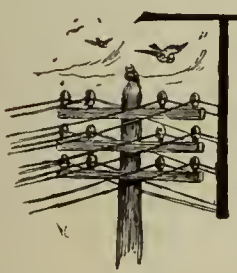
In the above equations also the effect of the receiving instruments upon the disturbed circuit has been omitted. While playing little part in a disturbed circuit of considerable length, their effect is all important on short lines and greatly reduces the value of the induced current, especially at the portion of the circuit where introduced.

The disturbed circuit has been assumed to be similar in all respects to the disturbing circuit and both used as closed metallic circuit loops.

In conclusion, to bring out more clearly the point I have attempted to make, the difference in the electrostatic capacity of a certain wire in a given cable measured first with another wire in the same cable, but not directly adjacent, and second with a wire in another similar cable separated a distance of one mile from the first cable, can only be detected by a careful test with delicate apparatus, and would in general be less than one per cent. Yet we know that cross-talk will exist between the two conductors in the same cable (assuming the pairs are not twisted) and will not exist between the two wires which are separated a distance of one mile. The electrostatic theory offers no explanation of this fact.

Non-Infringing Telephone Transmitters.

BY WILLIAM A. ROSENBAUM.



THE telephone situation, so far as affected by the fundamental patents, was discussed in an article in *The Electrical World* of the 6th inst., and the fact was pointed out that after Jan. 30, 1894, there will be but one of the fundamental patents left, the others all having become void by reason of expiration of the regular term, or by limitation due to foreign patents. The single remaining patent referred to was the Berliner patent of Nov. 17, 1891. I also pointed out the fact that a suit by the Attorney General is now in progress for the nullification of the Berliner patent on various grounds, which appear to be ample for the purpose intended.

A recent writer on this subject, with an apparent intention of bolstering up the Bell telephone monopoly, gives as his opinion that there are also strong grounds for believing that the Edison transmitter patents will be finally sustained. This opinion, however, is likely to prove quite as erroneous as another statement in the same article that "previously patented in a foreign country" should be taken to mean previously applied for in a foreign country. What the writer should have said; Previously patented in a foreign country should be taken to mean patented in a foreign country previous to applying for patent in this country. Any one

at all familiar with the subject knows that in foreign countries the date of application is the same as the date of the patent.

But regardless of the result of the suit to annul the Berliner patent and regardless also of the final disposition of the Edison patent, it appears to me that the larger part of the disturbance and anxiety which exists concerning these patents is needless, and it would seem that the safest and speediest way of relief from all such anxiety is in the use of a transmitter which does not infringe either of the patents, if such is possible.

The Berliner patent contains six claims, of which the first two are the most important. The first claim covers electrodes in constant contact, the pressure between which is varied by the sound waves. The second covers electrodes in constant contact, the pressure between which is varied by a diaphragm acting upon them, the diaphragm being moved by the sound waves.

The first claim is a little broader than the second, because it is not confined to the use of a diaphragm, while the second is so limited. The vital feature is the use of electrodes in constant contact. If it is impossible to construct a practical microphone without using electrodes in constant contact, then of course the public must wait until the Berliner patent is nullified, either through the pending suit or by the expiration of the term of the patent.

The broad Edison patent contains one claim which covers a diaphragm with one or more carbon points resting against it, the resistance being altered by the variations of pressure of the diaphragm against the point or points. Neither electrodes in constant contact nor a diaphragm exerting various pressures upon an electrode are absolutely essential to a successful transmitter. In the first place, the Bell receiver makes a very good transmitter, and, no doubt, will be used largely on short lines. Again, there are various forms of transmitters patented which do not comprehend the features of the Berliner and Edison claims.

For instance, in 1878, a patent issued showing a pair of electrodes separated from each other and immersed in water. The vibrations of the diaphragm vary the distance between the electrodes, and therefore the electrical resistance of the water between them. In the same year another patent was issued, in which the movements of the diaphragm were communicated to a pivoted lever, which in turn made contact with more or fewer of the terminals of a rheostat and thereby cut resistance into and out of circuit in proportion to the amplitude of the vibrations of the diaphragm.

The Cuttriss transmitter has no electrodes at all. The variable resistance is a small spiral spring of carbon, the convolutions of which are opened and closed by the movement of the diaphragm.

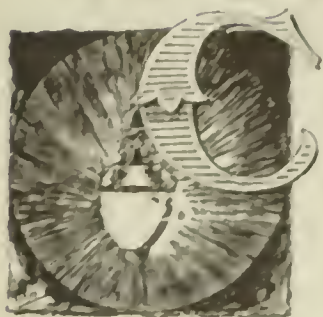
These patented forms are cited to show that it is possible to construct a practical transmitter without infringing the Edison or Berliner patents. It is not intended to convey the impression that these various forms are open to the public. But they are sufficient to point out lines upon which inventors may work with an expectation of producing a practical transmitter which does not infringe the two patents referred to.

The Chicago Congress.

Our London contemporary, "Electrician," says: "The gathering at Chicago was distinguished from most of the previous meetings of the same kind by its thoroughly representative character, the high order of merit of the papers read, and the increasingly large share that America, hitherto remarkable chiefly for its practical applications of scientific discoveries, is taking in the pure science work of the world."

The Theory and Design of the Closed-Coil, Constant-Current Dynamo.*

BY HENRY S. CARLHART.



CONSTANT current dynamos for arc lighting have been in practical use for the past fifteen years. Most of the public lighting by arc light service has been done with dynamos of the open-coil type. They secured the field at an early day in the development of this branch of electrical industry through the inventive genius of Mr. Charles F. Brush and the splendid ability of his business associates. This success was repeated a little later by the equally brilliant achievements of Profs. Thomson and Houston and the phenomenal management of the company formed to exploit their patents. Aside from any question of inferiority, it is therefore easy to see why the closed-coil dynamo for constant currents has remained so long in the background. It has not received the attention to which it is justly entitled, and has not been investigated with the thoroughness and skill which it merits.

It is not my purpose to draw any comparisons whatever between open and closed-coil armatures. The former is entitled to that consideration which long continued and satisfactory service in public and private illumination has earned for it. But the latter is making its way into public favor, and it has certain peculiarities which make it an interesting subject for study. If I were to draw attention in this paper to comparisons between dynamos of different type, it would be between those for constant potential and those designed for constant current, both with closed-coil armatures. For in almost every particular the latter is diametrically opposite to the former. The one is designed to give a constant potential; the other a constant current. One is shunt or compound wound; the other series wound. In the one the resistance of the armature is as low as possible in comparison with the field; in the other the armature resistance is relatively large compared with the field. The one has a sensitive field and is worked below the saturation point; the other should have a stable field which is worked well up on the saturation part of the curve of magnetization. Ideally the characteristic of the one is a horizontal line; that of the other, a vertical line. In the constant potential machine the brushes are set only slightly in advance of the theoretical neutral line or plane; in the constant current dynamo the brushes may be at any point on the commutator, according to the load, while the neutral plane remains fixed. When the load decreases with the one the brushes, if moved at all, are rocked backward for sparkless commutation; when the load decreases with the other the brushes are rocked forward for minimum sparking, or even sparkless commutation and constancy of current. When the load increases on the one it governs by an increase of induction from an increasing field; when the load increases on the other it governs by decreasing the counter E. M. F. in the coils between the brushes and the neutral plane. In the one armature reaction is purposely reduced to the smallest dimensions; in the other it is purposely made of considerable dimensions. In these comparisons it is assumed that the speed is constant in both cases. If some of these statements are not self evi-

dent they will be supported, I hope, by subsequent portions of this paper.

By neutral plane is meant a plane passing through the axis of the armature and so situated with reference to the poles of the field magnet that when a coil of the revolving armature is carried across it the E. M. F. generated changes direction. This plane intersects the armature in a straight line, but it may broaden out more or less into a surface of small lateral dimensions.

The plane of commutation is a plane passing through the armature axis and the points of contact of the brushes on the commutator. It is the plane joining the poles of the armature considered as an electromagnet. This latter plane of course shifts with the brushes, since the poles of the armature are the points at which the current enters and leaves the armature, and these are necessarily the points or surfaces of contact of the brushes with the commutator, assuming that the connections from the armature to the commutator run directly out parallel to the shaft. To state the proposition now under discussion in the form of a question, Does the neutral plane shift when the brushes are shifted forward or backward? If we were to make answer from the assumption that the resultant of two impressed magnetizations or magnetomotive forces may be obtained in the same manner as the resultant of two forces by means of the triangle of forces, we should probably conclude that the neutral plane rotates forward with a forward movement of the brushes. But experiment along several different lines shows that this conclusion is in error. If we were to apply to the solution of this problem the principles derived from constant potential machines, we should be forced to the conclusion that, to maintain sparkless commutation at the brushes, the lead of the brushes beyond the neutral plane should be constant, since the current remains constant; and therefore that any attempt to govern for constant current by rocking the brushes must be attended by destructive sparking, unless at the same time the field is greatly modified. But these conclusions are also erroneous. We must therefore first establish the facts and then make a theory to fit them.

The fixed position of the neutral plane I have determined on a ten-light machine in two different ways.

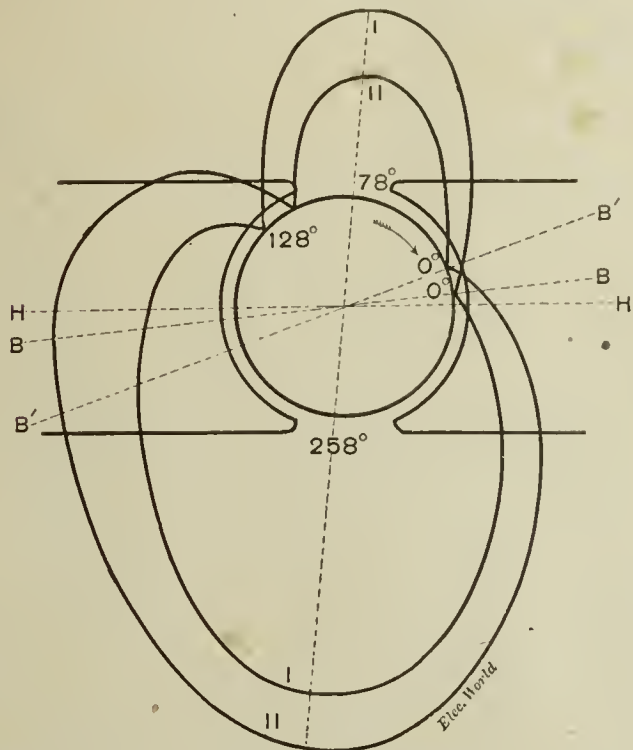
First Method.—Four turns of No. 16 silk covered magnet wire were wound around the armature ring as an exploring coil. One end of this coil was soldered to a copper band or ring fastened on the commutator and insulated from it by several thicknesses of mica. The other end was soldered to a piece of brass let into a fibre collar placed around the commutator. One extra brush was fastened to one of the main brush holders and rested on the copper band. The other extra brush rested on the fibre collar, and could be attached to any point of a circular scale made concentric with the commutator. A twisted cord ran from these two brushes to a telephone at some distance. When the dynamo was running the movable brush, which rested on the fibre and made contact with the brass strip every revolution, was moved around the circle till a minimum sound was heard in the telephone. The exploring coil was then on the neutral plane at the same instant when the brush made contact with the strip. Motion of the brush either way caused the sound to increase in loudness. The position of the exploring coil for minimum sound was to be found about five degrees in advance of the normal plane intermediate between the pole pieces; and its position did not change from full load to no load, as far as could be detected by this method.

Second Method.—To the brush holders was attached an insulating ring slotted on the periphery at every ten degrees on a milling machine. It was made as nearly concentric with the commutator as possible. A third brush holder was placed in the successive slots, and the potential difference be-

* A paper read before the Electrical Section of the Franklin Institute.

tween it and one main brush was measured in its several positions. These measurements gave the integrated P. D. between the main brush and successive points on the commutator all the way round the circle and back to the starting point. This was done with no load or nearly short circuit, with a load equivalent to three lamps, and finally with a load equivalent to nine lamps, the current being ten amperes in each case.

The results in the first two cases are plotted round a circle



DETERMINATION OF NEUTRAL PLANE OF ARC DYNAMO.

in Fig. 1. Positive values, or those in which the potential of the third brush was higher than that of the main positive brush, are set off outside the circle in the upper part of the figure; while negative values are set off outside in the lower section of the diagram. The direction of rotation is clockwise. With no load the highest positive potential was about 78 degrees behind the positive brush. From this point it fell again, and at 128 degrees it was the same as that of the positive brush. For all the coils between 0 degrees and 128 degrees the integrated positive and negative E. M. Fs. exactly equal each other. The neutral plane falls evidently 78 degrees behind the brush, or the brushes may be said to have a load of 78 degrees, with no increase in sparking. A negative maximum occurred at about 260 degrees, and the potential difference between the positive and negative maxima was 644 volts. The same P. D. was found by direct measurement when two extra brushes were set at these points.

With a load equivalent to three lamps the brushes were rocked back 15 degrees to bring the current to ten amperes. Hence the zero of this curve begins 15 degrees back from the zero of the first curve. Again the observations are plotted and the positive maximum falls at the same place on the circle, and therefore at the same place on the commutator. The two maximum points are at about 65 degrees and 245 degrees from the positive brush, and the two potential differences are 168 and 456 volts. Their sum this time is 624 volts, a little less than with no load. With the highest load carried the brushes were rocked backward about 50 degrees further, and the lead was then about 15 degrees. The extreme P. D. obtainable this time did not exceed 600 volts. So far as can be discovered from these curves the neutral plane remains fixed, while the brushes move round the commutator to adjust to a constant current. I find no evidence in them that the forward movement of the brushes to control the current causes the neutral plane to move with them. As the brushes advance with a diminishing external load they put between them and the neutral plane an increasing number of armature turns generating counter E. M. F.; and it is a striking fact that, when the field coils are

not cut out, the back turns on the armature cut down the P. D. between the brushes, not by a counter magnetomotive force apparently, but by counter electromotive force; for the maximum P. D. to be found on the commutator is no less on no load than on full load, showing that at least as many lines of force traverse the armature core with the brushes far forward and with many back armature turns as with the brushes in the position for the maximum load and with the back turns reduced to a minimum.

(To be continued.)

Prof. H. A. Rowland vs. the Cataract Construction Company.

The suit brought by Prof. Henry A. Rowland, of Johns Hopkins University, against the Cataract Construction Company, of which mention was made in these columns last week, has proved to be one of the most interesting which has appeared in the courts for some time, although its relative importance, as far as the public is concerned, is, of course, not great. Prof. Rowland had sent in a bill for \$10,000 for his services as an expert in connection with the work of the company and had received from the Cataract Construction Company a check for \$3,500 in payment therefor. He then brought suit against the company for \$30,000 on the ground that his first estimate of the value of his services was too low.

The case came up in the United States Circuit Court for the Southern District of New York before Judge Shipman and a jury on Jan. 17. The plaintiff was represented by Wise & Flannagan and W. L. Marbury, while Messrs. Bangs, Stetson, Tracey & McVeigh and Joseph H. Choate looked after the interests of the defendants.

Prof. Rowland was first called to the witness stand, and after stating that he had held his present position of professor of physics at the Johns Hopkins University since 1876, gave a brief outline of his career and work, from which it appeared that he began his studies in electricity and magnetism at the early age of ten years, and that they therefore have covered a period of over thirty years. He stated that he was first connected with the Cataract Construction Company in 1889. At that time he took up for them the question of electrical transmission of power at Niagara and received for his services the sum of \$1,000. He then showed what an immense undertaking the work, which was the subject of the present controversy, was, and that it had occupied his time constantly for seven hours a day for over six months. The question of determining the proper frequency or period he regarded as the most important, for this decided whether arc or incandescent lighting was possible, and determined the number of revolutions of the motor, number of poles, size of transformers, etc. He had recommended a period of 33, provided they were willing to give up arc lighting, and that which was adopted was 25, which was very near his recommendation. The weight of the moving parts was perhaps the next most important question, and he had recommended 25 tons with an armature 10 feet in diameter; he believed this recommendation had been practically adopted. He had also advised the use of step-up transformers, which feature was also part of the present plans. He further suggested artificial cooling of the transformers, and he believed that this device was an origination of his own and had not been before used. He had objected seriously to making an adverse report on the work of a brother physicist, Prof. Forbes, but a report had been insisted upon by the officers of the Cataract company.

In one of his letters Prof. Rowland had spoken of himself as the "acknowledged first physicist and electrician in this country," and the defense brought this statement unpleasantly into prominence. In answer to a question as to what practical work of this nature he had previously done, he stated that he had been employed by the Sprague Railway Company

some years ago on work which he shared with Dr. Louis Duncan, and which occupied altogether, as he remembered, somewhat less than two months and for his half of which he had received \$1,000. The United States Government had also employed him in regard to a report on the placing of electric wire underground in the District of Columbia, and for this work, which covered a period of four or five months, he received about \$4,000. The Weems Electric Railway Company some years ago had also employed him, together with Dr. Duncan, and for this work, which took about one week, he received \$500. He stated that his salary at the Johns Hopkins University was \$5,000 per annum, or about \$30 per hour, as he lectured about one-half hour twice a week.

In reply to inquiries as to his acquaintance with various members of the Niagara Commission, Prof. Rowland gave some interesting estimates of the prominent men connected with that body. Sir William Thomson he acknowledged to be the greatest physicist and electrician in Europe, and presumably in the world. Coleman Sellers, he said, had no standing as an electrician; he was a mechanical engineer, and of this Prof. Rowland did not pretend to judge, although in reply to a question he declined to name any one who stood higher. In regard to Mascart he stated that his standing as a physicist was very good, but not the highest. Being asked who stood higher, except Sir William Thomson, he replied as follows: "Sir William Thomson is very eminent, and Stokes is most eminent, and Lord Rayleigh is most eminent, and J. J. Thomson, a young man, I think is superior." He also added that he could give a longer list than these whom he regarded as superior to Mascart. Col. Turretini he had never heard of, except in connection with the commission. Prof. Unwin's standing he thought very high. He stated that he had done no work during the period in which he had been engaged in preparing the report for the Cataract Construction Company, except the preparation of two scientific articles published in *The Electrical World*.

A deposition from Dr. John Hopkinson was read in which he stated that his usual charges for work of this character was three guineas an hour. Speaking of Prof. Rowland, he said that his position was the very highest, and his contributions to electricity and magnetism most important; that if he himself (John Hopkinson) had done the work his charges would have been in accordance with the rate just stated.

Dr. Louis Duncan, of Johns Hopkins University, was called for the prosecution, and testified to the high professional standing of Prof. Rowland, and to the amount of work Prof. Rowland had devoted to the report. He said that Prof. Rowland had worked on the average seven hours a day on the report for a period of six months; that the report contained the results of much original investigation and research, and was of very great value to the defendant.

Mr. F. J. Sprague was called by the prosecution to prove what was reasonable compensation, and after stating his connection with electrical engineering, and before answering any question relative to amount of compensation, was examined by the counsel for the defense to test his competency to testify, which resulted in a lively skirmish between the counsel of the two sides, and ended by the court qualifying the witness. The witness stated on direct examination that his usual charge for consulting on work which required no original ideas was 5 per cent. of the cost of the plant; where original investigation or invention was necessary 7 1/2 per cent. to 10 per cent. On cross examination the witness admitted that where such percentage charge was made it was generally arranged beforehand. He also admitted that if a corporation hired ten consulting electrical engineers at this last rate the whole property would be consumed, but added that if any corporation was foolish enough to hire ten such experts they ought to have all their property taken away from them. Witness admitted that if such expert devoted a

large part of his time to villifying and condemning a fellow worker he should not charge for such time, but should make a deduction from his bill, but would not admit that it should make any difference whether his work was used or not. Witness testified that he was a member of the corporation of Sprague, Duncan & Hutchinson, but refused to answer how much he got for his work for the North American Company, the Baltimore and Ohio Company, the Rapid Transit Commission or any other client. He also declined to state whether the whole receipts of the whole five members of his firm for one year were not less than \$25,000.

Prof. Barker, of the University of Pennsylvania, was then called and began to establish Prof. Rowland's standing. Mr. Choate rose to say that the defense admitted Prof. Rowland's standing, and had never disputed it. His client always wanted the best of everything that could be bought, and that is why they hired Prof. Rowland. Mr. Wise asked if the defense admitted that the plaintiff was the only man who could do the work that was given him, and Mr. Choate replied: "We do not admit that if Prof. Rowland was to die electrical science would come to a standstill." Mr. Wise began to examine the witness as to usual fees of electrical experts, when Mr. Choate questioned Prof. Barker's competence as a witness, and was allowed by the rules to examine him on that point, as in the case of the last witness, before he testified further. Witness stated on this examination that he was interested in keeping up the prices of expert services, that he had worked for the various Edison companies, for the United States Company and for the Fort Wayne Company, all on the percentage basis, and that the per diem compensation for ten years ought to be same as for a single day, but he admitted that there might be a usage reducing the rate as the time is greater. The Judge asked the witness if the magnitude of the undertaking was in itself sufficient novelty to require original investigation, and the witness replied in the affirmative. The Judge then declared the witness qualified. The witness on direct examination said that Prof. Rowland was the only man who could prepare this work and get it into shape for engineers to take hold of. On cross examination he said that had Prof. Rowland died or never existed, the work could not have been done by any one in this country, but he could not mention any new principle, idea, discovery or invention in Prof. Rowland's report, or show any new application of theory to practice, or any novelty beyond the magnitude of the enterprise.

Dr. Jacques, of the American Bell Telephone Company, was then called to prove what was reasonable compensation. He stated that as an officer of the Bell Telephone Company he audited the bills of electrical experts, and in his connection with the Massachusetts Engineering Company he was himself an expert, and charged, like an architect, a percentage. On the examination for competency he said that he had himself been employed to determine the proper size of wire and other matters relating to the direct New York and Chicago telephone line for a considerable time on a per diem compensation, besides his salary. Witness also said that Prof. Cross had been employed from five to seven months on a per diem compensation, and Mr. F. L. Pope a longer time, but admitted that Mr. Pope had part of the time been an expert witness. Mr. Choate objected that two cases did not establish a precedent. The court ruled that it would admit instances of per diem compensation of four or five months' duration. Witness then mentioned the employment of experts by the city of Boston to investigate the deterioration of water pipes, and was qualified by the court. Witness stated on direct examination that Prof. Riker had been paid \$100 per diem and other experts \$50; that the work for the Cataract Construction Company performed by Prof. Rowland was so extraordinary and that it justified an extraordinary charge. He considered the charge should not be less

than \$37,500. On the cross examination Mr. Choate asked the witness if \$157,500 would not be more just, to which the witness replied in the negative. Mr. Choate was pleased to hear that there was some charge which the witness considered excessive. The witness further said that he was interested in depressing rather than raising expert charges. He knew of no more per diem payments for services lasting six months, nor five months, four months or three months. An instance of per diem compensation for two months was Prof. Cross at \$100, and Prof. Riker at \$100 on microphone work was another. Mr. F. L. Pope and Mr. d'Infreville were also mentioned. On direct examination witness stated that Mr. Pope received \$50 per diem. Witness was asked if he was not the man who had put the plaintiff up to sue for \$30,000. Question objected to, on the ground that what witness had said in that respect was in a letter; if defense would admit letter in evidence plaintiff would admit the point, but otherwise he would admit nothing. Defense would not admit the letter in evidence.

Mr. Joseph H. Choate then addressed the jury. He stated that Prof. Rowland was at the head of his profession and they expected to pay him well, and had paid him well; in fact, more than any one else. At the rates proposed by the plaintiff's witnesses, however, experts would devour any company. Ten would take it all. The business of the defendant was to harness the waters of Niagara and furnish water power for use there. The proposed electric transmission to Buffalo was only 10,000 h. p., or one-tenth of the whole. The general plan was decided before Prof. Rowland was employed. The dynamo was worth at most \$50,000. Mr. Wise here interrupted to know if Mr. Choate was opening the case or summing up, and a wrangle ensued, after which Mr. Choate resumed. He said it was an excellent thing to get Prof. Rowland to do this work, as also to secure a practical electrical engineer and a mechanical engineer. Three things were necessary—ideas, electricity, mechanics—but should the defendant company for that reason be compelled to pay three times \$37,500? Prof. Rowland receives a salary of \$5,000 per annum from the Johns Hopkins University. Four years ago he was employed by defendant for something over two months, for which he was paid \$1,000, with which he was apparently perfectly satisfied. Prof. Rowland had characterized Prof. Forbes as puerile, foolish, ignorant, partisan, etc. He had undoubtedly learned a great deal himself in the course of his work. There was nothing new in his report; neither he nor Dr. Barker could name any novel feature. Five hundred dollars per month was more than Prof. Forbes or Dr. Sellers received. Plaintiff was put up by Dr. Jacques to ask \$30,000, because \$10,000 was too much. Mr. Choate then exhibited a model of the dynamo designed by Prof. Forbes and Dr. Sellers, and said that all its substantial features were different from that in Prof. Rowland's report.

Mr. Rankin, of the Cataract Construction Company, was then called for the defense. He stated that the business of the Cataract Construction Company and its associate, the Niagara Power Company, was the development and renting of water power. Up to the present time only about 3,000 h. p. had been developed, which is in use now on the spot; that the capacity of the tunnel is 100,000 h. p., and that the electric transmission is as yet entirely prospective. The project had been broached in 1889, and Prof. Rowland had reported when first consulted that transmission to Buffalo was impracticable in the then state of the art by either direct or alternating currents. In 1892 Prof. Rowland had changed his opinion on account of the progress in the art. In 1890 the Niagara International Commission was formed. It consisted of Lord Kelvin, Dr. Coleman Sellers, Prof. Mascart and Col. Turrettini, commissioners, and Prof. Unwin, secretary. This commission was formed to consider plans and to award prizes therefor, with power to withhold any or all

prizes if they saw fit so to do. They examined twenty-six plans, but used only fourteen. They decided upon the use of a 5,000-h. p. dynamo, or two dynamos of 2,500 h. p. each, if any dynamo were used at all. The efficiency was guaranteed in each case in connection with the plan. The Oerlikon and Brown plans were considered practicable from an engineering point of view, but two purely commercial considerations prevented their acceptance: First, the high tariff; second, the distance of the factory from the power station. The Westinghouse company had guaranteed the performance of the machine and the price was less than \$50,000. Witness saw the plans submitted to the international commission; they comprised long and short transmissions; the former meant fifteen miles or more and the latter use on the land of the company. Lord Kelvin received £500 for his work on the commission, Prof. Mascart £400, Col. Turrettini £400, and Prof. Unwin £400. Dr. Sellers was at the time on a salary of \$12,000 per year from the company. His present salary is \$5,000, and Prof. Forbes' salary and expenses amount to about \$400 per month. Witness further said that Prof. Norton reported on the development of Niagara, including electric transmission, in November, 1889, charging \$250. Dr. Hopkinson, in the spring of 1893, reported on the type of dynamo, number of phases, etc., charging \$250, the work occupying perhaps three weeks. Prof. Fleming reported on the same subject, charging £10.

Dr. Sellers was then called by the defense. He said that in 1890 he visited the Rome and Tivoli transmission plant, also the Deptford-London installation at 10,000 volts; that the present apparatus of the defendant was designed entirely by Prof. Forbes and himself, and was entirely different from that in Prof. Rowland's report. Under cross examination the witness stated that Lord Kelvin was employed by offering him £500 in advance, and that he was well satisfied with the price. The commission awarded two second prizes, but no first prize. On redirect examination witness said that there was a consensus of opinion of the commission at that time in favor of continuous current transmission, but that since that time all the members of the commission, with one exception, had been converted to alternating current transmission, which Prof. Forbes had all the time advocated.

Mr. William Stanley, Jr., was then called, and stated that artificial cooling of transformers was not new at the time of Prof. Rowland's report; that James B. Fuller, in 1887, had used it, and that Mr. Swinburne had used a chimney draught for the purpose.

Prof. George Forbes was then called for the defense. He said that he had continuously advocated alternating currents since 1890, and that all the essential features of the present plan, including two-phase transmission and synchronizing motors, were decided upon before he saw Prof. Rowland's report; that although Prof. Rowland might have discovered the importance of the sine curve at the time of his report, it was public property and practically applied. Prof. Forbes refused to answer many questions which he apparently considered as bearing on controversies foreign to the suit, and avoided making reflections on others.

Mr. Choate, in his closing address to the jury, said that the ideas of philosophers and discoverers have never been convertible into large sums of money. Nothing could be more valuable to humanity than the discoveries of such men as Galileo and Newton, but they never sent in any bills, but with the advice of Dr. Jacques, Galileo would have claimed 5 per cent. of the earth and Newton 10 per cent. of the universe. Mr. Wise replied in his speech that had Galileo and Newton done work for millionaire corporations they probably would have sent in bills.

The jury was out about an hour, and brought in a verdict for the plaintiff for \$5,500, the unpaid balance of \$9,000.

Notice of appeal was given.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE PRINCIPAL FOREIGN ELECTRICAL JOURNALS

ELECTRO-PHYSICS

BY CARL HERING.

Dielectric Hysteresis.—Referring to the researches of Mr. Arno (see Digest Jan. 20 and July 15), Mr. Meylan, in "L'Elec.," Dec. 30, states that the author committed an error and that the numerical values given by him are therefore quite wrong, and are not physical constants but simply results of experiments under certain circumstances; the error lies in the assumption of the value of the electric field.

Dynamical Theory of the Electric and Luminiferous Medium.—The Lond. "Elec. Rev.," Jan. 5, publishes the first portion of an abstract of a Royal Society paper by Mr. Larmor on this subject; the present portion is devoted almost entirely to phenomena which are neither electrical nor magnetic.

Sudden Acquisition of Conducting Power.—The "Phil. Mag.," for January, contains a communication from Prof. Lodge "On the Sudden Acquisition of Conducting Power by a Series of Discrete Metallic Particles," forming a part of the discussion of Prof. Minchin's paper mentioned in the Digest Dec. 23.

Currents Produced by Heating.—"La Lum. Elec.," Dec. 30, mentions an article in "Science" by Mr. Stelle, on his researches in the production of electric currents in single metals by the action of heat.

Rotary Field Apparatus.—Mr. Blondel's mathematical article is continued at some length in "La Lum. Elec.," Dec. 30, a mathematical theory of non-synchronous rotary field motors being deduced.

Propagation of Light in Metals.—Mr. Raveau's article is continued in "La Lum. Elec.," Dec. 30.

Dissociation.—"La Lum. Elec.," Dec. 30, contains a note referring to an article by Mr. Wildermann.

MAGNETISM

Magnetic Elongation.—The "Phil. Mag.," for January contains an illustrated paper by Mr. Nagaoka on "Hysteresis Attending the Change of Length by Magnetization in Nickel and Iron"; also a supplementary paper by Prof. Knott on "Magnetic Elongation and Magnetic Twist Cycle."

Transformation Produced in Iron by a Strain.—"La Lum. Elec.," Dec. 30, abstracts an article by Mr. Charpy from "Comptes Rendus," in which he shows that a permanent deformation produces a modification which may be considered as an allotropic transformation of the iron.

Magnetic Shielding.—Prof. Ruecker's Physical Society paper on "The Magnetic Shielding of Concentric Spherical Shells" is contained apparently in full in the "Phil. Mag." for January.

UNITS, MEASUREMENTS AND INSTRUMENTS

Registering Instruments.—Dr. Rapp, in the "Elek. Zeit.," Jan. 4, gives in detail with the aid of eight illustrations a description of an improved registering instrument, the principle of which is briefly as follows:—A drum revolving once in twenty-four hours and enclosed in a box contains a band of sensitized paper; the light from an incandescent lamp passes through a slot on to this drum, producing a sharp line of light parallel to its axis; the pointer of the measuring

instrument moves over this slot, its position at every moment is therefore recorded by its shadow on the sensitive paper; vertical wires are stretched in front of the slot and are photographed on the paper in the form of lines; a glass disc with graduations representing the hours revolves between the slot and the drum, thus photographing the time on the sensitive paper; the readings on the paper are therefore entirely independent of the position of the paper, and it is therefore made possible to recover the drum with sensitive paper in a closed box with openings for the hands and without being necessary to see the paper itself.

Standard Cells.—Mr. Rimington, in a short article in the Lond. "Elec. Eng.," Jan. 5, states that a Clark standard cell is perfectly unharmed by being circuited through a resistance of 1,000 ohms which opinion he bases on experiments made with two identical cells, one of which was closed through 1,000 ohms for 17 minutes, its internal resistance being about 130 ohms and the current therefore 1.27 milliamperes; the circuit was then broken and the E. M. F.s. compared with that of the other cell, showing that in nine minutes it recovered sufficiently for all practical purposes, the recovery being complete in one hour and 20 minutes.

Resistance of Compressed Bismuth.—"La Lum. Elec.," Dec. 30, abstracts an article by Mr. van Aubel, in which he shows, among other things, that the influence of magnetism on bismuth does not depend appreciably on the molecular state of the bismuth, so long as it is pure.

Shunts.—The somewhat lengthy correspondence on shunts is continued in the Lond. "Elec. Eng.," Jan. 5, in the form of a lengthy dissertation on the subject, intended more particularly for amateurs.

DYNAMOS AND MOTORS

The Dynamos for Niagara Falls.—Mr. Weckes, in the Lond. "Elec. Eng.," Jan. 5, in the form of a discussion of Prof. Forbes' paper, gives an illustration of a Brown machine from Kapp's book, page 345, intended to show the great similarity between this and the form designed by Prof. Forbes.

Irregularities in the Action of Dynamos.—The article by Mr. Montpelier is continued in "L'Elec.," Dec. 30.

TRANSFORMERS

Transformers.—In his serial on "Electric Light and Power" in the Lond. "Elec. Eng.," Jan. 5, Mr. Guy discusses transformers.

ARC AND INCANDESCENT LIGHTS

Scientific Study of Arc Lamps.—A fifth paper of Mr. Kennedy is contained in the Lond. "Elec. Rev.," Jan. 5; in it he discusses lamps with inclined carbons with a lateral motion, and lamps with electromagnet feeding devices; he gives an illustration of an hydraulic device, the action of which is analogous to that in an arc lamp.

ELECTRIC RAILWAYS

Electric Traction.—The Lond. "Elec. Rev.," Jan. 5, contains an article by Mr. Epstein, the purpose of which is to investigate the relative merits and costs of the three different systems, overhead, underground conduit and accumulator,

his estimates being based as far as possible on data relating to actual working. The article, of which the first portion only is given, appears to be well worth reading in its entirety, as it consists mostly of tables and figures; from these the following are extracted: The cost of a 90-pound rail he gives as \$4,000 per mile of single track, which is the same for all three; for the laying and paving, \$25,000 per mile, the same in all three; for the overhead work, \$2,400 per mile; for the underground structure for a conduit road, about \$7,500 per mile; for feeders he gives a more extended table for a number of different conditions; for cars on trucks for forty passengers, \$1,150 per car; for motors and gearing, \$900, the same for all three; for accumulators and trays, allowing 2 1-2 sets of accumulators of 72 cells each for each car, for four to six hours' running with one charge, the cost of the batteries for a forty-passenger car will be \$1,800; for trays and connections, \$90; for elevators for handling the accumulators, \$250 to \$600 per car; for buildings and car sheds, \$1,000 to \$2,000 per car, for all three systems; for boilers and engines at \$40 per indicated horse power, \$160 per ton propelled, assuming four indicated horse power of steam plant for every ton weight propelled, which includes the reserve plant; this is for the overhead and underground systems; for the accumulator system, \$90 for the steam plant per ton weight propelled, based on 2.2 indicated h. p. of steam plant for every ton weight propelled; for the electrical plant at the station for the overhead and underground systems, \$85 for every ton weight propelled, based on 2.4 kilowatts per ton propelled; for the accumulator system, \$52, based on 1.5 kilowatts per ton weight propelled; from a table of efficiencies the average total efficiency for the overhead and underground systems is 27 per cent., while that for the accumulator system is 33 per cent. Two large tables are given containing the detailed expenses of the cost of construction and equipment of a double-track line six miles long with cars for forty passengers, average speed, including stoppages, six miles an hour, and weight complete, with passengers, eight tons; for the overhead system, using insulated wire for feeders, the cost per car per mile of double track for five-minute headway and twenty-four cars, is about \$91,450, while for the underground system it is about \$102,000, and for the accumulator system for a weight of ten tons per car it is \$79,765; similar figures are given for twelve cars and ten minutes' headway and for forty-eight cars and two and one-half minutes' headway. The above figures are at the rate of \$5 per pound sterling, which is slightly higher than the actual exchange.

High Speed Railways.—In a short article by Mr. Lea in the Lond. "Elec. Eng.," Jan. 5, he bases a calculation on the data given by Dr. Hopkinson, from which he finds that the air resistance per square foot of area is nearly 33 pounds at a speed of 200 miles per hour; this figure is extremely high when compared with 15 pounds, which Mr. Crosby in his experiments found to be 50 per cent too high. He thinks that such speeds will be attained only by a complete change in the type of roadway adopted, and he thinks that the Lartigue single-rail system may be a forerunner of a permanent roadway suitable to high speeds, but he doubts whether any ordinary girder work on a foundation which is more or less shallow would serve the purpose.

Electric Equipment of Steam Roads.—According to the "Elek. Zeit.," Jan. 4, the steam railroad from Arad to Csana-der is to be equipped for a portion of its route with a system of electric traction; the railroad cars will be equipped with electric motors and will receive current from an overhead line; trains can thereby be propelled after the locomotive has been uncoupled; if this is a success the whole line will be changed into an electric road.

Gas Motors for Street Railways.—According to the "Elek.

Echo," Dec. 30, a street car with gas motors was recently started in Dresden; it contains two motors of 8 h. p. each, weighing 1.9 tons each; the car without passengers weighs 8.5 tons; 1.3 cubic metre of gas is carried at 6 atmospheres in 10 receptacles, but it does not state for how long a trip this will suffice.

Liverpool Overhead Railway.—This, the first electric overhead railway, although started as recently as March of last year, is to be extended; although the contractors were under obligations to work the line for two years at 8 cents per train mile, the working has been so satisfactory that the railway company has decided to take over the line from the beginning of this year.

Electric Railways in the British Kingdom.—The Lond. "Elec.," Jan. 5, gives a list of the railways in operation and projected, representing a total of 44 miles, of which 23 3-4 miles are operated by the third-rail system, three by accumulators, two by conduit and 15 1-4 by the overhead (trolley?) system; the projected roads amount to 37 miles.

Rules and Regulations.—The "Elek. Echo," Dec. 30, publishes the rules for electric railways in the city of Leipsic. **CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.**

Central Stations in Germany.—In an article in the "Elek. Zeit.," Jan. 4, comparative data are given for six large stations in Germany, the deductions from which are quite interesting; the data are all given in the form of tables, which cannot be reproduced here, but they are well worth the attention of those interested in central station work. Among some of the features are the following: In general the financial returns, even during the first year of operation, were satisfactory; an amortization of 4 per cent. on the total capital invested is found to be sufficient, among which is an item of 6 per cent. on the accumulators; the increase of the income over the expenses in per cent. of the cost of installation is about 7 per cent. for the lowest of these six stations (Cologne) to about 18 per cent. for the best (Hamburg); a detailed table is given showing the operating costs, the ratio of the generated to the consumed energy, which varies from 70 to 97 per cent., and various other items, general averages of which cannot well be given; the cost of generating per kilowatt hour consumed varies between about 4.7 cents to 7.0 cents. The average watt efficiency of the accumulators varies from 71 to 79.5 per cent. and the loss in the accumulators in per cent. of the total current leaving the station varied from 11 to 14 per cent. In these stations from 35 to 62 per cent. of the total energy came from the accumulators; the maximum current in per cent. of installed lamps varied from about 36 to 68 per cent. and the average time of burning of installed lamps varied from about one to two hours per day.

Central Stations in the British Kingdom.—The Lond. "Elec.," Jan. 5, publishes as a supplement a table of the central stations in operation and in progress in London and in the provinces, giving, in tabulated form, the most important data for each; the table is interesting, especially as there are very few blanks; general deductions of any value can hardly be made.

See also paragraph on "Review of the Past Year," under "Miscellaneous."

Three-Phase Installation at Wangen, Wurttemberg.—The "Rev. de L'Electricite," Dec. 31, describes briefly this installation, which was started in April of last year. There are two stations about one mile apart, which feed in common into the same mains; the principle station has a 200-h. p. dynamo driven by a turbine; by means of transformers the voltage is raised from 3,000 to 5,200; the second station is supplementary and is used only when the first is insufficient; it is located in a factory, the power for which is ready whenever it is required; the second dynamo is a 100-h. p.

machine; the two are connected in parallel by the usual method; in the city there are three secondary transformer stations of 20 kilowatts each; the motors are run from the three wires, but for the lighting the system is divided into three separate currents, each of which leads to different districts, the return being by means of a common neutral wire, thus making four wires in all, and to this modification the successful application to both lighting and power is attributed; motors up to 50 h. p. are in use; an increase of the station is already contemplated.

Multiphase System at Budapest.—This installation, although it has been in operation for only two months, is to be extended; the frequency used is 25 and the voltage 2,000, the multiphase currents being transformed into continuous currents for distribution.

Single-Phase vs. Two-Phase System.—Mr. Kennedy, in the Lond. "Elec. Rev.," Jan. 5, criticises unfavorably the system of Messrs. Reis and Scott recently described in The Electrical World, in which he says that "the extravagant claims made by the inventors cannot be admitted for a moment in the absence of evidence of their having accomplished the feats described"; he states that what they have written does not convey "the remotest idea as to what it is they have really discovered."

Copenhagen.—In the "Elek. Zeit.," Jan. 4, Mr. Uppenborn gives a well illustrated description of this station, installed by the firm of Siemens & Halske; the continuous current, three-wire system is used in connection with a large accumulator battery.

Motive Power and Gearing.—Mr. Carter's serial is continued in the Lond. "Elec.," Jan. 5; he discusses the storage of energy and in general the study of motive power and gearing.

Fuel Economy.—The Lond. "Elec. Rev.," Jan. 5, contains an article on this subject.

WIRES, WIRING AND CONDUITS.

Cost of High Tension Lines.—"La Lum. Elec.," Dec. 30, contains an article by Mr. Bocherot, in which he discusses the various conditions which enter into the problem. He expresses surprise that the statement should have been made (see Digest Oct. 14) that if one accepts as a limit 10,000 volts, for instance, for continuous currents, the effective limit for alternating currents ought not to exceed 7,000 volts, and that therefore an alternating current line costs double that of a continuous current line; he states that experience has shown this reasoning to be erroneous; alternating currents act beneficially on the insulation when compared with the destructive electrolytic action of continuous currents; on account of the lag in phase between the voltage and the current the cost of a line is greater for alternating currents than for continuous currents, but this is of small importance considering the relative ease with which high voltages may be generated with alternating currents. He then discusses the conditions for the minimum cost and gives a proof of Lord Kelvin's theorem; in discussing it, he states that the copper and not the poles, subways, etc., should be considered as variable, and for the price of a kilowatt hour one ought not to take that for the ordinary distribution but that for generating so many additional units; in the case of water power the price of the energy lost should be replaced by the interest and amortization on the capital invested in the increased size of the machines corresponding to the lost power; whether the power is furnished by steam or water the conditions for minimum cost are independent of the length of the line; for overhead lines of bare wire the application of Lord Kelvin's law is quite simple, but not so when the lines are underground; in the latter case there is a third factor, namely, the interest on the capital in the insulation, depending on

the voltage and on the cross-section, and which can be considered as proportional to the voltage and to the diameter, that is, to the square root of the section; if the voltage is fixed in advance, this third factor may be considered as proportional to the square root of the section; he discusses the case of the voltage not being fixed and endeavors to find the most economical value to give to it, for if the expense of the insulation is considered, the highest voltage is not always the most economical; if the loss of energy in the line is considered constant, the section or the price of the copper will be inversely proportional to the square of the voltage; the only expense will then be the sum of three terms, two of which, the loss and the insulation, are constant and the third is inversely proportional to the square of the voltage; the voltage should therefore be as high as possible; if the weight of the copper, that is, the interest on the capital, is assumed constant, the price of the insulation will be proportional to the voltage and the annual expense will be the sum of three terms, of which two are constant and the third proportional to the voltage; in this case it is best to diminish the voltage as much as possible; in the third case he shows how the best conditions may be arrived at by a few trial calculations. He then considers the subject of the capacity of the line and the advantages of using condensers.

Resistances With Alternating Currents, Errata.—In the table published in the Digest last week under this heading, the commas in the values for K should be periods, thus making the values of this constant begin with unity.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Signalling Between Trains in Motion.—The Lond. "Elec. Eng.," Jan. 5, describes briefly the trials made in Germany in October with the Perls system, which resulted very favorably; a battery is carried on each locomotive and is connected by sliding contacts, with conductors laid parallel to the rails, these conductors being divided into block systems in such a way that if two trains are on the same block both engineers will be warned of each other's presence by the ringing of a bell on each locomotive, while at the same time they are brought into telephonic communication with each other.

Interchangeable Telephone System.—The Lond. "Elec.," Jan. 5, publishes an illustrated description of the Sloper system, especially adapted for factories, institutions, dwellings, etc., as no central station and no services of an attendant are required; the system is so arranged that it is impossible to leave the instrument in a condition which interferes with the talking of other stations or in a condition in which it cannot be rung up.

A New Telephone.—"L'Elec.," Dec. 30, quotes from the journal "Le Nord," stating that a new telephone invented by Gwozdeff is to be installed between Odessa and Nicolaieff; no description is given, but it is stated that the telephone can be used for transmissions to very great distances through a single telegraphic wire without interfering with the regular telegraphic services; messages may be transmitted simultaneously in four different directions.

Improved Mouthpiece.—The "Elec. Tech.," Dec. 15, states that in Germany a mouthpiece is being introduced for public telephones, the object of which is to avoid the spread of diseases carried by the condensed moisture of the breath; a pad of a large number of discs of paper, with a hole in the middle, is inserted in the mouthpiece and after or before every conversation the upper disc of paper is torn off.

ELECTRO-CHEMISTRY.

Electrolysis with Alternating Currents.—The Lond. "Elec. Rev.," Jan. 5, calls attention to a paper by Mr. Malagoli in the "Jour. de Physique," August, 1893, in which he states "that the phenomena of electrolysis produced by alternat-

ing currents must be considered as a succession of elementary electrolyses when there are alternations of current; hence it becomes necessary in studying the elementary phenomenon by applying to a single alternation the well-known laws of electrolysis, and then integrating with respect to the number of alternations which the current makes in a given time." At the end of his mathematical discussion he deduces the following general conclusions: "The necessary and sufficient condition under which electrolysis by alternating currents is possible is that the quantity of electricity passing through the voltameter during a single alternation of current must be greater than twice that which is necessary to produce in the voltameter the maximum polarization. Electrolytic production ceases when these two quantities are of equal value and the amount of electrolyte decomposed is proportional to the difference between these two values."

Electric Concentration of Sulphuric Acid.---Mr. Blount, in the Lond. "Elec.," Jan. 5, discusses some recent theoretical calculations, and claims that direct experiment is the only means for determining the value of such a process; hot concentrated sulphuric acid is not a very familiar electrolyte and but few can foretell its behavior with any pretensions to accuracy; experiments have been carried out which, he claims, show that the electric process is not sufficiently economical to supersede the other; a current of 14 amperes and 7 volts was sent through a platinum wire in a beaker of sulphuric acid at 60 degrees B., raising its temperature to 190 degrees and causing it to lose about 11 per cent. in weight in 21-2 hours; the comparatively large loss was due to electrolysis, and sulphur was separated; in order to overcome the effects of electrolysis the acid and the wire were placed in a tube, and it was found that only when the tube was small tolerable results were obtained, but even then the success was not sufficient to warrant its continuance with direct currents, but with alternating currents electrolysis nearly disappeared; thus, with 14 amperes and 7 volts, it was concentrated to 65.8 degrees B., with a loss of weight of less than 20 per cent.; the energy amounted to 1.49 kilowatt hours for 1 kilogram of concentrated acid, which represents an efficiency of 25 per cent. and does not compare favorably with the usual method. (The efficiency, however, seems to be of less importance than the outlay for the large platinum discs required in the usual process.)

Primary Batteries.---Dr. Battandier in "Cosmos," Dec. 23, describes several new batteries; one by Mr. Rosati contains a negative plate of lead, to which 5 per cent. of tin is added to make it oxidizable in sulphuric acid, the positive electrode is made of retort carbon and the liquid is a mixture of equal parts of sulphuric acid and nitric acid, with water in proportion depending upon the desired effects; the lead is dissolved, forming a heavy precipitate, which falls to the bottom, thus keeping the lead surface always clean; the cost of a kilowatt-hour is given at \$1.20, but by selling the bi-products this is reduced to 40 cents, if the battery is used on a large scale. In the battery of Kousmine carbon plates are surrounded by a 7 per cent. solution of chromate of potassium, while the zinc is in sulphuric acid, the liquids being separated by their specific gravity. He also mentions a process for reversing a Daniell cell; after a cell is exhausted the liquids are poured away, sulphuric acid is poured in the porous cup containing the copper, while a concentrated solution of sulphate of zinc is poured in the portion containing the zinc, the cell is then short circuited, in which case it is claimed that the current is reversed, the copper being dissolved into copper sulphate and the zinc deposited from the solution on to the electrode, after which the cell is again ready for use; he does not vouch for the correctness of this statement.

Purification of Sewage.---Mr. Webster, in a communication

to the Lond. "Elec. Rev.," Jan. 5, claims that the Hermite process at present used is covered by his (Webster's) patent of 1887, from which he quotes at some length. He claims that the hypochlorous acid formed, although an admirable disinfectant, acts injuriously on bricks, cement, metals, etc.; instead of electrolyzing sea water and mixing it with the sewage he advocates treating the sewage directly, in which case the chlorine compounds are much more active than chlorine in solution; the sewage need only have its alkalinity neutralized; he describes at length his process, in which the sewage is brought into contact with large positive and negative electrodes of iron, which produces an effluent not liable to secondary decomposition and innocuous to the rivers into which it flows.

Electric Tanning.---A short description of the projected installation at Orbe, Switzerland, using the Groth system, is given in the Lond. "Elec. Eng.," Jan. 5; this installation when finished is estimated to turn out 1,000 hides per week; the power is obtained from a waterfall nearly two miles distant. The results of a test made by Prof. Unwin are given, in which he states that the leather thus tanned is rather above the average strength of good leather belting.

MISCELLANEOUS.

Electric Ignition of Benzine in Laundries.---Referring to the danger of the ignition of benzine by the discharge of the electricity generated in rinsing clothing in baths of benzine, as described in the Digest last week, Dr. Goehring states in the "Elek. Rundschau," No. 6, that by adding to the benzine 2 per cent. of a soap which is soluble in benzine the danger is completely avoided, as it is then no longer possible to detect even the slightest electrification by means of an electroscope; its properties as a cleansing material are not only not destroyed thereby, but even increased.

Review of the Past Year.---The Lond. "Elec." Jan. 5, gives a general review of the electrical industry during the past year, especially in Great Britain; it states that there has been a considerable and sound extension in the business of supplying electricity; no new central stations have been opened in London; the twelve companies and one vestry in London have about 700,000 lamps of 8 c. p. connected, as compared with 500,000 a year ago; prices have gone down and dividends are said to go up; it is followed by a diagram showing by means of lines the statistics for London and the provinces for the year 1889.

The Lond. "Elec. Rev.," Jan. 5, also reviews the past year in an editorial. It states that "some persons affirm that the year has been fairly prosperous, but a dismal cry comes from the great majority; * * it must be confessed that the record at best is a sombre one." It states that there has been a considerable increase in central stations and that most of them are due to municipal enterprise; a year ago the number of alternating and direct current systems was about equal, but now the proportion is 45 to 34, and among the more recent ones 21 to 9; house transformer systems are being abandoned in favor of central transformer chambers.

The editorial on the same subject in the Lond. "Elec. Eng.," Jan. 5, includes quite a large number of letters from different English manufacturers, enumerating the work accomplished by them during the past year.

Summary of Electrical Events for 1893.---The Lond. "Elec." Jan. 5, publishes a good chronological summary, not only for Great Britain, but for the electrical world in general.

An Electric Balloon.---The "Rev. de l'Electricite," Dec. 31, states that at the Antwerp exhibition of 1894 there will be a balloon driven electrically, which will make regular trips from the centre of the city to the exhibition; it will be about 260 feet long and 52 feet in diameter, carrying from

20 to 25 passengers, and will be operated by 125 h. p.; it will receive its power through a flexible cable connected to a sort of trolley, which travels on fixed overhead wires, the current being generated by gas engines; the amount of power per unit of weight of the balloon is by this means increased sevenfold over that if the source of power were contained on the balloon itself; in the latter case it was found that at least 110 pounds were required per effective horse power, and even then it would not be powerful enough to resist a strong wind. (The idea of supplying power to a balloon from fixed overhead wires and a travelling contact was suggested several years ago by Dr. Bonwill, of Philadelphia, in a paper read at the Franklin Institute.)

Electric Shot Firing in Mines.—The Lond. "Elec." Jan. 5, publishes an abstract of a paper by Mr. Houghton, which, however, is intended more for mining than for electrical engineers. He states that electric firing has made very rapid strides and is considered by the government inspectors to be the only safe method by which the safety explosives now in use can be fired. In the history of this subject he says that "Mr. Franklin in America" suggested the possibility of the electric ignition of gunpowder in 1751. He explains in detail the different systems, including high and low tension electric exploders and fuses, the series and the parallel circuit system.

Acidity Indicator.—According the "Elek. Tech." Dec. 15, an instrument was exhibited in Paris for indicating the degree of acidity during the process of fermentation; it consists of a zinc and a copper plate bolted together so as to remain a fixed distance apart, which are inserted in the liquid and short circuited from a galvanometer, the reading of which will indicate the degree of acidity, and may be used to measure it.

Ignition of Benzine in Chemical Laboratories.—Referring to the phenomenon mentioned in the Digest Jan. 13-20, Dr. Richter, in the "Elek. Echo," Dec. 30, states that by the addition of one-hundredth of one per cent. of a liquid, the composition of which is kept a secret, the generation of electric discharges and the consequent ignition of the benzine ceases completely.

Cranes.—The Lond. "Elec. Eng." Jan. 5, contains the first part of an article on cranes and hoisting apparatus in general, which is to be followed by one on electrical cranes.

Electric Machine for Voting.—The "La Lum. Elec." Dec. 30, abstracts briefly a description from the "Rev. Universelle" of the Moreau machine.

Expenses of an Electrical Engineering Business.—The Lond. "Elec. Eng." Jan. 5, contains an article by Mr. Sydney F. Walker under this heading, the object of which is to deter those engaged in this business from the stupid practice of cutting prices.

Controlling Hemorrhages by Electricity.—The Lond. "Elec. Rev." Dec. 29, abstracts an article by Dr. Goelet, of New York, on this subject.

Electricity in Medicine.—The "Elek. Echo," Dec. 23, reprints a paper by Dr. Bloebaum.

A Peculiar Case of an Explosion.

At a further inquiry into the recent explosion on board the "Resolution" at Devonport the primary cause of the accident was ascertained. Part of the mechanism of the evaporator, says the London "Electrician," consists, it seems, of a quantity of zinc slabs and copper pipes; the salt water to be distilled caused electro-chemical action to take place, and it was due to the accumulation of hydrogen and oxygen thus liberated that the explosion occurred. The evaporator is fitted with a safety valve, which, if opened by hand, would have allowed the hydrogen to escape.

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—Boston Journal of Commerce.

THE MOST IMPORTANT AND INFLUENTIAL ELECTRICAL JOURNAL. The Electrical World, No. 1 of Volume XXIII, comes in a revised form. The size of the pages has been reduced, allowing the publication to be conveniently carried in the pocket. The letter press is in new and modern type, and the paper is of fine quality. The number contains 40 pages of reading matter, and combines all the essentials of a technical newspaper, with many of the elements that go to make up the highest class magazine.

—The Jewelers' Circular.

A NICE-FITTING GARMENT. The Electrical World made its appearance last week in a new form, being very neatly and completely presented in 9 3/4 x 13 size. We congratulate the W. J. Johnston Company on the improvement. Our readers will remember a larger paper. The World was rather clumsy to handle, but in its present form it can be easily carried and more practically bound. It contains the same, if not a larger amount, of useful information and data, while its facilities for advertisement are greatly improved and more to the point. The Electrical World has our best wishes for 1894.

—National View, Washington, D. C.

Moonlight Tables for February, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of February under his modified form of moonlight schedule.

TABLE NO. 1 Standard Moonlight Philadelphia System				TABLE NO. 2 Frund's New Moonlight System.			
Date	Light	Date	Exting	Date	Light	Date	Exting
1	5:50 P. M.	8	6:10 A. M.	1	5:50 P. M.	8	6:10 A. M.
2	5:50 "	9	6:10 "	2	5:50 "	9	6:10 "
3	5:50 "	10	6:10 "	3	5:50 "	10	6:10 "
4	5:50 "	11	6:10 "	4	5:50 "	11	6:10 "
5	5:50 "	12	6:10 "	5	5:50 "	12	6:10 "
6	5:50 "	13	6:10 "	6	5:50 "	13	6:10 "
7	5:50 "	14	6:10 "	7	5:50 "	14	6:10 "
8	5:50 "	15	6:10 "	8	5:50 "	15	6:10 "
9	5:50 "	16	6:10 "	9	5:50 "	16	6:10 "
10	5:50 "	17	6:10 "	10	5:50 "	17	6:10 "
11	5:50 "	18	6:10 "	11	5:50 "	18	6:10 "
12	5:50 "	19	6:10 "	12	5:50 "	19	6:10 "
13	5:50 "	20	6:10 "	13	5:50 "	20	6:10 "
14	5:50 "	21	6:10 "	14	5:50 "	21	6:10 "
15	5:50 "	22	6:10 "	15	5:50 "	22	6:10 "
16	5:50 "	23	6:10 "	16	5:50 "	23	6:10 "
17	5:50 "	24	6:10 "	17	5:50 "	24	6:10 "
18	5:50 "	25	6:10 "	18	5:50 "	25	6:10 "
19	5:50 "	26	6:10 "	19	5:50 "	26	6:10 "
20	5:50 "	27	6:10 "	20	5:50 "	27	6:10 "
21	5:50 "	28	6:10 "	21	5:50 "	28	6:10 "
22	5:50 "	29	6:10 "	22	5:50 "	29	6:10 "
23	5:50 "	30	6:10 "	23	5:50 "	30	6:10 "
24	5:50 "	31	6:10 "	24	5:50 "	31	6:10 "
25	5:50 "			25	5:50 "		
26	5:50 "			26	5:50 "		
27	5:50 "			27	5:50 "		
28	5:50 "			28	5:50 "		
29	5:50 "			29	5:50 "		
30	5:50 "			30	5:50 "		
31	5:50 "			31	5:50 "		

Total hours, 196.

Total hours, 240.

Regulation of Arc Currents.

BY DANIEL HIGHAM.

An electric light possesses the seemingly curious property that the E. M. F. required to sustain it falls with increase of current and rises with decrease of current, for which reason it is an impossibility to supply an arc of given and fixed length under constant potential, since it would either take an infinitely great amount of current or extinguish itself entirely. This is the unstable condition of the electric arc.

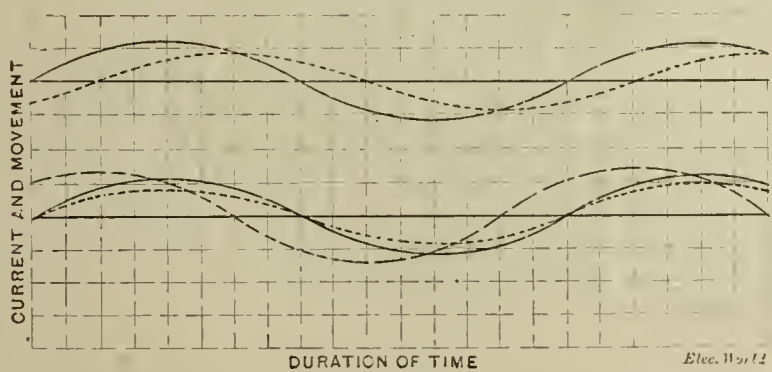
Theoretically, the E. M. F. of an arc could be made to rise with increase of current and fall with decrease of current by lengthening and shortening the arc by a magnet mechanism; but such an action has not been practically carried out, because it has always been behind time in its movement, and a hammering or pumping condition of instability has, in consequence, always resulted.

Instability is overcome in multiple arc lighting by inserting a resistance in each arc branch in order that an increase of current will require a slight increase of E. M. F., and a decrease of current a slight decrease of E. M. F. at the terminals of the branch E. M. F. About 25 per cent. of the watts taken by a lamp are used in this resistance to overcome the unstable condition of the arc, and about 35 per cent. to overcome the hammering, or pumping, condition of instability in the type of lamp in which the arc is lengthened and shortened by variations of current, for which reason the type of lamp now adopted for multiple arc lighting is one in which the magnet mechanism operates simply to feed the carbons.

In series arc lighting stability is obtained by designing the dynamo to work down on the dip of the characteristic, where the E. M. F. will fall with increase of current and rise with decrease of current, to meet the requirements of the arc, but this is obtained at a sacrifice of efficiency and at an increased cost of the dynamo.

The writer, however, assures stability of current in the multiple system without the resistance in the branch by making the current which controls the lamp magnet mechanism (so far as pertains to lengthening and shortening the arc) advance in phase ahead of the current flowing through the arc, and in the series system by making the current which controls the regulator of the dynamo, the mechanism of the lamps, or both, advance in phase ahead of the current in the main or working circuit.

Fig. 1 will serve to illustrate the lag, or loss, of time in the movement of the lamp magnet mechanism of the type



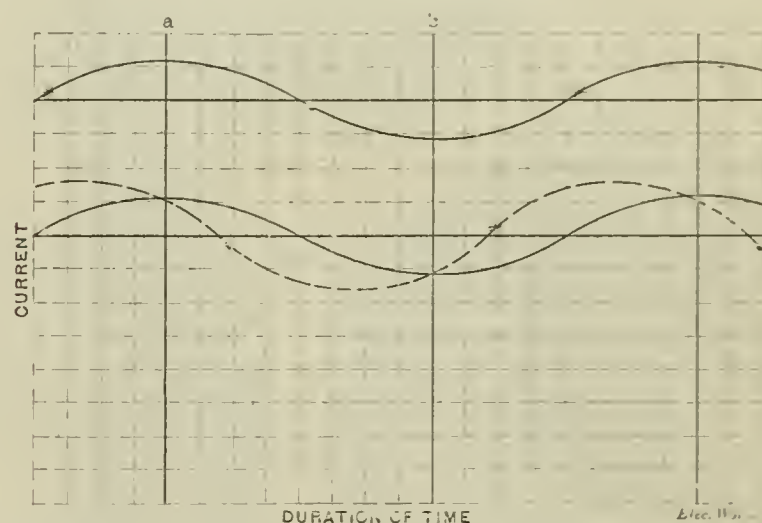
FIGS. 1 AND 2.—REGULATION OF ARC CURRENTS.

of lamp in which the arc is lengthened and shortened by variations of current. The full curve represents an abnormal wave variation of current flowing through the arc and operating (by means of the series coils in the lamp) the lamp magnet mechanism; the dotted line represents the movement of the lamp magnet mechanism, and the straight, or horizontal, line the mean, or normal, intensity of the current and position of the lamp magnet mechanism—the abscissae denoting time and the ordinates the intensity of current and the movement of the lamp magnet mechanism. From this diagram it will be seen that the length of the arc, if con-

trolled by the movement of the lamp magnet mechanism, would not be lengthened and shortened with the rise and fall of current flowing in the former, and a hammering, or pumping, condition of instability would be the result, in the absence of the resistance in multiple arc lighting and of the low efficiency design of dynamo in series arc lighting.

Fig. 2 illustrates the writer's method of operating lamp magnet mechanism in order to lengthen and shorten the arc with the rise and fall of current flowing through the same. The dash line represents a wave variation of an independent, or branch, current, made to differ in phase from the wave variations of current flowing through the arc, and adapted to operate the lamp magnet mechanism. From this diagram it will be seen and understood that the independent, or branch, current would operate the lamp magnet mechanism (allowing for the same amount of lag shown in Fig. 1) in phase with the wave variations of current flowing through the arc, so that stability would be obtained within a small variation of current, according to the sensitiveness of the lamp magnet mechanism employed, and without the need of the resistance or the necessarily inefficient design of dynamo mentioned above.

Fig. 3 will serve to illustrate the loss of time in the per-



FIGS. 3 AND 4.—REGULATION OF ARC CURRENTS.

formance of arc circuit regulators, such as now used in connection with series arc lighting. The full curve line represents an abnormal wave variation of current in the main, or working, circuit, the straight line the mean, or normal, intensity of current, the star (*) the point of time in the wave variation of current, where the regulating mechanism moves to check the rise of current and the period (.) the point where the regulating mechanism moves to check the fall of current; time being denoted by the abscissae and the intensity of current by the ordinates. From this diagram it will be seen that the time from ordinate *a* to ordinate *b* when the current is falling will be more than half spent or lost before the regulating mechanism moves to check the fall of current, and that the time from ordinate *b* to ordinate *c* when the current is rising will be more than half spent or lost before the regulating mechanism moves to check the rise of current, so that hammering, or pumping, condition of instability (adding to that defect in the lamps) would be the result, in the absence of the low efficiency design of dynamo referred to.

Fig. 4 illustrates the writer's method of operating arc circuit regulators in order to make this loss of time less than half the amount spent during the rise and fall of current. The broken line represents a wave variation of an independent, or branch, current, made to differ in phase from wave variations of current in the main, or working, circuit, and adapted to operate the regulating mechanism of the dynamo. From this diagram it will be seen that only a small portion of the time from ordinate *a* to ordinate *b* when the circuit is falling will be lost before the regulating mechanism

ism moves to check the fall of current in the main, or working, circuit, and that only a small portion of the time from ordinate *b* to ordinate *c* when the current is rising will be lost before the regulating mechanism moves to check the rise of current in the main, or working, circuit; as a consequence stability would be thus attained within a small wave variation of current, according to the sensitiveness of the regulating mechanism employed, and without the need of any, or very little, of the properties of stability now given to dynamos used in series arc lighting.

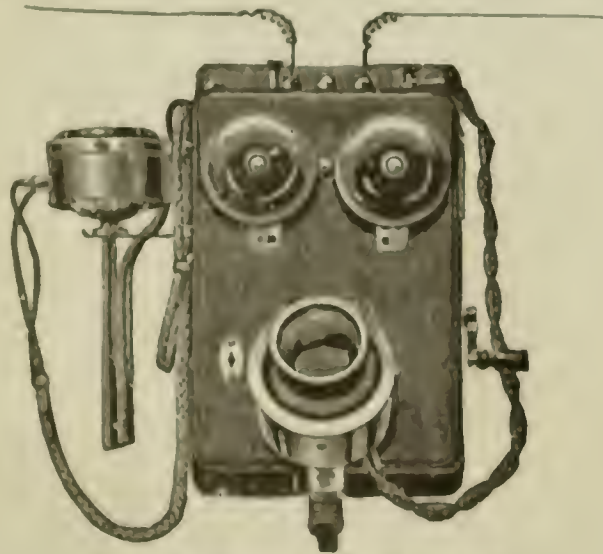
This method of operating or regulating mechanism by an independent, or branch, current advanced in phase ahead of the current wave variations in the main or working circuit is readily accomplished by connecting a coil of high self-induction in parallel with the coil or coils which operate the regulating mechanism—that is, in connection with lamp magnet mechanism—by connecting a coil of high self-induction in parallel with the series acting coils of the lamp, or lamps, and, in connection with dynamo regulating mechanism, by connecting a coil of high self-induction in parallel with the coil or coils which affect the movement of the dynamo regulator. By this means every wave variation of current in the high self-induction branch would be made to lag in phase, and consequently every wave variation of current in the branch operating the regulating mechanism would be made to advance ahead in phase—in the series acting coils of the lamps or the coils of the dynamo regulator, as the case might be.

The resistance of an induction coil to produce the necessary difference in phase between the current operating the regulating mechanism and the current in the main, or working circuit, has been found by the writer in the case of the dynamo regulator to be about an ohm for a ten ampere current in the main circuit, and in connection with lamp magnet mechanism for multiple work about one-third of an ohm.

The Brown Telephone.

A telephone will be placed upon the market by the Brown Telephone and Telegraph Company, Manhattan Building, Chicago, upon the expiration of the Bell patent on Jan. 30, for which many claims of superiority are made.

The Brown transmitter will, it is claimed by the manufacturers, speak distinctly over a distance of 200 miles or more with a metallic circuit, half that distance with a ground



THE BROWN TELEPHONE

return and 1,000 miles with a special transmitter. Spluttering noises and vexatious confusion of sounds are obviated and the annunciator is surprisingly clear.

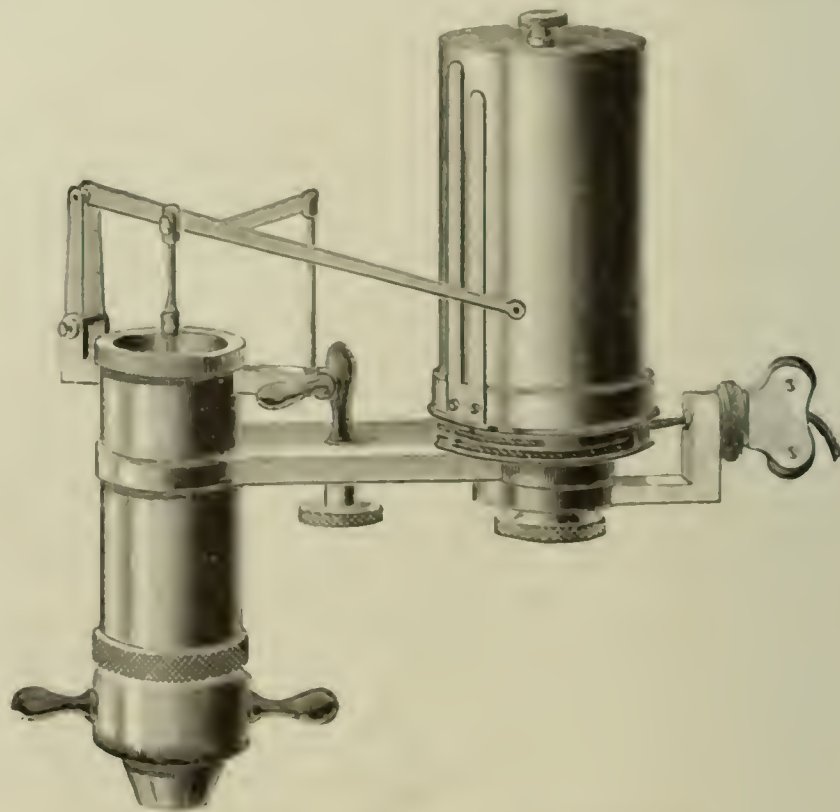
Owing to the absence of any battery the telephone needs no attention, and is satisfactory in all states of weather, and if accidentally put out of order it can be easily adjusted by any one.

The Brown telephone is a magnetophone and is sharply differentiated, it is claimed, from all other telephones of its type by the employment of repulsive magnetism. Without the incorporation of this basic principle, the patentee claims that no magnetophone can be made of any commercial value, but are limited to a mile or a little better in their range, and even for such short distance they transmit the voice in a most unsatisfactory and fragmentary way. It is also claimed that for want of this basic principle the Bell Telephone Company is compelled to employ a battery, and that a battery telephone has never yet given full satisfaction.

The manufacturers state that with the aid of expert electricians in their employ they have, at the expense of much time and money, invented their own call dynamo, switch and magneto bell, and have constructed them upon lines so distinct from any employed by others that there can be no question of infringement against the Bell patents.

A New Indicator.

A new Thompson improved indicator recently brought out by Messrs. Robertson & Thompson, 57 Cortlandt street, New York, is shown in the cut below. It is the standard size, with a piston one-half an inch in area, and exhibits in every detail workmanship of the highest class. The



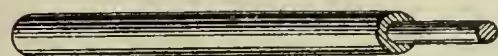
THOMPSON IMPROVED INDICATOR

parallel motion is the Thompson improved, designed so that the movement of the pencil is proportional to that of the piston at all points of the stroke. The drum is very light, with cone bearings to take up wear. The double guide pulley can be swiveled so that the cord may lead in any direction.

Bimetallic Wires for Telephonic Transmission.

A patent has been recently issued to Mr. W. H. Eckert, 80 Broadway, New York, for an improvement in telephonic transmission, and, generally, in the distribution or transmission of rapidly alternating currents, whose claims are startling in their character. Mr. Eckert is so well and honorably known in the electrical circles, however, where he has occupied positions of the greatest prominence, that claims made by him are entitled to respectful consideration, particularly as they relate to a branch of electricity in regard to which, with our present knowledge, it would be hazardous to dispute the improbability of any assertion from a competent source.

According to the patent specifications the invention for the most part consists in the discovery that telephonic transmission, or rapidly alternating currents in general, may be more perfectly effected upon a bimetallic conductor, such as steel and copper in substantially equal parts, than upon a conductor of one material, such as copper; and with the advantage that such transmission may be effected upon a circuit consisting of a single composite wire and an earth return as perfectly as though two copper wires, each of equal conductivity, were arranged in a closed metallic circuit. In other words, it is found that a single bimetallic conductor joining two distant points is a more perfect medium for tele-



BIMETALLIC WIRES FOR TELEPHONIC TRANSMISSION.

phonic transmission and for conveying generally rapidly alternating currents than are two copper conductors, each of a resistance equal to that of the bimetallic wire; and that from this fact the two conductors necessary to form a single metallic circuit may be replaced by a single wire costing little, if any, more than one-half of a copper metallic circuit. It has also been discovered that less insulation is needed to protect a bimetallic wire than is necessary for copper or other single-substance conductors, in the transmission of rapidly alternating currents, and that from this fact not only the expense of constructing cables, whether aerial, underground or submarine, may be greatly reduced, but more wires may be placed within a cable than could be done if the usual thickness of insulation were used. Moreover, for the transmission of alternating currents wires of smaller conductivity, according to the ordinary resistance measurements, may be used than is possible if they were constructed of copper, iron or other single metal.

The patentee states that he is aware of what is popularly termed the "Ferranti effect," and that it has long been known that in the mains of Ferranti's circuit potentials are higher at a distance than at the source of generation; but notwithstanding prior knowledge of this law or effect, he believes that he is the first to point out the fact that alternating transmissions are aided or made more perfect by the use of bimetallic conductors.

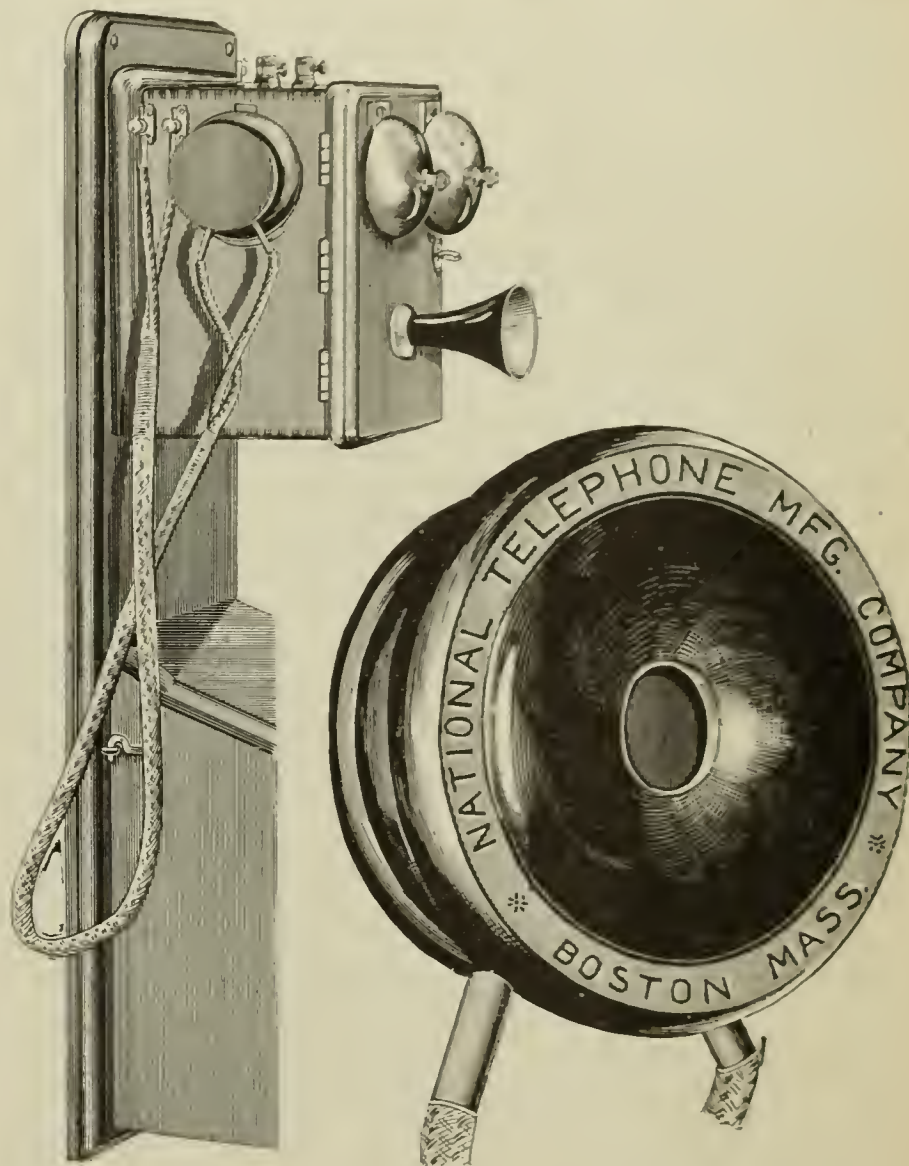
Either iron or steel may be used with copper, but steel is better adapted to the purposes of bimetallic wire and its use in transmitting alternating currents to great distances. Other dissimilar metals of essentially different specific resistances may be used to advantage in transmitting alternating currents, but to what extent their adoption would be beneficial the patentee is unable to state. The accompanying illustration shows a bimetallic wire with an iron or steel core with a copper coating.

Mr. Eckert has no theory to account for his claims, which he bases upon actual realizations. Among the experiments made was to lay a composite bare wire of No. 20 B. & S. gauge ten miles long on the ground, when it was found that telephonic articulation was not impaired. Mr. Eckert also recalls the telephonic experiment over the composite line of the Postal Telegraph Company between New York and Cleveland and New York and Chicago in 1883, when, with the circuit grounded at both ends, it was found that conversation could be carried on with ordinary Bell receivers. An account of these experiments will be found in *The Electrical World* of March 17 and 31, and April 14 and 21, 1883.

Long-Distance Transmitter.

The accompanying illustrations represent a new long distance transmitter manufactured by the National Telephone Manufacturing Company, 620 Atlantic avenue, Boston, Mass. We are not at liberty at present to explain the construction of this new instrument, but it is claimed that it fully equals anything of its kind heretofore introduced to the public. The cut illustrates the little instrument full size, but it is nevertheless a compound receiver telephone and different, it is claimed, from anything of its kind ever produced in this country. The magnets are not horseshoe in shape, but full circles of the finest steel.

It has been the aim of this company to produce a telephone peculiarly its own in style and shape, and one that infringes



A NEW TELEPHONE.

no patents. It claims that in this it has succeeded, in which respect it is alone, and that it is now in correspondence with many street car, electric light and even Bell sub-companies for the purchase of its instrument, which are sold outright.

The New-Comer in the Electrical Field.

The Walker Manufacturing Company, of Cleveland, Ohio, whose intention of entering the electrical manufacturing field we have before referred to, announces that it has made all preparations and is now about to commence manufacturing electrical machinery and appliances. With the fine manufacturing equipment of this company, its eminent business qualifications and competent technical advisers, there can be no doubt as to the high standing it will take and the services it will render to the electrical industry.

Injunction Dissolved.

On Tuesday, Jan. 23, Judge Ricks dissolved, without bonds, the injunction against the Buckeye Electric Company of Cleveland, Ohio.

Financial Intelligence.

The Electrical Stock Market.

New York, Jan. 22, 1904.

THE ELECTRICAL STOCK MARKET has strengthened considerably during the week, like the other industrials. This is due in a large measure to Secretary Carlisle's issue of bonds, which put a better tone on the whole market. From the ready demand for the bonds there seems to be plenty of purchasers for good securities, and when the electrical stocks are proven to be a thoroughly safe investment there will be no trouble in disposing of them to the public.

GENERAL ELECTRIC stock has been under fire during the week, but has lost but a fraction of a point thereby. There was a well-concerted bear attack on the stock at the announcement of a receiver for the local Thomson-Houston Company, but as the General Electric people had no connection with it, the bear raid failed and the stock has held its own. Transactions in it were heavy, 10,244 shares being sold on Thursday. The selling was largely on Boston orders. The stock showed greater strength during the week than it has for some time. It is now offered at 26 1/4.

THE EDISON ELECTRIC ILLUMINATING COMPANY has issued its annual report and the directors are much encouraged over it, for, despite the prevailing hard times, the demand for light has exceeded the company's capacity to supply. The ratio of increased earnings, as might be expected, is not as great as in former years, though there was a gain of 22 per cent. in net earnings for 1893 over 1892. The report shows gross earnings for 1892 to be \$1,193,338, an increase of \$259,763 over the preceding year, and a surplus in the treasury of \$42,794. Since 1890 the gross earnings have increased from \$188,595 to \$1,221,560, and the net from \$33,222 in 1884 to \$581,678. The company now has almost four times the number of customers that it had in 1890, and is running 192,691 incandescent lamps and 2,538 arc lights. During the year \$1,000,000 of bonds were disposed of, and the company has now \$750,000 under option. The bond sale was required for additional plant in order to meet the demand for more light, but it is thought that the bonds out will be sufficient to meet all needed additions for 1894. The authorized capital stock is \$10,000,000, of which \$2,062,000 is in the treasury. The first mortgage bonds authorized are \$1,312,000, of which \$750,000 are in the treasury, but on which an option has been given. The only change made in the management at the annual meeting was the election of W. E. Glyn as a director in the place of Director Henry, who has resigned. The stock of the company is still quoted a trifle below par owing to the depressed stock market and its now being an ex-dividend security. This is a low figure for a good 6 per cent stock, and is considerably below the Edison Illuminating properties of Philadelphia and Chicago. A year ago the New York Edison stock was ranging around 120, rivaling the General Electric Company. From the present quotation, 99, it is seen that it has stood fire much better than the General Electric security, and the transactions in it on the Exchange show it to be looked upon as a sound investment. In view of the fact that the business of the company is said to have increased 33 per cent. the first fifteen days in January over that of last year, and with the indications of a stronger electrified stock market, the stock looks like a good purchase.

THE BROOKLYN EDISON ELECTRIC ILLUMINATING COMPANY stock is quoted one point lower than at the close of last week, as it is ex-dividend. The annual report of the company shows an increase of net earnings of \$62,242, which indicates that the Brooklyn Edison, considering its capitalization, compares favorably with the Edison companies of other large cities. During the past week the bids for lighting the streets and public buildings of Brooklyn were opened, and it is thought the Edison people will secure a good share of the contract. The field has hitherto been entirely occupied by the Municipal and Citizens' electric light companies, but since the change in the municipal government the Edison people will probably be given their due rights. The Edison stock is a 5 per cent security and is now held at 101.

ELECTRICAL STOCKS

	Par	Bid	Asked
Brush Ill., New York	50	20	10
Detroit Electrical Works	10	9	3
Cleveland General Electric Co	—	85	90
East River Electric Light	100	—	60
Electric Con. & Supply Co., pref.	15	15	16
" "	15	15	17
Edison Electric Ill., New York	100	99	100
" " " 1sts	—	100	—
Edison Electric Ill., Brooklyn	100	99	101
" " " Boston	100	112	117
" " " Chicago	100	115	120
" " " Philadelphia	100	120	124
Edison Electric Light of Europe	—	—	—
" Bonds	—	85	87
" Ore Milling	—	5	12
Fort Wayne Electric	—	1	2
General Electric Company	100	99	100
" " " deb. 5%	—	—	—
Interior Conduit and Ins. Co	100	35	35
Mount Morris Electric	—	—	—
Westinghouse Consolidated	50	41	44
" " " pref.	50	38 1/2	44
Western Union Telegraph	—	85 1/2	85 1/2

New Incorporations.

THE BLACK AND BOYD MANUFACTURING COMPANY, capital stock \$25,000, has been formed to manufacture electric light and gas fixtures. J. E. Black, 139 East 21st street; W. P. Boyd, 216 West 22d street, and H. Plant, 14 East 87th street, all of New York, are the organizers.

THE WALLACE ELECTRIC COMPANY, Chicago, Ill., capital stock \$2,000, has been formed to manufacture, buy, sell, etc., electrical goods and supplies, etc., etc. The incorporators are W. J. Candlish, K. V. Lansing and F. Pebbles.

THE A. C. WOLFRAM ELECTRIC COMPANY, St. Louis, Mo., capital stock \$20,000, has been formed to manufacture and sell electrical machinery, etc. The promoters are A. C. Wolfram, T. J. Wolfram and H. W. Buckner, all of St. Louis.

THE BIG HOLE IMPROVEMENT COMPANY, Butte, Mont., capital stock \$100,000, has been formed to supply electric power, electric railways, and other improvements. W. A. Clark, A. H. Wethey and C. W. Clark are the interested parties.

THE MANCERONA ELECTRIC LIGHT AND POWER COMPANY, Mancersona, Mich., capital stock \$10,000, has been formed to furnish electricity for light, heat and power. J. W. Morris, J. H. Andrews and J. R. Jenkins, of Mancersona, are the interested parties.

THE LAKE CHELAN AND COLUMBIA VALLEY RAILROAD COMPANY, Spokane, Wash., capital stock \$500,000, has been formed to carry on a general steamship, railroad and electric motor business. F. H. Cook and L. C. Cook, of Spokane, are interested therein.

THE FISHER ELECTRICAL MANUFACTURING COMPANY, Detroit, Mich., capital stock \$50,000, has been formed to manufacture and sell electric lighting plants, steam engines, dynamos, etc. C. H. Meday, W. E. Reilly and F. E. Fisher, Detroit, Mich., are interested.

THE LEFFLER ELECTROMAGNETIC RAILWAY COMPANY, Chicago, Ill., capital stock \$1,000,000, has been formed to manufacture and construct electrical, magnetic and electromagnetic railways, cars, motors, conduits, systems, machines and appliances. P. W. Leffler, W. L. Platt and James Brady are the incorporators.

THE PRIESTLY ELECTRICAL SUPPLY COMPANY, San Francisco, Cal., capital stock \$100,000, has been formed to manufacture and deal in electrical apparatus and machinery, patents and patent rights. L. G. Harvey, J. M. Beck, E. M. Bray, E. F. Murdock, all of Oakland, and H. E. Wright, San Francisco, Cal., are the promoters.

THE HOLT ELECTRIC STORAGE COMPANY, Camden, N. J., capital stock \$10,000, has been formed to manufacture, buy and sell storage batteries, electrical supplies, etc. The organizers are N. H. Edgerton, Kirkland; A. B. Felt, 1509 Columbia avenue; L. H. Clymer, 1608 North Eighth street, and J. F. Holt, 1335 Poplar avenue, Philadelphia, Pa.

THE GREAT BRITAIN AND CONTINENTAL PRINTING TELEGRAPH COMPANY, New York, maximum capital stock \$1,000,000, has been formed to construct, equip and maintain lines of telegraph in Great Britain, Germany, Belgium, and all other countries of continental Europe. The organizers are C. F. Meek, New York; Joseph Thorne, Port Richmond, N. Y., and Abner McKinley, Canton, Ohio.

THE HARBOR LIGHT AND POWER COMPANY, San Francisco, Cal., capital stock \$100,000, has been formed for manufacturing machinery, etc., for generating light, heat and power, and to deal in and operate telephone and other lines, etc., etc. The promoters are A. Devoto, W. B. Breadwell, H. J. Kuhlmeier, W. W. Brown and G. B. Fraley, all of San Francisco, Cal.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
100 N. 11th Street, New York, Jan. 22, 1904.

MAYOR GILROY has approved the resolutions authorizing the extension of the Lexington Avenue Street Railroad to the Astoria Ferry, and the building of a connecting line by the Ninth Avenue road from 125th street to the Fort Lee Ferry.

HON. C. P. VEDDER has been elected by a unanimous vote general manager of the Cataract Electric Company, which company owns the rights for the distribution of electricity from Niagara for all of New York State outside of Erie and Niagara counties.

THE THOMSON-HOUSTON ELECTRIC COMPANY, of New York, has gone into the hands of a receiver, at the instance of Henry R. Worthington, a judgment creditor of the company for \$176,000. As the company is only a local one and has no connection with the General Electric Company, it had no bearing upon the electric stock market.

THE LONG ISLAND TRACTION COMPANY has secured con-

trol of the Broadway and associate lines of Brooklyn, and, according to President Daniel F. Lewis, of the Brooklyn City Railroad Company, the consolidation forms the most extensive system of street surface railroads in the world. The capital of the company is \$10,000,000, and the system will cover 106 miles of track when the lines are extended as intended. As the trolley system is the motive power, it means big contracts for the electric companies.

ELECTRICITY ON THE BROOKLYN BRIDGE.—A correspondent writes to the "Morning Advertiser" as follows: "I see that the project to put the trolley on the Bridge is beginning to take shape in a proposition from the Brooklyn and Kings County Elevated railroads to the trustees. There is a big steal in this and I advise the 'Morning Advertiser' to look out for it. It is an attempt to still further aid the Brooklyn elevated roads at the expense of the people."

MR. J. KYTE COLLETT, in a recent issue of the New York "Herald," describes a plan for rapid transit which was submitted by him to the Rapid Transit Commissioners when they first took up the consideration of the problem of rapid transit in New York. It consists, briefly, of a car or carriage suspended from an aerial cable and provided with one or more aeroplanes. The motive power would be electricity. High rates of speed would be possible, he claims, because the weight of the cars at such speeds would be sustained by the aeroplanes.

R. T. WILSON & CO. has proposed to the Rapid Transit Commission to construct underground railways in New York, using electricity as the motive power, and also for light and heat, as follows: From the Battery, underneath Broadway and the Boulevard to Fort George on the West Side; another projected line would start from 14th street and Broadway and run up Fourth avenue to 42d street, and thence to Harlem, possibly through Madison avenue or Lexington avenue. The proposition is coupled with the condition that the city shall loan the enterprise \$30,000,000 of the \$45,000,000 required.

THE JAMAICA AND BROOKLYN RAILROAD COMPANY stockholders on Jan. 15 met at the office of the Broadway Railway Company, No. 29 Broadway, and ratified a lease by which the companies are practically consolidated. The Broadway Company controls the East New York line, Reid avenue line, and Sumner avenue line. Hereafter the companies will be known as the Brooklyn, Queens County and Suburban Railroad Company. Rumors have been in circulation for some time that the Brooklyn City Railroad Company was negotiating for the purchase of the Broadway Company. Last evening at the office of the latter company no information on this subject would be given. That a lease between the Broadway Company and the Jamaica and Brooklyn Company had been signed was the only information obtainable.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Jan. 20, 1894.

MR. J. N. EMMONS is now in charge of the General Electric factories at Lynn. Some of the departments are being consolidated and will remain at Lynn, it is said.

HON. MOODY BOYNTON has asked for the grant of charters for elevated bicycle railways connecting all the depots of Boston, with branches radiating to Cambridge, Somerville, Lowell, Lynn, Salem, Beverly, Quincy, Brockton, Dedham, Attleboro and Providence.

THE COMMITTEE ON MERCANTILE AFFAIRS of the Massachusetts House of Representatives gave a hearing Jan. 18 on Representative Hoar's bill to place the wires of Boston underground. Among those in attendance were Vice President Cummings and Counsel Hyde, of the West End Street Railroad Company; Fire Commissioners John R. Murphy and George H. Innes, and Osborne Howes, Jr., secretary of the fire underwriters. Mr. Murphy stated for the fire department that he was not particular that all wires should be placed underground now, but that a beginning should be made in that direction in the congested part of Boston, where, he said, 20 per cent. of the wires were high tension. He stated that his department could do better work with no overhead wires, and that also by the removal of them from overhead to underground the insurance companies would lower rates. The hearing was adjourned one week, when further information will be received.

Canadian Notes.

OTTAWA, Jan. 20, 1894.

LETHBRIDGE, N. W. T.—The Cardston Telephone Company is seeking incorporation.

OTTAWA, ONT.—The loss by fire at the Electrical Railway Company's sheds was \$2,500. The company had \$1,000 insurance in the Atlas Insurance Company, which it received on the preceding Thursday.

HAMILTON, ONT.—The Hamilton, Grimsby and Brantford Elec-

tric Railway Company has let the contract for building eleven trolley cars to Ahearn & Soper, of Ottawa. Three of these will be cars for fruit and milk. The others will be fitted with plate-glass vestibules in front for the protection of the motormen, will have Maguire trucks and all the latest improvements. Several of the cars will be short four-wheeled coaches, such as are used on the James street south line in the city, and the remainder will be long eight-wheel cars, especially adapted for long-distance running.

English Notes.

(From Our Own English Correspondent.)

LONDON, Jan. 19, 1894.

THE ELECTRIC ACCUMULATOR INDUSTRY.—The London "Gazette," of Friday last contained an announcement of the Home Secretary, placing electric accumulator works within the category of factories in which dangerous occupations injurious to health are carried on. This classification enables the aforesaid official to interfere more or less in the management of such works.

ELECTRIC MOTORS IN THE ROYAL NAVY.—Last week H. M. S. "Centurion," one of our new battleships, was put through her gunnery trials. The "Centurion" is interesting as being the first battleship of the Royal Navy in which use is made of electric motors for heavy gun working. So far their application will be very tentative, and restricted to elevating the big guns and to shot-hoisting, hand gear being available in each case, in the event of breakdown.

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.—The founders of this society, which has been formed by electrical engineers resident in the North of England, have lost no time in getting to work. The first meeting was held at Manchester a week or ten days ago. Dr. John Hopkinson was unanimously elected first president of the society, and a council was formed, amongst whom are Dr. Edward Hopkinson, of Messrs. Mather & Platt; Mr. A. R. Bennett, of the New Telephone Company; Mr. Henry Edmunds, of Messrs. Walter Glover & Co., and three or four municipal electric lighting engineers.

ELECTRIC LIGHT MAIN ACCIDENTS.—On Monday last no less than three distinct accidents were caused by electric light mains. In London the lids of two street boxes were blown off, one being smashed to pieces and severely injuring a passer by. In Newcastle an employe in the service of the National Telephone Company was engaged in melting the ice off the lid of a telephone duct-box when an explosion occurred which resulted in severe injury to the man. At Bournemouth, as a two-horse omnibus was proceeding along the streets, one of the horses suddenly fell down dead. Investigation revealed that the ground for some distance around was electrically charged, presumably by a leak to earth from the high pressure electric light main running under the roadway.

News of the Week.

Electric Light and Power.

TOLEDO, OHIO.—It is proposed to use electricity on the swing bridges.

DENISON, IOWA.—Residents are again agitating the matter of electric lights.

OPELIKA, ALA.—The Opelika electric plant will be enlarged and improved.

SIGOURNEY, IOWA.—William Fuller is organizing an \$8,000 electric company.

MILAN, TENN.—Residents are working for electric lights and waterworks system.

CHATHAM, N. Y.—Thomas E. Sterne is thinking of establishing a power and light plant at his mill.

NORWOOD STATION, DELAWARE COUNTY, PA.—Residents of Norwood have voted for electric lights.

IPAVA, ILL.—Residents of Ipava, in Fulton county, are discussing the matter of an electric lighting plant.

ATLANTIC CITY, N. J.—Proprietor White, of the Luray, proposes to purchase an electric plant for his hotel.

EASTON, PA.—Bonds are to be issued to the amount of \$2,000 for the purchase of an extra dynamo and belting.

QUITMAN, GA.—Residents of Quitman have voted to issue \$20,000 in bonds for waterworks and electric lighting plant.

PITTSBURG, PA.—A project for generating electricity at the Kanawha Falls to supply light, heat and power has been revived.

EGG HARBOR CITY, N. J.—The Council of Egg Harbor City has awarded the contract for electric street lighting to A. Bolker.

CLAY CENTRE, KAN.—P. W. Wickstrum is interested in the scheme to put in an electric lighting plant in connection with the flouring mill.

FITCHBURG, MASS.—A bill to enable cities and towns to manu-

facture their own electricity and gas is before the House of Representatives.

TOLEDO, OHIO.—Harbor Master Sheldon is moving in the matter of changing the motive power to operate swing bridges from steam to electricity.

NEWTON, N. J.—There is much talk of the poor quality of the light furnished by the gas company here, and a proposal for electric lights is being discussed.

ATTLEBORO, MASS.—Owing to complications of the street railway company here, the town is in darkness. There are poles and connections but no power.

POWELLTON, PA.—The Powellton Electric Light Company, of which W. J. Latta is president, will extend its plant to the city limits. They will issue \$150,000 of new stock.

THE STATE ELECTRIC LIGHT AND POWER COMPANY, of Brooklyn, has renewed its application for an electric lighting franchise and the matter has been referred to the proper committee.

NEWTON, KAN.—The Newton city electric light plant has been leased by James D. Nicholson from the Newton Real Estate and Investment Company. Mr. Nicholson will manage the business hereafter.

PARSONS, PA.—The Anthracite Light, Heat and Power Company has been formed to supply Parsons, Miner's Mills and Plains. Some of the incorporators are W. S. Mears, Alexander Simpson, P. W. Blackley and A. B. Turner.

MONROE, LA.—The Monroe Electric Light and Water Company, which has one of the most complete plants in this section, is now running almost full capacity. The company has found it necessary to open an uptown office.

MONTREAL, CAN.—The Royal Electric Company proposes to locate a plant in Carleton Place, near Ottawa, and the residents there are urging Parliament to allow them to grant an exemption from taxation and a \$20,000 bonus.

PALMER, MASS.—The Palmer and Monson Electric Company has formed the Central Massachusetts Electric Company to give service to Warren, West Warren and West Brimfield. The capital stock will be increased from \$75,000 to \$150,000.

YORK, PA.—Residents are discussing the report of the special committee appointed in the matter of electric street lighting, which was that a plant would cost \$25,000 and that it could be run at a cost of \$10,000 per annum. No definite action has yet been taken.

KEARNY, N. J.—Councilman Kenny, of the Kearny Township Committee, has been instructed to request Assemblyman Kerr to support and work for the passage of an act to permit incorporated townships to maintain and use electric lighting plants and issue bonds therefor.

JAMESTOWN, N. Y.—The Jamestown "Journal" is very bitterly opposed to the proposed expenditure of \$30,000 for enlarging the present electric light plant. It quotes figures to prove that Jamestown is paying a high price for inefficient light and asks that the matter be reconsidered.

RUMFORD FALLS, ME.—The Rumford Falls Light and Power Company has applied for right to extend its electric light and power system along the highways and public roads of Rumford. The matter will be given a public hearing at the office of the Rumford Falls Power Company on Jan. 29 at 2 p. m.

JERSEY CITY, N. J.—Sealed proposals will be received to 4 p. m. Feb. 1 for furnishing an electric lighting plant (steam) for the purpose of lighting the new public road, as per detail to be had of the Clerk of the Board of Freeholders, or at the office of the engineer of the new public road, in the Fuller Building, Jersey City, N. J. John Lloyd is clerk of the board.

GRIFFIN, GA.—Mayor Boyd states that a contract has been entered into between the city and the Southern Engineering and Construction Company, of Atlanta, Ga., to put in a complete new electric lighting plant before the 15th of March. There will be two dynamos run by a 155-h. p. engine. E. W. Dutton is the manager of the Southern Engineering and Construction Company.

LANCASTER, PA.—Sealed proposals will be received until 7 p. m. Jan. 26 by H. P. Metzger, chairman of the Lamp Committee, at the Mayor's office, Lancaster, Pa., for lighting the city, 2 miles square, with 25 or more electric arc lights; also for lighting the Central Market house with eight or more electric arc lights; also for furnishing gas per 1,000 cubic feet; all as per details to be had of said Metzger. David L. Deen, clerk of the committee, will also give details.

READING, PA.—A new company will be organized in Reading to be known as the Metropolitan Electric Company, and it will apply for a charter on Feb. 8 through Solicitor Richmond L. Jones. It proposes to furnish light and power and has selected a site for its plant at the foot of Chestnut street. John A. Rigg, Richmond L. Jones, Robert N. Carson, R. Nelson Buckley and David C. Golden are interested.

CLEVELAND, OHIO.—Sealed proposals will be received at the office of the Board of Control, 130 City Hall, to Jan. 26, for furnishing and delivering at the foundations of the Division street pumping station one 115-volt compound wound dynamo with a capacity

of 300 16-c. p. 60-watt 110-volt incandescent lamps; also, one single cylinder non-condensing horizontal cut-off engine which shall develop 50-brake horse power. Each bidder on dynamo and engine is required to state in his bid the amount he will deduct from the same for the dynamo, engine and ampere meter now in use at the waterworks. J. H. Farley is Director of Public Works.

The Electric Railway.

WILLIMANSETT, MASS., is considering the building of a street railway to Holyoke.

MARLBORO, MASS.—The State Central Railway has received a franchise from the authorities of Marlboro.

BEREA, OHIO.—The Cleveland and Berea Street Railway Company will at once change to the trolley system and purchase rolling stock.

ST. LOUIS, MO.—The St. Louis and Baden Railway Company has issued \$250,000 twenty-year bonds to pay for the cost of changing the motive power to electricity.

WAVERLY, N. Y.—A. N. Brodhead and H. D. Wade, of Jamestown, are in town looking up a site for the power house of the electric road. Three carloads of poles have arrived.

KINGSTON, PA.—The Dallas and Harvey's Lake Electric Railway Company has been granted permission to build an electric line on Hoyt, Chestnut and Pringle streets.

SHREVEPORT, LA.—The electric road, gas and light companies have consolidated. This takes in two electric street roads, and the light and gas plants, which will be operated under one management.

NORTHAMPTON, MASS.—The Northampton Street Railway Company has asked for leave to make certain extensions, and a public hearing will be given at 4 p. m. Jan. 25 in the Aldermen's rooms in the City Hall.

NORWICH, CONN.—The Norwich "Record" is authority for the statement that General Manager Shaw, of the Norwich and New London Street Railway, contemplates extensive improvements in the New London service.

FRANKLIN FALLS, N. H.—The Franklin Falls "Journal" is authority for the statement that a party of capitalists have offered to build, equip and operate an electric railroad between Exeter and Hampton Beach.

OAKLAND, CAL.—The Oakland Railway Company has reincorporated for \$2,500,000. Chas. F. Crocker, H. F. Huntington, S. T. Gage, and F. S. Dou'v are interested. They will build about five miles of extensions.

NORWALK, CONN.—The Norwalk and South Norwalk Horse Railroad Company will double track West avenue and prepare their entire road for the trolley system. Work will be begun as soon as the weather permits.

THE PORTLAND (ME.) STREET RAILWAY COMPANY has re-elected the old board of directors. The directors' report shows the past year's gross earnings to have been \$200,779; operating expenses, \$174,130; net earnings, \$26,647.

WOODBURY, N. J.—A special meeting of the Council of Woodbury will be held Feb. 2 in the matter of granting a franchise to the Camden, Gloucester and Woodbury Electric Railway. J. Willard Morgan is president of the company.

ALBION, ORLEANS COUNTY, N. Y.—A committee is to be appointed to look into the matter of the proposed electric elevated railway to Batavia. Judge Q. S. Signor and D. W. Beckwith are interested and will represent the interests of the citizens of Albion.

PLAINFIELD, N. J.—Messrs. Thomas, Nevins, Riker and Serrell have offered to build an electric road in New Brunswick, N. J., but the Aldermen and the capitalists cannot come to terms as to the time to be given for building the road, and the project hangs fire.

TAMAQUA, PA.—At a meeting of the stockholders of the Tamaqua and Lansford Street Railway Company F. P. Spiese was elected president, P. J. Ferguson treasurer, and A. P. Blakeslee secretary. They will build the road as soon as right of way can be secured.

NEWCASTLE, DEL.—The Newcastle and Wilmington Electric Railway, it is stated on good authority, will soon be built, and it is expected that it will be finished in May. Preston Lea and Willard Salisbury, of the Wilmington City Railway Company, are interested in the enterprise.

NEW BRUNSWICK, N. J.—The Common Council of New Brunswick and the City Railway Company have locked horns in the matter of permitting the company to change its motive power to electricity, it now being horses. The principal ground of difference is the time to be allowed for completing such proposed change.

HOMESTEAD, PA.—An ordinance has been submitted to the Council granting right of way to the Homestead and Highland Railway Company, in combination with the Pittsburg and Homestead Railway Company. This would shut out the Second Avenue Traction Company and the Pittsburg and Birmingham

Traction Company, and was vigorously opposed, and the matter deferred to Jan. 20 for action.

NIAGARA FALLS, N. Y.—The Niagara Falls "Journal" states that the parties engaged in the enterprise of building a street railway from the city of Niagara Falls to the Devil's Hole say that they have money enough subscribed to build the road, and that work will be commenced in the early spring and it will be in running order by June next.

PITTSBURG, PA.—A meeting of railway men interested in the proposed new line from West Bellevue to the Perryville road has been held and the report of the preliminary survey showed that the line could be built for \$25,000. Secretary W. D. Henry, of the Pleasant Valley Railway, states that the road will be built if the money can be raised. Part of this sum has been subscribed.

PASSAIC, N. J.—The Passaic Common Council has granted a franchise to the Paterson, Passaic, Rutherford and Carlstadt Electric Railway Company to build its line through the city. It will run from Paterson to Jersey City. Councilman Huber, who headed the opposition, has asked for an ordinance granting franchise to the Passaic and Newark Electric Company, which will be granted at the next meeting.

WORCESTER, MASS.—The Worcester and Millbury Street Railway Company proposes soon to take definite steps in the matter of extending its lines from the present terminus at Bramnaville through Sutton and Grafton to Northbridge, and it is now before the Legislature with a bill applying for such right and also for right to issue bonds at the rate of \$15,000 per mile, to run twenty years. It proposes thus to cover the intended route of the projected Blackstone Valley Railway, which company failed to float its stock.

NANTASKET, MASS.—The scheme for leasing the Old Colony track along the beach at Nantasket to a corporation that desires to operate it by electricity has not developed beyond the stage of inquiry between the parties. An electric company desires to have the entire operation of the road northerly of the Nantasket steamboat pier and the remainder of the road during the months in which the Old Colony people do not desire to operate it. The outcome of the project is yet quite uncertain.

AUGUSTA, ME.—Augusta is having a street railway war, which will be of doubtful termination. The Mayor declared the principal street of the city unsafe and ordered the street commission to fill in the track, which was done, but the street railway company reopened it. The Board of Aldermen has passed an order and served notice to compel the company to keep the streets safe for travel for their entire width. The company declares the city must pay for damage caused by filling its tracks.

NORWALK, OHIO.—Mr. J. H. Stewart, of Sandusky, who had charge of the building of the Short Line Railroad, was in the city recently in consultation with several business men who are interested in the building of an electric road from Norwalk to Fairfield and the south part of the county. Upon looking over the map of the county, Mr. Stewart was much impressed with the idea of building this road. He estimates the cost of the road from here to Fairfield and Greenwich, 17 miles, at about \$200,000.

ALLEGHENY CITY, PA.—An ordinance has been presented and referred to Corporations Committee, granting the Pittsburg, Allegheny and Manchester Traction Company the right to use electricity or cables as motive power on railways owned or operated by the Pittsburg, Allegheny and Manchester Company, or the Pittsburg Union Passenger Railway Company. Another ordinance was similarly referred granting to the Pittsburg Union Passenger Railway Company right of way on certain streets.

GARDNER, ME.—The incorporators of the Gardner Electric Street Railway Company are duly organized for business, having chosen L. A. Greenwood, James A. Styles, Charles Heywood, George R. Godfrey, of this town; M. A. Coolidge, F. S. Coolidge, of Fitchburg, and E. F. Blodgett, of Leominster, as temporary directors. They ask the Selectmen for a franchise, and propose a route about three and one-half miles long, connecting the three villages with each other and with the stations of both railroads. Work will begin as soon as practicable, and supplies will be promptly on hand.

ANDOVER, MASS.—A majority of the directors of the association for the formation of the South Side Street Railway Company, Messrs. Larkin T. Trull, J. L. Chalifoux, W. S. Knox, C. T. Guild, Winslow Goodwin and M. E. Clemons, have petitioned the Board of Selectmen for a location for their proposed electric road in the streets of Andover, Mass., and the said Selectmen, Messrs. Arthur Bliss, Samuel H. Boutwell and John S. Stark, have called a public meeting, to hear such petition in the Town Hall of Andover, at 2 p. m., Jan. 31.

NORTHAMPTON, MASS.—The directors of the Northampton Street Railway Company have voted to build the proposed extensions from this city next spring to Williamsburg and to Easthampton. The surveys have been made to Williamsburg for some time, and that was looked upon as a sure thing, but the Easthampton route has burst upon the public with greater suddenness. A few days ago Engineer Strong began the survey which he has just completed. The directors also voted to pay a quarterly dividend of \$2 per share. If the roads go through in the spring it will be necessary to increase the stock of the company.

Personal.

MR. ROBERT B. CARTER, the father of Mr. Franklin C. Carter, of the Partrick & Carter Company, Philadelphia, Pa., died at Riverton, N. J., Jan. 14, aged 72 years. Mr. Carter was well-known in New York and Long Island (his former home). For many years he had been retired from active business and had devoted his time and talents to literary work and benevolent enterprises, and was among the earlier and active promoters of the Society for the Prevention of Cruelty to Animals. Mr. Carter possessed a genial nature which endeared him to a large circle of friends.

PROFESSORS ROWLAND AND FORBES, whose names are now so prominently before the public in connection with the Niagara plant, both began their careers as teachers at about the same age and in the same year, 1872, Prof. Henry A. Rowland as instructor in physics at the Rensselaer Polytechnic Institute, Troy, N. Y., and Prof. George Forbes as professor of natural philosophy at Anderson College, Glasgow, Scotland. From Rensselaer Polytechnic Prof. Rowland was called to Johns Hopkins University, where he has since remained and continued the scientific work which has placed him among the great physicists of the world. The career of Prof. Forbes has been more varied, but yet eminently successful, though in more practical and active lines. While



attached to Anderson College he was sent, in 1874, in command of a British expedition to the Sandwich Islands to observe the transit of Venus, and in 1877 acted as special correspondent of the London "Times" during the Russo-Turkish war, and was the only Englishman who gained access to the Russian camps in Asia. In 1881 Prof. Forbes became manager of the British Electric Light Company, and the next year began to practice as a consulting engineer, which he has since continued. Prof. Forbes is of distinguished ancestry and the son of the famous Prof. Forbes, of Edinburgh University, and a member of many learned societies of Europe. The writings of Prof. Rowland have been confined to papers and articles published in various scientific collections and periodicals, including *The Electrical World*, giving the result of original researches and of his remarkable experimental investigations. Prof. Forbes is the author of a book on the "Transit of Venus of 1874," of one on "Glaciers," and of the well-known "Lectures on Electricity," and of numerous papers read before learned bodies on various subjects, mostly electrical, many of which are notable for their deduction of practical applications from theoretical principles.



GEORGE BARTLETT PRESCOTT, one of the pioneers in the electrical field, died of heart failure at the Buckingham Hotel on Thursday afternoon, after an illness of two weeks. Mr. Prescott was born in Kingston, N. H., on Sept. 16, 1830, and was a descendant of James Prescott, an incorporator of the town in 1634. He received his education principally at private schools in Portland, Me., and began in 1846 the study of electricity. He learned the art of telegraphy soon after its invention by S. F. B. Morse, and from 1847 to 1858 was manager at New Haven, Boston, Springfield and other telegraph offices, after which he was superintendent of the American Telegraph Company, and later on superintendent of the Western Union Telegraph Company. He was electrician of the International Ocean Telegraph Company from 1873 to 1883, and for several years he was one of the vice presidents of the Gold and Stock Company, and also one of the incorporators of the Metropolitan Telegraph and Telephone Company. He was president of the Manhattan Telegraph Company and the American Speaking Telephone Company. While manager of the Boston office, in 1852, he made the discovery that the aurora borealis is of electrical origin and published an account of the discovery. On various occasions he removed the batteries from the telegraph wires and operated the latter by means of the current induced by the aurora. Mr. Prescott's name is connected with several important inventions relating to telegraphy, including the quadruplex and duplex telegraph systems, the use of pneumatic tubes for the transmission of messages, etc. At the request of Postmaster General Dennison, he wrote a paper on the proposed acquisition of the telegraph by the Government, which was incorporated in the Postmaster General's report. He ap-

peared frequently before various committees of Congress, and wrote many pamphlets in opposition to the Government's control of the telegraph. Mr. Prescott was the author of the following works on electrical subjects: "History, Theory and Practice of the Electrical Telegraph," "Electricity and the Electric Telegraph," "The Speaking Telephone," "Dynamo Electricity," "Bell's Electric Speaking Telephone, Its Invention, Construction, Application, Modification and History" and "The Electric Telephone." Mr. Prescott married Miss Eliza Curtis Parsons, a granddaughter of General Israel Parsons, of revolutionary fame. He retired from active participation in business in 1882, and after that devoted himself exclusively to literary pursuits. He leaves mourning him his widow and only child, Mrs. Philip V. R. Van Wyck, Jr.

Miscellaneous Notes.

THE WORLD'S FAIR authorities will have sufficient money left over to pay its stockholders a dividend of 10 per cent. at least.

AN INTELLIGENT LEGISLATOR—A bill has been introduced in the New York Legislature by a member requiring all wires used by trolley roads to be insulated.

PRESIDENT MATTINGLY, of Vicksburg, Miss., says that since the announcement of Mr. Walter Mattingly's resignation in *The Electrical World*, he has had worlds of applications from all sections of the country.

A NEW ELECTRIC FURNACE—Henry S. O'Neill, of Boston, claims to have succeeded, by the use of the electric current, in obtaining a temperature above that hitherto attained and, moreover, in regulating the temperature to any degree required.

COPPER AND THE TARIFF—The New Bedford Copper Company says it expects its business will be greatly promoted if the Wilson tariff bill passes in its present form. It has prospered under the McKinley bill, which reduced the duty on copper ore. The present bill removes it altogether, and once it goes into effect the market will be considerably enlarged.

THE HON. LEVI P. MORTON, whose stock barn at Rhinecliff, N. Y., was destroyed by fire some months ago, is rebuilding another, in which he is evidently determined to prevent a like occurrence. The barn will cost about \$75,000, and is to have a very complete electrical equipment. Among other devices will be an electric clock system of four stations, and the Electric Heat Alarm Company, of Boston, will have 300 thermostats in the building.

ECONOMIC USE OF TRANSFORMERS—Mr. W. Forman Colman read a paper before the recent meeting of the Northwestern Electrical Association at Milwaukee on the "Economic Use of Transformers," which is in many respects a model of what such a paper, intended for a non-technical audience, should be. The theory of the transformer is simply explained, its construction described and the main points bearing on its use in distribution described.

THE DRAWBAUGH TELEPHONE COMPANY, of Philadelphia, has been organized with a capital stock of \$2,000,000, and in a proposition for a city ordinance fixes a maximum charge of \$78 a year for business houses and \$50 to private families within the city limits, the Bell rates ruling now from \$120 to \$120 a year; gives the city free ducts in the conduits for telephone and telegraph purposes, and 2 per cent. of the gross receipts for the privilege of using the streets, and also provides free 'phones to all the city departments.

Trade and Industrial Notes

MR. A. B. LAWRENCE, 25 Pearl street, New York, is sending to his friends and patrons a handsome roll calendar, which he will also mail to engineers and superintendents should they send a two-cent stamp with their name.

WILLIAM S. HINE has recently severed his connection with the Case Engine Company, and will take charge of the electrical supply warehouse at Chicago of the Stanley Electrical and Manufacturing Company, of Pittsfield, Mass.

THE RAILWAY EQUIPMENT COMPANY, of Chicago, of which Mr. W. R. Mason was the manager, has transferred to Mr. George O. Fairbanks, as assignee, all its property for the benefit of its creditors. Claims against the Railway Equipment Company are to be sent to the assignee at 26 Ashland Block, Chicago.

HINE & ROBERTSON believe in the old adage that "in union there is strength." They appreciate the superior merits combined in the Robertson-Thompson Indicator, now owned by the New York Indicator and Specialty Company, of 105 Liberty street, and have brought about a consolidation, so that the new firm of Hine & Robertson Co., 37 Cortlandt street, New York, now controls both the Improved Straight Line and the Robertson-Thompson Indicators.

MR. WM. H. MCKINLOCK, president of the Metropolitan Electric Company, has been called to New York to close a contract for a full line of specialties, which that company is now in a po-

sition to handle advantageously in its commodious store and warerooms, 186 and 188 Fifth avenue. Here they have ample room for the display of specialties and are in a position to take care of their rapidly increasing business.

MESSRS. CARLISLE & FINCH have bought the repair shop and business of the General Electric Company, of Cincinnati, Ohio, and will continue the business and do all kinds of electrical repairing and manufacturing. Mr. Morton Carlisle and R. S. Finch, who form the firm, have been for a long time connected with the General Electric and Thomson-Houston interests, and the repair works were formerly conducted by Mr. Finch.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 26 Cortlandt street, New York, in a circular, states that after Feb. 15 they will announce telephonic devices to replace those covered by the Bell Company's patent on magneto bells with automatic switches changed by the weight of a telephone receiver, and on the shunt of the generator armature being automatically cut out by turning the crank that revolves the generator.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., has recently added several improvements to its Washington alternating arc lamp which make the lamp even more desirable than it was as originally placed on the market. A highly polished metal reflector has been placed over the outside of the globe which can be used or not as desired. The metal base of the lamp has been done away with entirely, leaving nothing whatever on the lower part of the globe to obstruct the light, and also shortening the lamp several inches, so that a 15-hour lamp is now only a trifle over 20 inches long over all.

THE JENNEY ELECTRIC MOTOR COMPANY, of Indianapolis, Ind., reports the following sales: One thousand light plant for the Park Gate Hotel, Chicago; 1,500-light central station plant for Washington, D. C.; central station lighting plant for Marceline, Mo.; 500-light isolated plant at Louisville, Ky.; a 500-light plant at Poughkeepsie, N. Y.; 120-light plant, Piggott, Ark.; 120-light dynamo, Hartford, Conn.; 80-light dynamo, city; 50-light plant for a dredge at Chicago. This company has just received an order for a complete lighting plant for the large mill of the Leonard Paper Box Board Company at Carthage, Ind. In addition to the above the company reports the sale of quite a number of motors and smaller lighting plants.

THE WESTON ELECTRICAL INSTRUMENT COMPANY was made to claim, in a recent advertisement in *The Electrical World*, that it had received the only award for testing instruments at the World's Fair. It is only fair to the company to say that it has not made any such claim, and that it was an employee of *The Electrical World* who, with well-meant zeal, added the line to the advertisement on the subject of awards. The Weston measuring instruments are so well known and bear such a deservedly high reputation in America that it is flattering to our national pride to know that even the foreign visitors at the World's Fair expressed the warmest admiration of their handsome design and workmanship, as well as of their accuracy and reliability.

THE DAY-MOBERG ELECTRIC COMPANY, 54 Pearl street, Boston, has recently placed upon the market a storage battery which, it is claimed, is giving most excellent results. The battery is known as the "Jupiter," and it is claimed is so constructed as to render short-circuiting absolutely impossible, possessing also other valuable advantages and differing materially from other storage batteries. Mr. Henry H. Day, manager of the company, states that business is very gratifying and is confident over the hold the battery will eventually obtain in the market. The Day-Moberg Company also makes a specialty of repairing dynamos, motors and storage batteries, and thoroughly charges storage batteries for 50 per cent. of the usual rates.

THE SWAN LAMP MANUFACTURING COMPANY, of Cleveland, Ohio, held its annual meeting on Jan. 16. Myron T. Herrick, who has been president and director of the company since its organization, owing to pressure of other duties, declined a re-nomination. The following officers were elected: S. M. Hamill, president and general manager; B. F. Miles, vice-president and treasurer; S. E. Cox, secretary and superintendent; E. P. Roberts, electrician. The secretary, Mr. Cox, made an annual report in which he stated that the business of the company was unusually large for the past year, and that they were at present from 25,000 to 30,000 lamps behind their orders. The Swan Lamp Company has been one of the most successfully managed of all companies manufacturing electrical apparatus during the past ten years.

THE ROYAL ARC ELECTRIC COMPANY, 143 Liberty street, New York, and 11 Haynes street, Hartford, Conn., is meeting with a flattering success with its new incandescent arc lamp. The Underwriters' International Electric Association, after carefully investigating the lamp, reports its unqualified approval of it as a spark arrester, which action will guide that of other underwriters' bodies throughout the country. Among many testimonials is the following from Hartford, Conn., where the lamp is also used for street lighting: "We have had on the arc light in our store one of the Howard cylinders since the 15th of last October. The cylinder has never been changed, but is the identical one that was originally put on and has been in constant use without any signs of breakage. We have never had so good a light before, and have greatly enjoyed the freedom from noise

and dirt, and especially the relief from our former anxiety as to damage from fire."

MR. R. D'UNGER, Chicago, Ill., in a recent communication, claims that his patent, issued Oct. 2, 1888, "is the only valid all-carbon microphone and transmitter patent in existence in this country." This telephone is now the property of the D'Unger Long Distance Telephone Company, of Chicago. The Chicago Twin Wire Long Distance Telephone Company owns the rights for Chicago and Cook county, Ill. They have a 25 years' franchise, he states, from the city of Chicago, and will put in 5,000 public and 15,000 subscribers' instruments within two years from the date of the passage of the franchise. The system used will be the Mann, which it is claimed does away with the expensive and intricate switchboard now used. It is also claimed that the telephone speaks clearly and distinctly through a resistance of 70,000 ohms, and out-of-door tests of 500 miles have been made with a resistance of 30,000 in circuit with excellent success. The instrument requires little or no care.

MR. WILLIAM HAZELTON, 3d, has been appointed the exclusive agent for the United States of the Societe Anonyme Industrielle des Etablissements Arbel, Rive-de Gier (Loire), France. This company is probably the best known manufacturer in Europe

of wrought iron forged centres for all kinds of wheels, making a specialty of this business. Mr. Hazelton has opened offices in the Havemeyer Building, New York City. The wrought iron forged centres of the Arbel manufacture are especially adapted to cable and electric service, and are sold with a five years' guarantee. These centres are used almost exclusively in France and many other European countries. Since Mr. Hazelton resigned from the Short Electric Railway Company, last summer, he has, in addition to devoting much time to several railway projects in which he is interested, been negotiating with several large manufacturers to represent them in the East. He will continue in the contracting for and building of street railways complete, in which line he is well known, and has had a long long practical experience.

Business Notice.

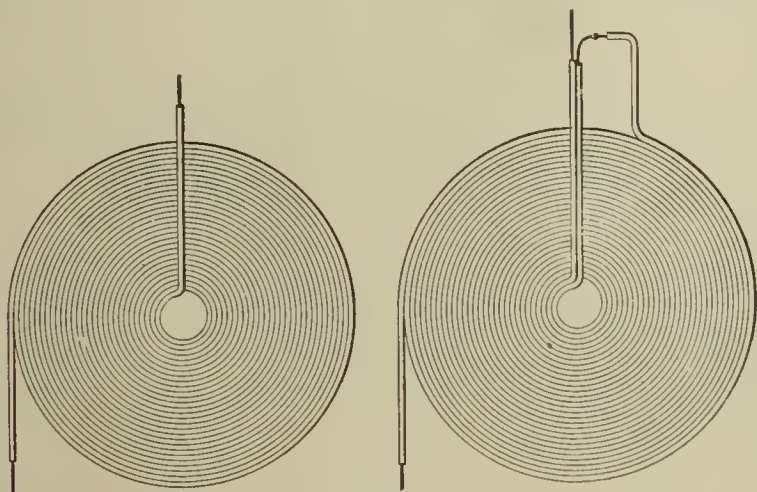
BATTERY CUT-OUT; CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED JAN. 9, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

- 512,316. ELECTRIC VALVE CONTROLLER; C. E. Ongley, New York. Application filed Dec. 18, 1890. The combination, with a cylinder and piston, or a similar motor, and pipes leading to opposite sides of the piston, of an apparatus for controlling the pipes, consisting of a cylinder having a single valve seat, a valve therefor, an armature connected to the valve, a magnet in operative relation to the armature, a waste pipe and a slide valve in the waste pipe common to both valve mechanisms and moved by water pressure.
- 512,320. ELECTRIC INCANDESCENT LAMP; John Peil and Carl K. MacFadden, Chicago, Ill. Application filed April 18, 1893. In electric incandescent lamps the combination with a glass bulb of a metallic cap, a fusible metallic seal, and inleading metallic wires provided with a vitreous coating inserted through the seal.
- 512,327. ELECTRICALLY PROPELLED VEHICLE; James Harris Rogers and Willard Fracker, Washington, D. C. Application filed Jan. 31, 1893. In combination with a frame provided with a hook by which it is adapted to be detachably connected at its front end to the front wheels of a vehicle, the battery carried thereby, the wheels at the rear end of the frame, and the motor geared to the wheels.
- 512,331. ELECTRIC CUT-OUT; Albert P. Seymour, Syracuse, N. Y. Application filed Nov. 18, 1892. In an electric cut-out, the combination of flat line and fuse clamp plates projecting beyond supporting shoulders or offsets on the base and cover respectively, whereby they may be hooked together, and screws tapped into the clamps on the cover from the exterior thereof.
- 512,340. COIL FOR ELECTROMAGNETS; Nikola Tesla, New York, N. Y. Application filed July 7, 1893. A coil composed of contiguous or adjacent insulated conductors electrically con-



NO. 512,340.—COIL FOR ELECTROMAGNETS.

nected in series and having a potential difference of such value as to give to the coil as a whole a capacity sufficient to neutralize its self-induction. See illustration.

- 512,373. TROLLEY CUT-OUT; Melancton Hanford, Malden, Mass. Application filed Sept. 22, 1893. In combination with a suitable hanger, and two bolts segmental in cross-section, two oppositely disposed rocker-plates formed with hooks at one end and tubular arms at the opposite ends, said hooks to engage said bolts, and two independent lengths of trolley wire electrically united and affixed at their extremities to the plates.
- 512,378. TIME AND DATING STAMP; W. C. Jewell, Indianapolis,

Ind. Application filed July 11, 1891. This consists of a device for conjunctively operating the hour, meridian and minute wheels, comprising a bent lever fulcrumed within the minute wheel, lever mechanism acting on the bent lever, whereby the latter is caused to periodically engage the adjacent wheel, and rigid connections between the hour and meridian wheels.

- 512,386. ELECTROMAGNET; Frank R. McBerty, Downer's Grove. Application filed May 16, 1893. The combination with a tubular magnet of radial arms of magnetic material connecting the core with the shell of the magnet, and a mass of conducting metal surrounding the arm.
- 512,395. PRODUCING ILLUMINATING LETTERS; James Harris Rogers, Washington, D. C. Application filed Feb. 28, 1893. As a means for producing a predetermined illuminated design, the combination with a group or bank of electric lamps, composed of a number of independent sections, arranged in separated and independent lines, each section with an independent wire, to which each light in the section is connected by a short wire, a source of electric energy having one of its poles connected electrically with all of said lamps, a pivoted circuit making and breaking device provided with contact points and electrically connected with each section, and electrical connections between all of such devices and the other pole of the source of energy.
- 512,397. SPARK REGULATOR FOR DYNAMO-ELECTRIC MACHINES; Charles E. Scribner, Chicago, Ill. Application filed June 1, 1889. The method of preventing sparking, which consists in maintaining, under given conditions, a practically constant field for the short circuited coil, the strength of said field being adjusted to build up a current in the short circuit coils which shall be practically equal to the current in the current producing coils, into the circuit of which said short circuited coils are introduced in the rotation of the armature.
- 512,398. APPARATUS FOR TELEPHONE SWITCHBOARDS; Charles E. Scribner, Chicago, Ill. Application filed April 26, 1893. This consists of a switch lever, actuated by the pressure of a connecting plug in its socket, a catch engaging the switch lever to retain it in one of its positions, and means for actuating the catch to release the switch lever.
- 512,399. APPARATUS FOR TELEPHONE SWITCHBOARDS; Charles E. Scribner, Chicago, Ill. Application filed April 26, 1893. The combination with two connecting plugs of continuous conductors connecting the like parts of the two plugs together, a self-restoring annunciator having its operating coil connected with the plug circuit, a generator of signaling current, a key for connecting the same with the plug circuit, the restoring or retaining coil of the self-restoring annunciator being included in the normally open circuit of the generator.
- 512,400. AMERICAN DISTRICT ELECTRIC SIGNAL APPARATUS; Charles E. Scribner, Chicago, Ill. Application filed Dec. 27, 1886. The combination with the carrying shaft of the spring rigidly connected therewith and provided with a roller at its free end, and an engagement wheel mounted loosely upon said shaft; whereby, while the shaft is turning, the engagement wheel is carried by the roller.
- 512,401. DUPLEX ARC LAMP; Charles E. Scribner, Chicago, Ill. Application filed May 1, 1891. In a duplex arc lamp, the combination of a single carbon arc lamp whose carbons rest in contact when the lamp is idle, connected to supply mains, of a second arc lamp provided with mechanism adapted to maintain the carbons separated when the lamp is idle, and with an electromagnet in shunt of the carbons of both lamps, which acts upon the said mechanism to cause the approach of the carbons toward each other when sufficient current passes through the electromagnet.
- 512,413. TELEPHONE CALL RECORDER; William B. Thomson, Chicago, Ill. Application filed June 28, 1893. A telephone wire,

- two transmitting mechanisms connected with its opposite ends and two recording mechanisms also connected with the opposite ends of the recording devices, a galvanometer needle adapted to be oscillated in either direction by the passage of a current about it, two electric circuits, including the electromagnets, respectively, and each adapted to be closed by the oscillation of the needle in the proper direction and two galvanometer coils encircling the needles, respectively, and each formed with a break adapted to remain closed as long as the corresponding transmitter is not in operation, but to be opened when the transmitter begins to operate.
- 512,422. PRINTING TELEGRAPH; Emil A. Wirsching, New York, N. Y. Application filed May 12, 1893. The combination with a driving gear of an electric motor having a rotating armature connected with and adapted to operate the gear in a direction reverse to the normal.
- 512,424. ALTERNATING CURRENT DYNAMO; James J. Wood, Fort Wayne, Ind. Application filed June 23, 1893. In a dynamo a brush holder adapted for holding two brushes tandem, consisting of a double socket piece formed at its middle with a boss for receiving the supporting stud, and two sockets for the respective brushes on opposite sides of said boss extended at such an angle converging toward the tips of the brushes as to bring the latter closely adjacent to each other.
- 512,425. CONNECTION BETWEEN SEPARATELY EXCITED DYNAMOS AND THEIR EXCITERS; James J. Wood, Fort Wayne, Ind. Application filed Oct. 17, 1893. The combination with a separately excited dynamo having an adjustably mounted armature, of an exciter for said dynamo adjustably mounted on a movable base, and a rigid connection between the surface of said separately excited dynamo and the movable base of said exciter, whereby the latter follows the movements of the former and the tension of the driving belt between the two is preserved.
- 512,441. CLOSED CONDUIT RAILWAY; Charles J. Kintner, New York, N. Y. Application filed June 22, 1893. In an electric railway system a series of removable pivoted switching boxes carried each by a shaft journaled in the sides of the conduit, and mechanically actuated switching devices inclosed wholly in said boxes.
- 512,448. SOCKET FOR INCANDESCENT LAMPS; Thomas L. Pfaff, Jr., Pittsburg, Pa. Application filed Feb. 13, 1893. In combination with a bulb holder for an incandescent lamp having one or more openings in the side of the case thereof, blinding screws with which the charged wires engage, and spring contact pieces connected to the respective blinding screws, and a branch fitting or plug having one or more projecting pieces containing spring contact points adapted to engage with the spring contact pieces of the bulb holder.
- 512,454. TIME INDICATOR ATTACHMENT FOR TELEPHONES; Charles Stever, San Jose, Cal. Application filed March 24, 1893. In a time indicator the combination of a movement having an arbor, a wheel thereon having notches in its periphery, an independently turnable segment plate in connection with said wheel and adapted to cover or to expose one or more of the notches thereof, and a sounding hammer having a stem or shank resting upon and actuated by said notched wheel, to deliver successive strokes.
- 512,464. INCANDESCENT LAMP; Augustus C. Carey, Lake Pleasant, Mass. Application filed March 23, 1893. In an incandescent lamp, a globe, or bulb, having a tubular butt provided with a tapering bore, combined with an illuminating tube having a stopper adapted to be fitted to such bore.
- 512,613. SECONDARY BATTERY; P. K. Irving, New York, N. Y. Application filed Sept. 13, 1892. This comprises a gauze plate folded to form pockets, the porous cups within the pockets and blinding rods surrounding the gauze elements in a group.
- 512,481. ELECTRIC ARC LAMP; R. Newirth, Berlin, Germany. Application filed March 23, 1893. This comprises a series of electrodes arranged around a common centre and adapted to be rotated on their axis, a commutator and brushes for supplying the electric current and imparting alternate polarities to the electrodes.
- 512,482. ELECTRIC ARC LAMP; R. Newirth, Berlin, Germany. Application filed Oct. 21, 1892. This comprises a series of electrodes arranged around a common axis and means for supplying the electrodes in pairs successively with electric currents in opposite direction, so as to impart alternately positive and negative polarities to the electrodes and form a continuous arc of uniform size.
- 512,510. DEPOLARIZER FOR VOLTALIC CELLS; G. Hewitt, New York, N. Y. Application filed April 2, 1893. An article of manufacture composed of a depolarizer for voltaic cells consisting of nitric acid, sulphuric acid and bichromate of sodium in the form of a dry powder.
- 512,514. ELECTRODE FOR SECONDARY BATTERIES; W. Morrison, Des Moines, Ia. Application filed April 23, 1892. An article of manufacture consisting of a plurality of bundles built up to form a continuous ribbon, to become active and conducting rods connecting the bundles together.
- 512,535. ELECTRIC RAILWAY CURRENT COLLECTOR; E. M. Roynton, West Newbury, Mass. Application filed Oct. 12, 1892. In an electrically propelled bicycle car, the combination with the guide wheels of current collectors guided and carried by the frame work of the wheels.
- 512,567. BATTERY; W. M. Stine, Athens, O. Application filed July 21, 1891. In a storage battery, an alkaline electrolyte formed of a mixture of sodium hydrate, sodium zincate, sodium chloride and sodium chlorate, the whole in aqueous solution.
- 512,603. ELECTRICAL TRANSFORMER OR CONVERTER; C. L. Coffin, Detroit, Mich. Application filed Dec. 11, 1891. In a transformer or converter a secondary formed of perforated metal.
- 512,604. APPARATUS FOR ELECTRICALLY WELDING METAL; C. L. Coffin, Detroit, Mich. Application filed March 2, 1893. The combination of means for connecting the metal to a source of electricity, an extraneous conductor connected to the other terminal of the source of electricity, two extraneous conductors and means for maintaining an electric arc between the electrodes within the field of force of a magnet.
- 512,612. DEVICE FOR BLOWING OUT SPARKS ON COMMUTATORS OF DYNAMOS; H. W. Hanahan, Winnsborough, S. C. Application filed March 28, 1893. This comprises a commutator having radial slots and longitudinal passages extending nearly through the commutator at the bottom of the slots and communicating therewith, and a stationary air chamber surrounding the armature shaft, of an adjustable non-rotary disc located in the air chamber at one end of the commutator and provided with apertures that are adapted to register at intervals with the longitudinal passages of the commutator and through which air will pass from the air chamber to the slots of the commutator to prevent sparking.
- 512,614. ELECTRIC SWITCH; J. L. Hinds, Syracuse, N. Y. Application filed May 16, 1892. This comprises a base plate provided with a pair of terminals, a lever having contact faces adapted to engage the terminals, supports hinged to the lever and push buttons removably mounted on the supports.
- 512,637. INCANDESCENT ELECTRIC LAMP; J. W. Turnbull, Pascagoula, Miss. Application filed May 2, 1893. The combination with a bulb of a separable tube, open at both ends, inserted therein and forming therewith a vacuum chamber.
- 512,656. RELAY; F. M. Locke, Victor, N. Y. Application filed June 19, 1891. The method of overcoming the effect of residual magnetism upon the armature of electromagnets, consisting in maintaining from one magnet pole through the receding armature to the other magnet pole a magnetic circuit.
- 512,667. DOUBLE CARBON ARC LAMP; C. E. Scribner, Chicago, Ill. Application filed April 16, 1892. The combination of a yoke and two symmetrical clutch mechanisms for the different rods, a retaining magnet and its pivoted armature lever adapted to support one or the other of the mechanisms to relieve the yoke of the weight thereof, and a cut-out, one of the contacts thereof being carried on the same lever with the yoke.
- 512,672. FIRE ALARM ATTACHMENT; C. E. Egan, Chicago, Ill. Application filed May 27, 1893. The combination of a chambered block, a disc in the chamber, a cross-bar with an adjustable screw in position to bear against the disc when heated, and a push button and housing for the same removably secured to the block.

U. S. PATENTS EXPIRED JAN. 2, 1894

- 185,841. MULTIPLE CIRCUIT CLOSERS FOR ELECTRIC CIRCUITS; J. H. Striedinger, New York, and A. Doerflinger, Brooklyn, N. Y. This comprises an independent actuating circuit having a suspending device and a circuit closing plate, all arranged so that by closing the actuating circuit the main circuit will also be closed.

U. S. PATENTS EXPIRED JAN. 9, 1894.

- 186,104. AUTOMATIC ELECTRIC TELEGRAPHS; R. K. Boyle, New York, N. Y. This comprises a local battery, two alternately charged induction coils, whereby a series of waves of electricity of the same kind are sent over the wire.

U. S. PATENTS EXPIRED JAN. 16, 1894.

- 186,215. PRINTING TELEGRAPH TRANSMITTERS; G. M. Phelps, Brooklyn, N. Y. This comprises rollers, a lever, hook, revolving finger, crank, circuit rocker, and connections to the distant printing telegraph instrument.
- 186,234. ELECTROMAGNETIC DENTAL PLUGGERS; J. E. Dexter, New York, N. Y. The combination of a spring yoke, vibrator and spring contact piece.
- 186,230. ACOUSTIC ELECTRIC TELEGRAPHS; T. A. Edison, Menlo Park, N. J. The combination with a receiving magnet of a condenser in a shunt around such magnet.
- 186,340. ELECTRO-HARMONIC TELEGRAPHS; E. Gray, Chicago, Ill. This consists in working a closed circuit with a continuous current from a main battery, portion of the whole of which currents are thrown into vibration at will by the transmitters.
- 186,225. UNDERGROUND TELEGRAPH LINES; W. Mackintosh, New York, N. Y. The combination with blocks of incased conduits, of split and lapped cement tubes, also made solid in a cement block, to take the place of a removed conduit block.
- 186,226. UNDERGROUND TELEGRAPH LINES; W. Mackintosh, New York, N. Y. For the purpose of looping cable in branch offices, an embedded conduit, severed at two points, and looping pipes, combined with the disjointed ends thereof.

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GENERAL ELECTRIC PATENT LITIGATION.

An unassailable patent seems to be about as uncertain as a "straight tip" at the races. Of this the experience of the General Electric Company, in its efforts to sustain the Edison lamp patent, is the latest instance. Of course the mistake of the company was in not being satisfied with a fair royalty from the other lamp manufacturers under the first decision which it secured, which doubtless could have been secured in response to a fair proposition. The General Electric Company apparently expected a vastly greater return by taking advantage to the full of its monopoly, but in deciding to pursue this policy, which it must now see was unwise, it neglected to take into consideration the bitter animosities that would be aroused and the ceaseless litigation that would ensue. As a matter of fact, it has distributed among the disciples of Coke and Blackstone a sum of money that would have enabled it, even in these depressed times, to have continued paying good dividends on its stocks, while the result of the litigation up to the present time must be thoroughly discouraging to the company. Its best friends, including many of its stockholders, would be glad if, profiting by the lesson learned, it would follow the example of the young German Emperor and inaugurate a period of reconciliation and fraternal good feeling by offering to come to a reasonable agreement in regard to its "feeder and main" and other patents now in litigation, instead of continuing to further arouse the intensely combative feeling from which it has experienced such disastrous results in the lamp cases.

THE BUCKEYE LAMP CASE.

It was little thought when the Goebel defense in the Edison lamp litigation was offered that still a greater surprise was in store, but the recent decision of Judge Ricks at Cleveland may in some respects be considered even more sensational than that most startling episode. As will be seen in another column, as far as the Buckeye Electric Company is concerned, the Edison lamp patent has been declared void through the extraordinary mistake of an Edison attorney in endorsing a wrong date on the Edison lamp patent. The decision, it will be noted, is only made to specifically apply to cases in which the alleged infringer can demonstrate that he invested capital upon a belief derived from the endorsement referred to that the Edison patent would expire on Nov. 10, 1893, so that its terms does not apply to any one who embarked in the business subsequent to March 18, 1893, when the endorsement was cancelled. Its effect also is only confined, of course, to those within the jurisdiction of the court which made the decision, although it is quite probable that the same point will be soon brought before other courts. The court considers several interesting points in its opinion. It decides that the dedication of a patent to the public, if legal at the time, is absolute whether the patent has yet years to run, and cannot be revoked at a subsequent date previous to the expiration of the patent. It is also decided that the complainant must abide by the date endorsed by it on the patent, even if the endorsement were not necessary and the date one that the courts have determined has no bearing on the life of the patent, and that it was not incumbent on the defendant to make inquiry in face of this definite endorsement by the complainant. It will also be noted that referring to the view that the patent was absolutely abandoned by the endorsement referred to, several opinions are quoted, which the court states seem to exactly meet the case.

INSTITUTE ELECTIONS.

The friends of the American Institute of Electrical Engineers are doubtless glad to learn from the report, at the last monthly meeting, of the Committee on Revision of Election Rules that an attempt will be made at the next meeting to secure the adoption of such measures as will prevent a recurrence of the equivocal methods employed at the last annual election. The report recommends that balloting envelopes emanating from other sources than the secretary's office shall be marked "unofficial," and that the number of votes in nominations shall be placed opposite the name of each candidate on the "general proposal list." The recommendations might have gone further and prohibited the use of the official head of the institute on unofficial communications, the duplication, typographical and otherwise, of official envelopes, and required that unofficial return ballot envelopes should conform to the institute rule in regard to being distributed unstamped. While it is not probable that any of these devices will again be adopted, yet the future prosperity of the institute demands that thorough checks shall be placed against any possible attempt to again introduce Tammany election tactics, such as were employed last year. The aggravating thing about such underground methods is that any mention of them is likely to be construed into reflections against some of the most highly esteemed members of the body from the unfortunate use of their names by the engineers of the movement, through which they are as much victims in this sense as those directly affected are in another. The action of the institute on the report referred to will be watched with unusual interest, as its defeat could be justifiably construed into an indication that the party responsible for the rejection had no desire to be thus held in check.

WHAT RIGHTS HAVE INVENTORS?

In his recent incandescent lamp decision Judge Ricks quotes with approval from an authority on patent law a statement to the effect that the patent privilege is not a mere reward bestowed upon the inventor for past services—the payment of a debt of gratitude toward one who has already conferred a benefit upon the state; that it is also a purchase by the government, acting on behalf of the whole people, of some new art or instrument capable of beneficial use, for which it recompenses the inventor by securing to him for *a time* its sole enjoyment; and when, without this recompense, it has obtained the invention through his voluntary act, so far from recognizing him as entitled to remuneration, it unhesitatingly appropriates the invention to itself, whatever loss and difficulty may result to an inventor. This is but in line with the entire course of patent decisions in recent years, which brings up the question if, under the innumerable rules of law that have grown up limiting inventors' rights, even the most meritorious patentee, except under exceedingly fortunate and unusual circumstances, can be assured the property in his invention evidently intended by the founders of our patent system. Doubtless all of the countless legal points that can now be marshalled against a patent with a view to having it declared invalid, however equitable a character it may have, date their origin from attempts to take advantage of the patent system to establish unwarranted monopolies. In other words, the honest patentee in his struggles to secure the benefit of his invention, and to protect it from those who would rob him of his profit, is harassed and perhaps undone through legal technicalities whose cause of existence lies in the very element he is fighting. This is on the supposition, of course, that he has been successful in guiding his invention through the technicalities of the Patent Office, but even here he is not on sure ground. The manner in which the Berliner patent was kept in the Patent Office for fourteen years, thus prolonging its life to that extent and stifling all independent invention in that line in the meantime, is far from reassuring. Even if an invention is

once safely granted and amply able to run the gauntlet of legal technicalities in the courts, the expense of establishing its ability to do this would ordinarily be so great as to either not be justified by the probable profit to be derived, or, what is more often the case, beyond any means that the inventor, who is seldom capable as a financier, may be able to enlist. It is not too much to say that our patent system at present is in a most unsatisfactory and even chaotic state, and that probably no other branch of Federal administration and law so sadly needs a thorough overhauling. Involved, as at present, in a maze of technicalities, with limitations applied at every turn and expensive legal processes necessary at every step, the protection promised an invention is in effect a mere pretence, and an inventor but little more than a subject for legal fleecing.

The Buckeye Lamp Case.

On Tuesday, Jan. 23, Judge Ricks, of the United States Circuit Court, of Ohio, rendered a decision, abstracted below, dissolving the injunction against the Buckeye Electric Company previously granted to the General Electric Company.

Subsequent to the decision Judge Ricks stated to a reporter that he cannot say how far the logic of his decision will be applied to companies which did not take advantage of the voluntary limitation of the Edison patent before it was revoked. He had received notice that application would at once be made by the Universal Electric Company of Cleveland, a company which did not take such action as the Buckeye company did, to dissolve the injunction against them, and the decision in that case will settle the question as to whether the Edison patent has, in fact, fully expired. He finally stated that the logic of the case seems to be that the patent has expired, and all companies are at liberty to manufacture the incandescent electric lamp.

Mr. F. P. Fish, counsel of the General Electric Company, stated that in 1883 the General Electric Company, acting under a mistake, and believing that the patent might possibly be invalid unless there was some reference to foreign patents on it, secured from the Commissioner of Patents a certificate of correction which was appended to the patent, in which they referred to the foreign patent for the same invention, and stated in substance that the American patent was limited by the foreign patent, in accordance with the United States law. This certificate of correction was removed in the spring of 1893. One of the issues in the Novak case, in which the General Electric Company sought an injunction restraining the use and manufacture of the incandescent lamp, was the validity of the American patent in connection with the English patent. Judge Shipman decided recently in that case that the English patent had nothing to do with the term of the American patent, because it was not, in fact, a patent at all until after the grant of the American patent. Judge Rick's decision, so far as is known, was based upon the contention that although the English patent did not, in fact, limit the term of the American patent, yet the General Electric Company was not allowed to say at the present time, as against the Buckeye company, and in view of the special facts in their case, that its patent did not expire with the English patent, because of the fact that in 1883 this certificate of correction was put upon the patent. It was also based upon the contentions that there were special reasons why the patent, even if good against the rest of the world after the expiration of the English patent, was not good against the Buckeye company. Counsel Fish says Judge Rick's decision will be appealed from, and that in any case it only refers to the company in whose favor it was rendered, on their plea that it was misled by the limitation referred to,

and as a result had largely increased its plant and investment.

The statement of the case recites the history of the Edison patent and of the Buckeye Electric Company, which was organized in February, 1890, upon the supposition that the decision of Judge Bradley in the Sawyer-Man case gave a right in general to the public to manufacture and sell incandescent lamps, and also that the decision of the Deputy Commissioner of Patents declaring the Canadian Edison patent void also terminated the Edison patent in the United States. In the summer of 1891, before the decision of Judge Wallace sustaining the Edison patent, a further search disclosed the indorsement on the Edison patent limiting its life to that of the English patent, which was dated Nov. 10, 1879, in the indorsement, thus making it expire Nov. 10, 1893, whereupon the said company further increased its investment. After the decision of Judge Wallace and pending an appeal the factory continued to manufacture lamps, and shortly thereafter negotiations were opened with a view to a sale or consolidation of interest with the owners of the Edison patent, which negotiations were carried on to February, 1893, during which time the factory was operated with the acquiescence of the General Electric Company. These negotiations having finally failed, the factory was immediately closed until the decision of Judge Hallet, in the Columbia lamp case, when it was reopened until Judge Seamen's decision in the Oconto lamp case, since when it has been closed.

The Buckeye Electric Company therefore claims that by the voluntary act of the owner in its indorsement of the date of Nov. 10, 1879, as the date of the English patent, it dedicated and abandoned its patent to the public after Nov. 10, 1893, when the English patent expired; and that by reason of said action the public generally, and especially the defendant, has made large investments upon the faith of the expiration of said patent at the date expressly selected by the owners thereof, and that the latter are estopped to claim any benefits under said patent against the defendants since Nov. 10, 1893.

The complainants, in reply, file affidavits in which they admit the proceedings relating to the endorsement, but declare that the said proceedings were taken under a mistake at law, and under the advice of eminent counsel, and that the necessary correction was subsequently made. They further deny that the defendant was misled by the negotiations set forth by them, and that they in any way have impaired their legal rights to insist upon a continuation of the injunction. They further deny that the defendant was misled by the Patent Office proceeding referred to, and deny that they are estopped by those proceedings to insist that their patent is in force seventeen years from the date of issue, Jan. 27, 1880.

The court, in considering if the action of the complainants was an abandonment of some right or a dedication to the public of a right conferred, states that the action of the complainants is not in all respects like an abandonment of a point of an invention by a failure to claim all of it, or by a disclaimer in express words of a part of it. In this case the complainant did not disclaim or abandon anything that could be immediately appropriated, but it was not, however, a simple declaration that at the expiration of the shortest foreign patent they would then dedicate to the public the full remainder of its term of seventeen years. If its legal effect was such a dedication to take effect ten years in the future, it would have been a gift or grant which was subject to revocation, but the time for which the patentee was conferred the sole enjoyment of the monopoly is just as much the subject of a dedication and grant to the public as a part of an invention or process. What the complainants asked for was a right to limit a United States patent so that it would expire with the British patent, believing that the said patent would expire Nov. 10, 1893, for if they correctly stated its date, it would by law then expire. Acting upon a belief that this

limitation was necessary to the validity of their patent, they fixed the limit for what seemed to them a pressing necessity and a sufficient consideration, and they unquestionably had the power to voluntarily fix such a limit whether the Patent Office was authorized by law or not to make such an official correction. That their proceedings were taken under a mistake of law might give them the right to correct their error by proper application made within proper time, but could not affect their power or right to make such a limitation.

In regard to the claim of the complainant that the public should have investigated the legal effect of the indorsement, the court states that it had the right to accept the complainant's statement and to act accordingly. If they had taken no action whatever, but had relied upon their legal rights as they might subsequently be defined, the public would then have acquired no advantage and the defendant would have acted at its own peril and have had no claim such as they now assert. Even conceding that the act was filed under mistaken advice as to law, and only for such action as the Patent Office might lawfully take, and that the terms in which said action was invoked were such as to put the defendant upon its inquiry as to the law, it was nevertheless a solemn and public act and the complainants are bound by it.

In regard to the claim that the dedication was revoked, and that the action of the commissioner for correction was wholly void and that the surrender of the letters patent for correction was without legal authority and of no effect, the court states that this is not a controversy in which the authority of the complainants to surrender their patent for correction or the commissioner's power to make such correction and to amend the records of the office, are involved.

The defendants contend that whether the Commissioner of Patents had legal authority or not the complainants certainly had the right and power to limit the duration of their own patent and make record of their intention to abandon it to the public on and after Nov. 10, 1893, at the expiration of their British patent. Having done so, and the defendant having in good faith acted on said public declaration, it now contends that the complainants are estopped from coming into court and asserting that such conduct was a mistake as to law, and therefore not binding upon them. This involves the consideration of a question as whether the plaintiff's conduct was a representation as to something it proposed to do in the future, and therefore subject to revocation, or whether it was an abandonment of an existing right. The court quotes several opinions in favor of the latter view and says that the exact question seems to be met by these decisions; conceding, however, that there is doubt as to whether these decisions are conclusive of the controversy, the revocation which the complainants claim to have made is dated March 18, 1893, nearly ten years after their voluntary limitation of the primary patent. If they were in doubt as to the legality of the proceedings in the Patent Office, they should have acted as soon as such mistake was suggested and not waited until the public had acted on their dedication.

As to whether the complainant acted in good faith in regard to the defendant's limitation of the life of their patent, their claim that the capital stock was increased and the capacity for manufacturing lamps enlarged by reason of their belief in the said limitation, is both reasonable and natural, and it seems plain to the court that the complainant is estopped from now claiming that its conduct did not induce such well-defined belief as to the limitation of its patent on the defendant's part. Without deciding how far others not similarly situated had the right to rely upon such conduct on the part of the complainants, or without passing upon the question of how far the public generally acquired rights under the complainant's proceedings in the Patent Office, by which they limited the life of their patent, it is sufficient to find, under the motion, that the defendant by reason of the

circumstances particularly set forth in its motion, did rely in good faith upon the complainant's conduct, and had a right to be, and was in fact, influenced thereby.

The court then considers its right to dissolve the injunction now existing, and concludes that in view of the fact that it would not have allowed the injunction if the facts now relied upon in support of the motion to dissolve it had been available as a defense, it can, upon these facts, now dissolve the injunction. The court concludes that as the case is now presented on the motion to dissolve one of the two parties must suffer loss. If the injunction is continued, the defendant is wholly without remedy. It has shown that it was honestly misled by complainant's conduct, and in good faith made additional investments upon the belief so formed. The complainants cannot complain if, for this reason, the benefit of the doubts expressed are given to the defendant and the injunction is dissolved. If the court is in error as to this conclusion, no great harm can result to the complainant, for if such error is established they can recover for the damages caused thereby, and their right to contest as to other infringers not able to show such meritorious claims to estop as defendant has established, can be asserted without prejudice from this decision.

The American Association of Inventors and Manufacturers.

The third annual meeting of the American Association of Inventors and Manufacturers was opened in Washington, D. C., on Jan. 16 and 17, with an address by President Gatling, showing the progress of the association during the year and giving much valuable information to all interested in inventions.

The Committee on Legislation, of which W. C. Dodge, of Washington, is chairman, reported as to patent bills pending in Congress. Fourteen bills have already been introduced, two of them radical in character—one to change the lifetime of a patent from seventeen to seven years, and the other giving the government the right to cancel any patent upon payment to the inventor or owner of not less than \$25,000 nor more than \$100,000. The association opposes these bills, and their passage is not probable.

House bill No. 5,014 contains some amendments to the patent law prepared by the association, the important sections of which are as follows:

No person shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid by reason of its having been patented or caused to be patented in a foreign country less than two years prior to the application for a patent on the same invention in this country, but every such patent hereafter granted shall be limited in duration to the term of seventeen years from the time when the earliest foreign patent commences to run.

That Section 4,921 of the Revised Statutes be amended by adding the following: But hereafter, whenever a patent is alleged to be infringed, patentee or his representatives shall seek remedy by bringing suit against manufacturer or vendor of the article alleged to infringe said patent, and shall in no case bring suit against any individual who shall have purchased in good faith article of a regular dealer in the open market for his own use until the patent has been sustained by the court. Provided, that such individual purchaser shall give to patentee or his representative, at his request, the name and residence of the party from whom said article was purchased; and where the damage so claimed is less than \$50, plaintiff shall pay costs of suits of both defendant and plaintiff, and provided, also, that this exemption from liability of individual purchasers shall not apply to any corporation or party as to any patented machine or process made or used by them. Actions at law or suits in equity for infringements of patent rights may be brought where the infringement occurs, whether defendant be domiciled therein or elsewhere.

A number of important papers were read before the association, notably the following:

"Needed Modifications of Our Patent Laws," by Walter S. Logan, of New York. He took the ground that the sole ownership in a patent does not rest in the inventor, and that

no one should be permitted to allow valuable devices to lie idle for years, but that the law should compel him to put them to use, or in the event that he did not wish to do so himself, it should compel him to grant a license to some other person, appointed by the government, perhaps, who should have the right to use it.

"The Right of Property in an Idea," by Allen R. Foote, of Washington, which paper dealt with the question from an economic standpoint.

"Improvements in the Personnel of the Patent Office," by Arthur Steuart, of Baltimore, in the course of which paper he urged that service in the Patent Office should be similar to that in the army or navy. The duties of the commissioner and the assistant commissioner were so technical and required such a large range of experience and education that only men should be selected who wished to give their life to the work. These offices, therefore, should be removed from politics. He thought also that a system of grades and of pensions would contribute to the efficiency of the office, for it would attract men of ability.

Other papers read were:

"The Material Influence of the Patent System Upon the Farmer and His Duty to Uphold It," by John W. Fairchild.

"The Patent Office," by Thomas Ewing, of New York.

"Procedure in Patent Cases," by Richard Henry Gatling, of New York.

"Proposed Repeal of the Caveat Laws," by F. A. Seely, examiner in the Patent Office.

"Suggested Reform in Patent Practice Concerning the Question of Invention," by Charles M. Higginson.

The following officers were elected:

President, R. J. Gatling, Hartford, Conn.; first vice president, Gardner C. Hubbard, Washington, D. C.; second vice president, George Harding, Philadelphia, Pa.; third vice president, J. C. Anderson, Chicago, Ill.; fourth vice president, B. H. Warner, Washington, D. C.; secretary and treasurer, George C. Maynard, Washington, D. C. Directors, F. A. Seely, Washington, D. C.; F. A. Pratt, Hartford, Conn.; R. S. Munger, Birmingham, Ala.; Marvin C. Stone, Washington, D. C.; Arthur Steuart, Baltimore, Md.; Albert A. Pope, Boston, Mass.; L. W. Serrell, New York City; John V. Rice, Jr., Edgewater Park, N. J.; Ward W. Willits, Chicago, Ill.

Cheap Telephones.

It is reported that the Metropolitan Telephone Company of New York will hereafter sell the Bell instrument for \$2.50.

The California Midwinter Fair.

The machinery of the Midwinter Fair at San Francisco, Cal., was started on Thursday afternoon, Jan. 25, when steam was turned on for the first time and the entire illumination of the grounds is now in successful operation. Mr. W. F. C. Hasson, the electrical engineer of the fair, is to be congratulated on the prompt and effective manner in which he has conducted the electrical part of the enterprise, which has been uniformly in advance of the other features, some of which are yet in a backward state.

They Knew It All, As Usual.

An English contemporary, in referring to the World's Fair, made a remark to the effect that it had been a very good thing for the Americans, as it brought before their notice for the first time the advanced state of electric lighting and electric power, about which they knew very little before they visited the Fair (!). But that from a European point view there were no electrical exhibits of any interest, as there was nothing new there for them! A rather better authority from the home of this journal, and one who came here himself instead of by proxy, expressed his great surprise to us at the marvelous development of electricity in this country, and at the very general introduction of the electric light and railway in so many American cities.

The Niagara Falls Power Plant.



THE great power plant at Niagara Falls, which has been in the course of construction for more than three years, was given its first practical test on Thursday, Jan. 25, when the water from the hydraulic canal was admitted to the wheel pit of the Niagara Falls Paper Company's mill, and pouring down the great penstocks set in motion the mammoth turbines and thence passed through the big tunnel out under the city to the river below the city, more than a mile away. One of the 1,100-h. p. turbines was started, then a second and at last a third, and it is stated that their operation was most satisfactory, the wheels running as smoothly as could be desired. The test was made in the presence of the officials of the paper mill and the of the R. W. Wood Company, of Philadelphia, who built and installed the turbines, and of Prof. Geyelin, who designed them.

At this time a brief review of the work that has already been accomplished toward the utilization of this great power and an outline of what it is hoped may be realized in the near future, may prove of interest.

The old hydraulic canal, which commenced on the shore of the river above the falls and extended about three-quarters of a mile to the high bank of the gorge below the falls, was the first attempt to utilize the falls of Niagara on any large scale. During the past sixteen or seventeen years a number of large manufacturing establishments have taken advantage of its resources until its capacity has been practically exhausted.

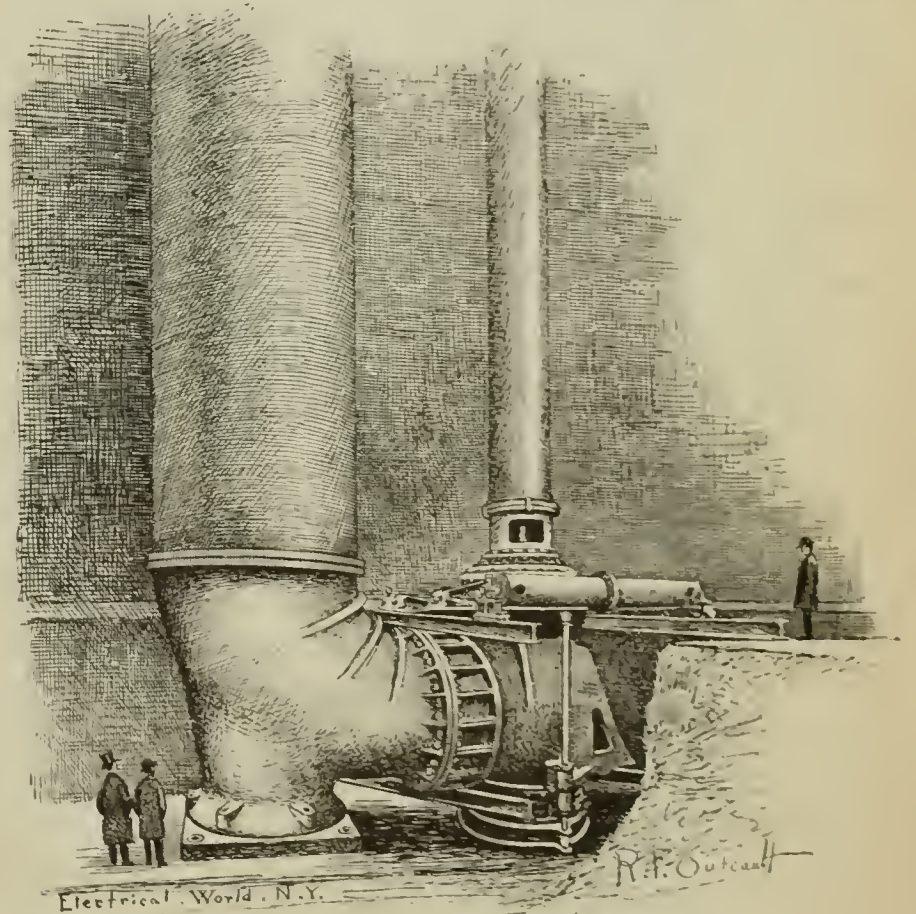
It was apparent that the power of the great falls could be utilized on a much larger scale, and in 1886 the Niagara River Hydraulic Power and Sewer Company of Niagara Falls, N. Y., obtained a charter under which it planned to construct a tunnel from a point in the Niagara River above the falls along the shores of the upper Niagara River for a distance of a mile or a mile and a half. The present Niagara Falls Power Company is the successor of that corporation. The Cataract Construction Company was organized for the construction of the great work, and secured for carrying out its project the services of the following engineers: Albert H. Porter, engineer; Coleman Sellers, John Bogart and Theodore Turrettini, consulting engineers; George B. Burbank, resident engineer; Clemens Herschell, hydraulic engineer; and George Forbes, consulting electrical engineer.

The chief features of this scheme are well known, and a general idea may be obtained from the accompanying map of Niagara Falls and vicinity. The central feature of the work is the great tunnel, 6,700 feet in length, with a cross-section of 19 by 21 feet. This great piece of engineering work was commenced in October, 1890. The tunnel, which is horseshoe in shape, is lined throughout with brick. Its base at its discharge point below the falls is 205 feet below the sill of the head gate at the entrance to the main canal from the river above the falls. Of this total fall, 140 feet is available, the difference being taken up by the allowance for clearance from the wheel pits, incline of the lateral tunnels, and the grade of the great tunnel, which is about 36 feet to the mile. The tunnel is lined on the invert and sides for a distance of 200 feet back from the discharge point with closely fitted cast iron plates, there being a heavy cast iron frame at the mouth. The brick lining consists of four courses of brick, or a total of 16 inches.

The first establishment to take advantage of this new

source of power was the Niagara Falls Paper Company, whose mill was finally put in operation last week, as has already been stated. This company has contracted for 6,600 h. p., half of which has already been installed. The turbines are of the Geyelin-Jouval type, built by R. D. Wood & Co., of Philadelphia, Pa., and are of 1,100 h. p. each.

It is the intention of the Niagara Power Company to lease to various enterprises of sufficient magnitude to establish mills in the immediate vicinity of the canals that right and the privilege of using the great terminal as a tail race. It is certain, however, that it will not be profitable to either the power company or the lessee to install plants of less than 500 h. p., or perhaps 1,000 h. p. for directly utilizing the water power. As the whole 100,000 h. p., which is the rated capacity of the tunnel, could not be thus used, a plan was devised to erect a central power station and transmit the excess of power for use at greater or less distances. Accordingly, Mr. Edward D. Adams, president of the Niagara Construction Company, and Dr. Coleman Sellers went abroad to carefully examine the various systems of power transmission in use there. It was finally decided to place the information in the hands of an international commission, which was organized under the presidency of Sir William Thomson, and consisted of, besides that eminent electrician, Prof. W. C. Unwin, Prof. E. Mascart, Col. Theodore Turrettini and Dr. Coleman Sellers. This commission awarded prizes to various firms offering plans, the most of which were foreign, the Pelton Water Wheel Company, of San Francisco, Cal., and the Norwich Iron Works, of Norwich, Conn., being the two American firms which received recognition. In the summer of 1892 Prof. Henry A. Rowland, of Johns Hopkins University, was asked to make a report upon the various



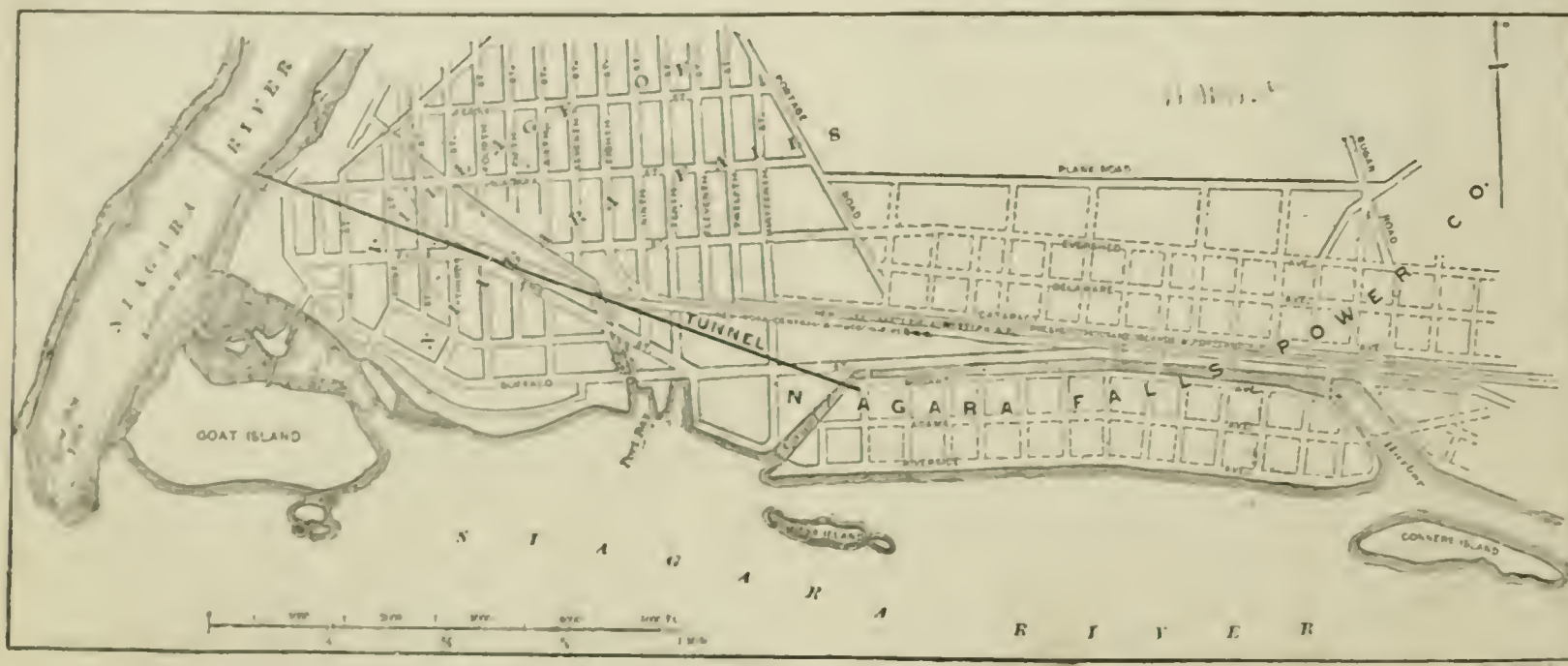
TURBINE FOR THE CENTRAL POWER STATION AT NIAGARA FALLS.

plans proposed, which he submitted about six months later. The officers of the company finally decided upon a general scheme, the principle details of which were made public some weeks ago.

The accompanying illustration gives a very good idea of the general plan of this plant. The ultimate capacity of the station is 50,000 h. p., but as yet the contract has been let for only about one-third of this amount. Five hundred h. p. twin turbines under a head of 140 feet are to operate Westinghouse alternating dynamos of approximately the

same capacity direct connected to the head of a vertical shaft. These turbines have been constructed from designs furnished by the Swiss firm of Faesch & Piccard and built by the I. T. Morris Company, of Philadelphia. The accompanying illustrations show their general form of construction. The speed, under a 140-foot head, is to be 250 revolutions per minute. Bronze is the material used in their construction,

casing are apertures through which the water can act upon the under side of the disc carrying the movable blades of the upper turbine and relieve the bearings of the weight of the shaft. In this way the weight of the water column is sustained by the stationary portions, which can be braced and supported for the purpose, and the pressure due to the head made to act upward for supporting the



MAP OF NIAGARA FALLS AND VICINITY, SHOWING LOCATION OF TUNNEL.

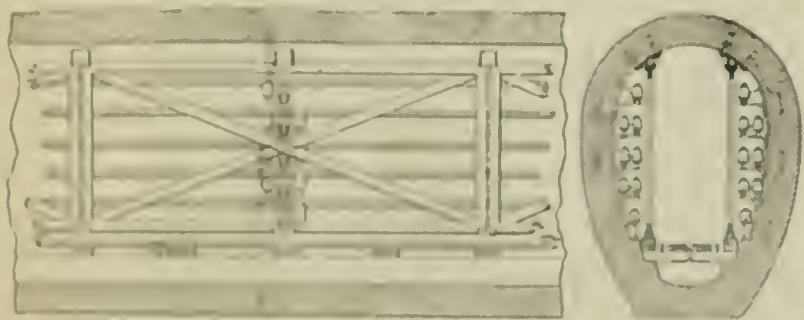
similar in quality to that employed for the propellers of steamships.

The power station is situated on the west side of the main canal, which is about 188 feet wide and 17 feet deep at the river, narrowing to 116 feet in width, but maintaining the same depth throughout its entire length of 1,260 feet. The depth of the water in the canal will be about 12 feet. The sides of the canal are built of solid masonry, seven feet thick

the parts attached to the shaft, while in the upper end of the weight of the revolving shaft, which is thus nearly in the condition of a shaft spinning upon the water.

The shaft consists of a steel shell about a foot in diameter, with smaller solid portions in the journals, which require to be of less frequency on account of the stiffness due to the large diameter of the hollow shaft. The latter is of rolled steel tubing without any visible vertical seam. No flywheel is required.

We are indebted to "Power" for a considerable portion

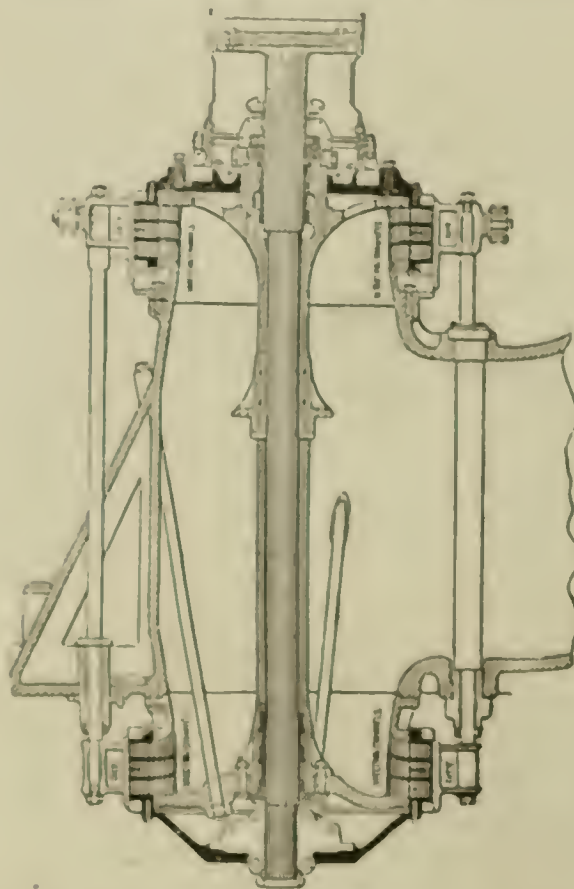


LONGITUDINAL AND CROSS SECTION OF ELECTRIC CONDUIT.

at the bottom, tapering to three feet at the top, on which a coping 2 1/2 feet wide has been placed. From this canal the water is taken through a separate inlet for each wheel, as shown in the illustration, and carried through a penstock seven feet in diameter into the centre of the turbine. It is thence discharged through directing passages upon the 32 multiple blades of the wheels, these passages being formed by 36 deflecting plates.

As has been stated, the shaft is vertical, which gives the wheels a horizontal position, one at the top and one at the bottom of each casing. The gates controlled by the governor are made to govern more or less of the discharge, opening according to the power required. It is claimed that the governor will control the speed under ordinary conditions with a variation of less than one-half of one per cent. One of the most serious problems in the construction of this plant was that of supporting the weight of the long vertical shaft with the moving parts of the dynamo and the great downward pressure on the column of water in the penstock.

This is solved in this design by closing the bottom of the casing so that the water cannot act downward upon any of



SECTION OF TURBINE FOR NIAGARA POWER PLANT

of the above information in regard to the details of the construction of the turbines.

The turbines have been constructed, and it is understood are ready to be placed in position, but the electrical portion of the plant is far from completion, although it is stated that

the whole installation is to be finished by June 1. As already announced in these columns, the contract for the generators was given to the Westinghouse Electric and Manufacturing Company, and these machines are now being constructed at their factory. They are to be of 5,000 h. p., and are two-phase machines, with stationary armatures and rotating fields, designed to give a potential of somewhere in the neighborhood of 2,000 volts, which for long-distance transmission will be increased by step-up transformers. The electric features of the plant are by no means settled. Although two-phase

Company is to erect a whole village on the extensive lands acquired. The Niagara Railway Company is to construct six miles of terminal railways to connect the factories, as they are built with the railways in the neighborhood. Other companies, such as the Cataract General Electric Company, is to supply power to all the cities within reach. Roads are made, leases of land granted, factories built and the engineering work taken in hand by the Cataract Construction Company, of which E. D. Adams is president, E. A. Wicks first vice president, W. K. Rankine secretary and treasurer. Mr. G. B.



NIAGARA FALLS CENTRAL POWER STATION.

alternating dynamos have been decided upon, it is not yet settled that two-phase motors will be used. It is quite possible that the two circuits of the generators may be used as single-phase circuits to supply single-phase motors, or, what is more probable, both single-phase and multiphase motors will be employed.

Little has been determined upon as to the method of distribution to distant points. All these questions will be settled as the plant is installed, and as it is necessary to meet the demand for specific cases. At first, however, the distribution will be through underground conduits, and such a conduit is already in course of construction to the works of the Pittsburgh Reduction Company, one of the largest and earliest consumers of power from the station, whose plant will be located about 2,500 feet from the power house. It will probably use about 3,000 h. p. One of the accompanying illustrations shows a section and elevation of this conduit. Conductors will be carried on insulated brackets on both sides, the brackets to be located about 30 feet apart. A track will extend throughout the length of the conduit and a car, propelled at first by hand but eventually by electricity, will carry men for the inspection and repair of the wires.

A recent paper by Prof. Forbes before the British Institution of Electrical Engineers, an abstract of which has been given in these columns, has stated at length the various questions which came up in the selection of the complete electrical system of power distribution, and it is unnecessary to repeat the details here.

The Cataract Construction Company, which has charge of the engineering work, will finish its labors when the plant has been completed, and will then hand it over to the Niagara Falls Power Company, which is the central figure of the whole scheme. Various auxiliary companies have been organized for different purposes. The Land Development

Burbank is chief engineer; Dr. Coleman Sellers acts both as consulting engineer for the Cataract Construction Company and as president of the Niagara Falls Power Company, while undertaking at the same time many of the duties of a resident engineer.

A Current Without a Difference of Potential.

BY WILLIAM A. ANTHONY.

In the last issue of *The Electrical World* is given a case of "A Current Without a Difference in Potential." Permit me to call attention to a case about which there can be no question, which will be found described in text-books of more than twenty years ago. Suppose a conductor of uniform cross-section, bent in the form of a circular ring and the ends joined, forming a conducting ring of perfectly uniform cross-section and conductivity. Let a straight bar magnet whose axis coincides with the axis of the ring be thrust into the ring along its axis. An electromotive force of uniform value acts in every element of the ring and develops a current, but with no difference of electrical potential in any part.

Another Case of a Current Without a Difference of Potential.

In connection with the note under this heading, in last week's issue, attention might be called to another case. If a copper ring be placed above a coil through which an increasing (or decreasing) current passes, a current will flow in the ring the relations of which to the ring would be similar to those in the supposed case mentioned last week. That there will be a true E. M. F. generated in this ring by the increasing flux is evident.

Relative Costs of Distribution by Different Electrical Systems.

The following letter has been received from Mr. Paul A. N. Winand:

"Your number of Jan. 13 contains a paper by Mr. W. D. Weaver on the relative cost of distribution by different electrical systems with the same effective or maximum E. M. F. I beg to remark in this connection that in a paper, read in May, 1892, contained in the journal of the Franklin Institute for October and November, 1892, and reprinted in part in *The Electrical World*, 1892, page 310, I have dealt with the same question, and arrived, in a very simple way, at substantially the same conclusions as Mr. Weaver. The only discrepancy in the conclusions is referring to the so called two-phase system. My figure for this is identical with that also found by Mr. G. Kapp."

(The paper referred to by Mr. Winand, "On Polyphased Currents," we find considers a number of interesting points in connection with polyphased currents, including efficiency of transmission and relative amounts of copper in different systems, and thus antedates Kapp's paper on the latter subject by more than a year. While the method used is comparatively simple in expression, the attempt to avoid analytical mathematics has resulted in somewhat involved explanations and a less general treatment, thus rendering the paper rather difficult reading, which may account for its undoubted value not having been more generally recognized.)

The National Electric Light Association.

An invitation has been sent by Secretary George F. Porter to the various central stations throughout the country to attend the seventeenth convention of the association, which is to be held at Washington on February 27, 28 and March 1, in which it is announced that among the topics of discussion will be the following:

"What Is the Most Economical Size for Arc Dynamos?" "Arc Lights on Incandescent Circuits." "How to Rate Arc Lamps." "Underground Circuits." "How to Wire Buildings." "Commercial Alternating Motors." "Electrolytical Effects of Return Currents." "Meters vs. Flat Rates"

and "Storage Batteries." A paper entitled "Electric Lighting at the World's Fair and Some of Its Lessons," illustrated with stereopticon, by T. C. Martin and L. Stieringer; "Impressions of a Central Station Man Abroad," by E. A. Leslie; "The Importance of Complete Metallic Circuits for Electric Railways," by J. H. Vail, and other papers will be read.

Mr. C. O. Baker, Jr., master of transportation, announces that the Boston Passenger Committee and the Southern Passenger Association have granted a rate of one and one-third fare for a round trip from points in their respective territory for members and delegates attending the convention.

Report of the Edison Illuminating Company of New York.

The Board of Directors of the Edison Illuminating Company of New York have issued their annual report, in which it appears that the year 1893 was a most prosperous one for the company. The net earnings of the company's stations were \$666,027.23, while the earnings from other sources and income from investments amounted to \$52,185.96, making a total of \$718,213.19. The general and legal expenses and taxes amounted to \$112,570.47, leaving as the net earnings of the company for the year \$605,642.72. The gross earnings increased 27 1-2 per cent. and the net earnings 27 per cent over those of 1892. The business depression tended to curtail the number of lights per customer, but on the other hand the company largely increased the number of customers. The total present installation is equal to over 270,000 16-c. p. incandescent lamps. The installation of incandescent lamps increased 25 per cent., of arc lamps 55 per cent. and of motors 45 per cent. The following table shows the net increase in the several classes of installations for the past three years:

	Dec.31, 1890.	Dec.31, 1891.	Inc., 1891.	Dec.31, 1892.	Inc., 1892.	Dec.31, 1893.	Inc., 1893.
Customers	1,698	2,875	1,177	4,344	1,469	5,154	810
Inc. Lamps.....	64,174	94,485	30,311	142,492	48,007	192,691	50,199
Arc Lights.....	254	841	587	1,637	796	2,538	901
Motors, h. p.....	697	2,000	1,303	3,807	1,807	5,529	1,722
Total 16 c. p. eq.	73,684	122,895	49,211	196,932	74,037	273,361	76,429

The number of customers would have increased still far more but for the fact that during part of the year the company was obliged to refuse business on account of its limited capacity.

The new Pearl street station has been completed during the year in its exterior, but the financial depression limited the interior work to that necessary for immediate requirements of the station. Five of the new double-deck Babcock & Wilcox boilers, adapted for 200 pounds' working pressure of steam, are in use in the boiler room, and a new 2,500-h. p. Van Vleck disconnective quadruple expansion engine, with two 800-kw. dynamos, have been installed in the engine room. The old Pearl street station was not dismantled during the year, as was hoped, but it is expected that the station will be put out of service early this year and the whole installation concentrated in the new station, which is now capable of producing over 30,000 amperes. The 26th street station has been equipped with its full complement of machinery, and has now a rated capacity of about 20,000 amperes. The 39th street station has been further equipped, and, with a rate of capacity of 6,500 amperes, has been run supplementary to the 26th street station. The 53d street station has had an additional boiler equipment during the year, and with its storage battery plant has now a capacity of 4,500 amperes. When the old Pearl street station is discontinued part of this equipment will be moved to the 53d street station.

The highest load of the entire system taken together was on Dec. 15, a maximum of 51,480 amperes, and the total amperage of the year was in the down town district, 47,317,512 ampere hours, and in the up-town district, 43,812,810, making a total of 91,130,322 ampere hours.

The report also deals with the underground installation, the work of the inspection department, the meter bureau and the lamp decisions. The company has made rapid progress in the arc light business, and now claims an arc light installation larger than that of any high-tension company. During the year the new arc light street system of Fifth avenue has been extended and the use of small arc lamps for interior lighting has been noticeably developed.

Magnetic Separator Litigation.

Judge Acheson, of the United States Circuit Court of the District of New Jersey, has handed down a decision sustaining a claim of infringement by the Magnetic Separator Company against the International Ore Separating Company. The court decides that the latter company has infringed various patents of Clinton M. Ball, of Troy, N. Y., and others, relating to the separation and concentration of iron ores, of which the essential elements are: a method of three-part separation, the method of forcing ore in a state of division through an alternating magnetic field with full opportunity for the dislodgment of gangue, air currents for removing the finer particles of dust from the ore, and means for adjusting the strength of the magnetic field. Orders are granted to recover profit, gains and advantages from such infringement, and that the defendants pay the costs of the suit and be perpetually restrained from further use of said inventions.

Storage Batteries on the Canals.

Mr. Frank W. Hawley, who had charge of the canal electrical experiments near Rochester in December last, will ask permission of Superintendent of Public Works Hannan to operate his boat on the State waterways next season as a sort of object lesson in the uses of electricity. He proposes to have a new boat of the most approved pattern, equipped with a propeller wheel of the latest design, and in place of the trolley used in the experiments already mentioned, proposes to use storage batteries to operate the Westinghouse motors that drive the shaft to which the wheel is attached. Two series of storage batteries will be used. On one side of the boat will be ranged the chloride accumulators of the Electric Storage Battery Company, and on the other side a series of batteries furnished by the General Electric Launch Company of New York. It is the intention to place upon this electric boat a number of devices for the use of electricity in daily life, including electric heating and cooking apparatus, and to exhibit these everywhere along the line of the canal, thus furnishing a useful object lesson. Mr. Hawley deserves the warm thanks of the electrical profession and industries for his enthusiastic faith in the possibilities of electricity and the yeoman's service he is performing in thus unselfishly advancing its interests.

Unipolar Dynamos, and the Action of Lines of Force in a Revolving Electromagnet.

BY A. RANDOLPH.

The article in *The Electrical World*, Jan. 13, by Mr. Carl Hering was interesting to myself, and no doubt it was to others also who, like myself, have been fascinated with the idea of a possible operative unipolar dynamo. Mr. Hering states regarding an electromagnet that "it was thought that if an iron core in a coil be revolved, the coil remaining fixed, the lines of force would move with the iron, and not remain fixed with the coil. But this also appears to be an error, as lines of force are said to remain and move with that which generates them; that is, with the coil of an electromagnet; they are stationary if the coil is stationary, and revolve if the coil revolves." "This statement

is made, however, on the authority of others, the writer not having made any experimental demonstration himself." I think that the above statement is incorrect, and that dynamos have been made which operated, and yet the only part of the magnet which revolved was the core and poles. In *The Electrical World* of Sept. 30, 1893, page 247, is described and illustrated a motor exhibited at the World's Fair by the Union Electric Company, called the Main motor. It has a stationary Gramme ring armature, the windings of which are connected to a stationary commutator; the magnet coil is stationary and the core and poles revolve. The magnet has four poles, which face the sides of the armature. Each pole face covers but a part of the side of the armature, and the two pole faces on one side of the armature are set one-fourth the circumference ahead of the two on the other side.

In this machine the lines of force must* follow the iron of the magnet and sweep around through the armature core as the magnet revolves, so that the stationary wires on the armature are not cut by the lines of force, or it would not be operative.

This is good experimental evidence* that the lines follow the iron of the magnet even though the magnetizing coil be stationary.

The Mordey alternating-current dynamo is well known to most of the readers of *The Electrical World*, and it has a revolving magnet, but the coil revolves with the magnet. S. R. Bottone is authority for the statement that this dynamo will operate all right if the exciting coil is stationary, but that it is not so made because of mechanical difficulties. The writer has made some experiments with a supposed unipolar dynamo, the magnet of which was of a shape similar to the Mordey magnet, but one end of it and the core and exciting coil was stationary, while the other poles revolved. The machine was not operative and the experiments were not carried very far, but as the result of this experience I conclude that if only one pole of the magnet revolves it is probable that the lines do not revolve with the pole, but pass directly through the air and iron in the shortest course to the core, or if they revolve with the moving pole they sweep through the air and take the shortest course to the core again through the iron and air, instead of all entering and passing through the stationary poles to the core. In either case I do not think it will make any difference whether the magnetizing coil is stationary or revolves with the movable pole of the magnet. Possibly some one has settled these points by experiment, and if so, I would be pleased to see them contribute the same to the columns of this journal, but if no one can refer me to any such experiments, I will not be satisfied until I do something toward it in the future.

(*The writer's mistake lies here. This machine does not necessarily prove that the lines really revolve with the core, for it evidently would also work if the lines remained fixed with the coil, being alternately strengthened and weakened through successive parts of the armature: if the pole pieces heat less when the coil also is revolved, it would tend to show that the lines remain fixed with the coil. But even this would not be conclusive, as the lines due to the iron might revolve with the iron while those due to the coil itself might remain stationary with the coil. We know of a similar machine in which the pole pieces heated so very much that the machine was of no use.—C. H.)

Surgical Electricity.

The curious and possibly important fact, says London "Electricity," has been noticed that when the eyes are illuminated from behind by a glow lamp in the mouth, the pupils, seen as blood-red apertures, do not contract.

Explanation of an Apparent Disagreement Between Certain Magnetic Formulas.

BY CARL HERING.



To the inquiring mind there appears to be a disagreement between two very common and useful formulas, and as both are undoubtedly correct, it often leads the careful student to believe that he does not fully understand them, and he may therefore be afraid to use them. It is for the benefit of this class of thinking students and beginners that the following explanation is offered. Those who are thoroughly conversant with the subject will, of course, see at once that the disagreement is only apparent and not real.

We are told that for a coil without iron the formula for the number of lines of force per square centimetre is

$$H = \frac{4\pi}{10} A l, \quad (1)$$

in which A is the number of amperes and l the number of turns per centimetre length of the coil. We are also told that for the same coil without (or with) iron the identical formula gives the value of the magneto-motive force thus:

$$\text{M. M. F.} = \frac{4\pi}{10} A l, \quad (2)$$

in which M. M. F. represents the magneto-motive force (which may be considered as that which causes the magnetic flux, just as the E. M. F. is that which causes the electric current). From these two identical formulas it appears as if H , which represents the number of lines per square centimetre, was the same thing as a M. M. F., which, however, is measured in entirely different units; or, to use analogous quantities in electricity, it appears as if a current density in a wire was the same thing as volts, which is naturally quite confusing. Even if it is known that H is really a M. M. F., the question arises, Why is its value always expressed in lines of force per square centimetre, which is an entirely different unit from the unit of M. M. F.? The numerical value of H in that formula is almost invariably stated as meaning a certain number of lines per square centimetre, or in terms of the new names which are about to be introduced in this country, its numerical value represents so-and-so many gaussses. But the M. M. F. is measured in gilberts, and it might seem, therefore, as if gaussses were equal and synonymous with gilberts, while they are really as different as current densities and volts.

The explanation of this apparent disagreement is that the first formula, although the more common, is really only a special case of the second, the special condition being that the reluctance or magnetic resistance is unity, and therefore does not appear in the formula. The second formula is quite general, applying to air, iron, steel, bismuth, etc., while the first applies only to one particular case, namely, air. Although the last condition, namely, that the formula for H applies only to air, is generally (and should always be) stated, yet this is not sufficient to make the true difference between the two self-evident, it is asked, "If the difference is in the reluctance, then why does not the reluctance appear in the second formula either?"

To illustrate how two different quantities may be numerically the same let us take an analogous case. Volts and amperes are entirely different quantities, yet if a wire has a resistance of one ohm per foot, then the number of volts for a certain number of feet will be the same as the number

of amperes. A more perfect analogy will be given later. We will first show, for the benefit of those who desire to see the true meaning of the magnetic formulas, how they may be reconciled with each other.

Quite analogously to Ohm's law there is a well-known formula in magnetism:

$$\text{flux} = \frac{\text{M. M. F.}}{\text{reluctance}}, \text{ or webers} = \frac{\text{gilberts}}{\text{oersteds}},$$

or using letters for the sake of brevity,

$$\Phi = \frac{\mathfrak{F}}{\mathfrak{R}},$$

which is quite general and applies to coils with or without iron or any other substance. From this it follows that

$$\mathfrak{F} = \Phi \mathfrak{R}, \text{ but as was stated in formula (2) } \mathfrak{F} = \frac{4\pi}{10} A T, \text{ in}$$

which, in order to make it more general, we have used the total number of turns T instead of the number of turns l per centimetre. From this it follows that

$$\Phi \mathfrak{R} = \frac{4\pi}{10} A T, \text{ or } \Phi = \frac{4\pi}{10} \frac{A T}{\mathfrak{R}}.$$

But Φ is the total flux in the coil (in webers), and must, therefore, be divided by a cross-section s to reduce it to lines of force, or flux, per square centimetre (in gaussses); we can then represent it by H' , as it is then a quantity of the same kind as H , namely intensity. Thus

$$\frac{\Phi}{s} = H' = \frac{4\pi}{10} \frac{A T}{\mathfrak{R} s};$$

substituting for $\mathfrak{R}$ its value $\mathfrak{R} = \frac{l}{s \mu}$, in which l is the

length of the magnetic circuit in centimetres and μ is the permeability, gives

$$H' = \frac{4\pi}{10} \frac{A T s \mu}{s l} = \frac{4\pi}{10} A \frac{T}{l} \mu.$$

So far it is still quite general, but we now come to the special case of a long solenoid without iron, in which the permeability $\mu = 1$ and $\frac{T}{l} = l$, the number of turns per

centimetre, in which case H' becomes H ; making these substitutions gives $H = \frac{4\pi}{10} A l$, which is the original formula (1). It will thus be seen how two formulas which are identical may, nevertheless, give values of two quantities which are totally different in quality.

For the advanced student who is more familiar with mathematical reasoning, the above detailed explanation may be reduced to a few words. Taking a very long solenoid with an air core, the flux density (in gaussses) will be the same in any part of a cross-section, not too near the ends; hence a cylinder one centimetre long and one sq. cm. in cross-section, with its axis parallel to that of the solenoid, will, when placed anywhere on this cross-section, always enclose the same number of lines, and the M. M. F. at its ends will be that given by the formula (2); from the other formula $\mathfrak{F} = \Phi \mathfrak{R}$ it follows that $\mathfrak{F} = \Phi$ if the reluctance $\mathfrak{R}$ of this cylinder is unity; but as the cross-section is also unity $\Phi = H$, hence $\mathfrak{F} = H$, that is the numerical value of $\mathfrak{F}$ (in gilberts) is equal to that of H (in gaussses).

Strictly speaking, however, H is really a magneto-motive force (expressed in gilberts) and not an intensity (expressed in gaussses), and if thus considered there is no disagreement at all between the two formulas. But owing probably to the easy conception of lines of force per square centimetre and to the more difficult and unusual conception of a magneto-motive force, it has become popular to represent H as an intensity in this particular case; hence the apparent disagreement. But it should be clearly under-

* The term "magnetic" formula is used here in place of the more correct but rather lengthy expression "formula for calculating magnetic quantities and relations", the term is quite analogous to the terms electric, chemical or hydraulic formulas, and its use therefore seems justified.

stood that such an interpretation of H is allowable only under particular conditions. If a uniform system of notation had been in use, no such confusion would have arisen.

Students who are fond of analogies will find the following to be quite a perfect one to the above magnetic calculations. Volts are analogous to magneto-motive force (gilberts), and current density is analogous to the H as it is usually represented (that is to gaussess). In general the volts generated in a wire moving through a magnetic field are represented by the formula

$$E = \frac{N}{10^8 n},$$

in which N is the flux (in webers), or the total number of lines of force, and n the number of seconds in which the wire cuts them. Now, under certain definite conditions the current density (Cd) in the wire might also be (although it never is) represented by precisely the same formula, namely,

$$Cd = \frac{N}{10^8 n},$$

from which it might appear as if $E = Cd$; that is, as if current density and volts were the same thing, which we know they are not. By substituting the above value for E in Ohm's law, and also the value for R in terms of the length, cross-section and specific resistance, and then dividing the resulting equation by the cross-section of the wire (quite analogously to the reductions made above with the magnetic formulas), we will obtain

$$Cd = \frac{N}{10^8 n s l r},$$

which in the special case of r (specific resistance) and (length of wire) being unity, as in the magnetic formula, will give the same value as that for E .

If we may be pardoned for following an old custom of drawing morals, the following would fit the above case: 1. Things which are numerically equal to the same thing are equal to each other *numerically*, but *not necessarily qualitatively*. 2. Authors of formulas will do less harm by being too explicit than by not being explicit enough.

Another Startling Discovery.

According to a German journal whose title leads one to believe that it is a scientific paper, a physician in Geneva, named Mandeuft, has made a wonderful discovery, which, as is usual with these discoveries, will completely revolutionize the present methods of generating electricity. With a 1-2-h. p. machine he claims to be able to light 500 lamps, the candle power of which, however, is not given. The apparatus consists of a hollow sphere of zinc about 20 inches in diameter and a solid sphere of copper inside of it about 16 inches in diameter; the outer one is revolved in one direction and the inner in the other, the speed being 500 revolutions per minute. But, the article states, no current is generated until the space between the two spheres is filled with water vapor at a pressure of 6 atmospheres, when a current of "enormous power" will be produced, whose intensity increases with the speed of revolution and the pressure of the steam. As usual, the first apparatus which has been tested in England is said to have been very satisfactory, even to scientists, the names being unfortunately omitted. The article ends up with what constitutes an advertisement of somebody's accumulator and somebody else's thermo-stove.

Nothing New Under the Sun.

"La Lumiere Electrique" announces as something new that an incandescent lamp was recently found in the stomach of a shark, but a Hering tells us that long ago he experienced the sensation of a vacuum in his stomach.

A Year's Record of Electrical Patents.

BY C. W. SWOOP.

Since the organization of the Patent Office and up to the present time over half a million patents in the application of the arts and sciences have been granted by the government to individuals. A very large proportion has been granted during the last decade, there having been over 100,000 patents issued in the past four years, against 140,000 issued for the ten years 1870 to 1880, so that the present time may well be called the "Age of Inventions."

During the past year over 22,000 patents were issued, of which more than 1,700, or 8 per cent., were issued for electrical inventions, which is a slight increase over the number issued the preceding year. To give some idea of how this number of patents is distributed over the various branches of the electrical business, as well as indicating the subjects which are engaging the attention of many inventors, the following statistics have been carefully compiled from the "Illustrated Record of Electrical Patents," as published each week by The Electrical World:

	Number of patents issued.
Electric Traction.	
Electric railway systems and conduits.....	84
Trolley and car appliances.....	104
Electric locomotives.....	25
	213
Dynamos, motors and parts thereof.....	164
Electric lighting fixtures and appliances.....	140
Regulator and current controlling apparatus.....	81
Cut-outs and circuit breakers.....	58
Arc lamps.....	77
Incandescent lamps.....	39
Systems of distribution and switchboards.....	64
Switches.....	66
Wires and cables, conduits.....	26
Insulators.....	50
Electric measuring instruments, meters, indicators, etc.....	85
Telephones.....	83
Telegraph.....	45
Signal systems.....	88
Bells, annunciators, gas-lighting clocks.....	79
Fire alarms.....	35
Batteries.	
Primary.....	36
Secondary.....	37
	73
Electric heating and appliances.....	40
Electric welding.....	18
Electric mining.....	13
Medical apparatus.....	25
Miscellaneous devices and appliances.....	158
Total.....	1,720

One thing especially noticeable in the table is that our every-day practical apparatus is being constantly improved and perfected, which of course means better service for the public. As will be seen, the subject of electric traction is paramount, claiming the largest share of attention from inventors, 9 per cent. of these patents being issued to foreign residents. Arc lamps continue to be improved, though 20 per cent. of these patents were issued to foreigners.

Quite a number of patents classed under lighting appliances related to lightning arresters, this subject apparently receiving considerable attention.

Patents relating to the transmission of power were classed under dynamos and motors and systems of distribution, and received a fair percentage. This subject, no doubt, will soon rival that of electric traction, and promises much for the future.

Storage batteries, as a solution of the traction question, are receiving more attention than usual, Americans being probably awakened to their practical use by the examples found in Europe. Of the number quoted, 28 per cent. were issued to foreigners. Of the whole number of patents issued during the year, 9 per cent. were granted to foreign residents.

Laboratory Notes.—XV.

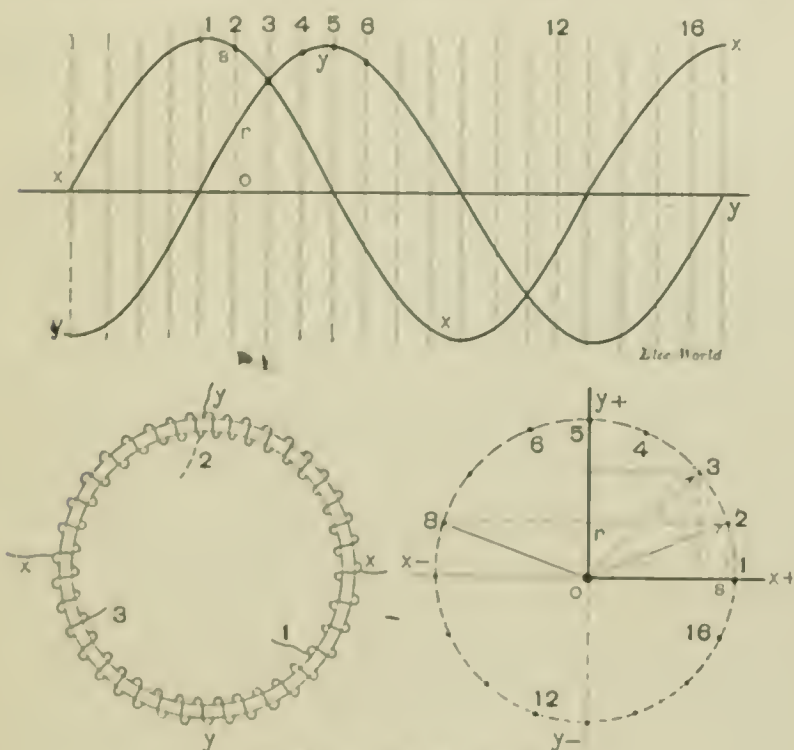
BY LIEUT. F. JARVIS PATTEN.



THE effect of two or more currents acting simultaneously in the same magnetic system, but which change in value constantly with respect to each other, can be plotted graphically and the resulting magnetic effect for a complete cycle determined by a simple graphical method, which for practical purposes is quite as exact as the more general methods of analysis, which for many students would be more difficult, if not entirely

beyond their powers.

The method consists in treating the magnetic forces due to the actions of the different currents in a system as so many separate and distinct mechanical forces having a common point of application, and by determining the resultant force



FIGS. 35, 36 AND 37.

of numerous different combinations the loci of the points of these different resultants define a curve which portrays the effect of the different magnetic or current forces at work during a single cycle.

Thus in Fig. 35 we have given two alternating currents, x and y . They are in quadrature and have equal maximum values. These must be first plotted as sine curves, if they vary according to the sine of the angle of rotation of the generating armatures, or to get a true result one must know the law of change and lay out the curves accordingly, seeing that the maximum value of one coincides in position with the minimum of the other if the currents are in quadrature, or that any two corresponding values have the proper phase difference. A distance along the axis or time line is then divided into a suitable number of equal parts, 1, 2, 3, etc., to 16, and ordinates are drawn cutting the two curves, and these ordinates may be taken to represent the relative instantaneous values, either of the currents themselves or of their magnetic effect in a system. Consider the latter, and suppose one current acts in the circuit x of the ring winding Fig. 36 and the other acts in the circuit y at right angles to the former vertical and horizontal diameters of the ring. We then lay off two axes of co-ordinates, X and Y , at right angles to each other, and on these we lay off positive values of x to the right and negative values to the left of the centre, or point, of intersection, and positive values of y above and negative values below this point, using the different values indicated by corresponding ordinates of

the curves x and y of Fig. 35. The points 1, 2, 3, etc., of the circle, Fig. 37, have been determined in this way.

Thus the point 2 on the circle is determined by laying off on the axis Y the distance or of the curve y above the axis in Fig. 35, and on the axis X the distance os of the curve x above the axis on the same ordinate. Through s and r , Fig. 37, lines drawn parallel to the axis of co-ordinates determine by their intersection the point 2 of the circle, which is the point where a mass free to move would land if actuated simultaneously by two forces, one of which acting alone would carry it from o to r and the other alone would take it from o to s . It makes no difference in effect whether the forces are mechanical or magnetic; in fact, a magnetic force is in many such instances made manifest by a mechanical effect, though not always.

We say, however, that the two currents x and y of Fig. 35 at the instant 2 have a resultant magnetic effect in the system of Fig. 36, which is represented both in its intensity and direction by the line $o2$, Fig. 37.

In like manner at the next instant of time assumed it has the intensity and direction $o3$, Fig. 37, and if we plot this resultant in the manner indicated for all the 16 periods of the cycle we shall obtain the successive 16 points of the circle, Fig. 37, because we shall find that the intensity of the resultant is always the same, its direction only changing by a fixed amount for each successive period of the cycle.

This shows that under the circumstances assumed the magnetic effect is a constant, not a variable, quantity. It only changes in direction, moving once around the circle during each successive cycle. This is what will be referred to as the true rotary field effect, i. e., a constant magnetic pull rotates uniformly around the circle or point of application. This effect will always result from the combination in a single system of two currents acting at right angles to each other and which vary according to the sine law, have equal maximum values, and are in quadrature relation. All the above conditions are essential to the true rotary field effect, and this effect, as will be shown, will be materially altered and disturbed by altering either one or more of the conditions imposed. With them, however, the rotary field is constant in strength and not pulsating, as I have seen stated in the earlier literature of the subject.

If now we rectify the two quadrature currents and superpose the rectified currents in a single circuit, as indicated by the dotted curves in Fig. 38, we should obtain such a pulsat-

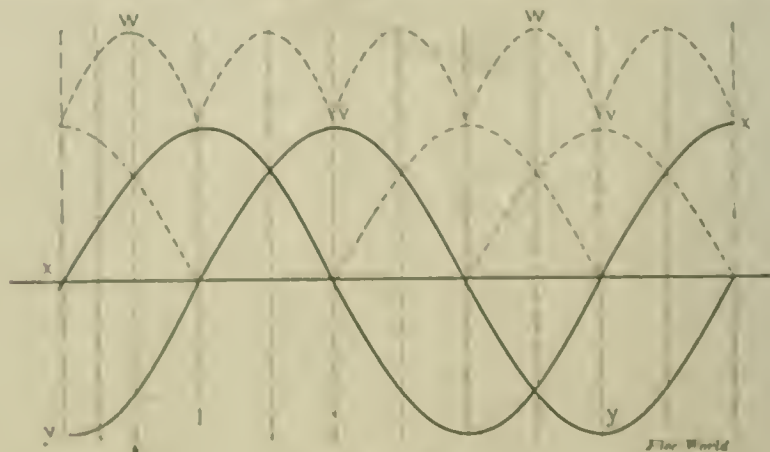


FIG. 38.

ing curve as w for the expression of the result—a curve that has no zero value, to be sure, but which is pulsating in character, and it was formerly quite erroneously assumed that the magnetic field produced by the introduction of biphasic currents into a magnetic system would partake of this pulsating effect. This would only be the case, however, if we rectified the currents with the object in view of obtaining from the resulting currents, acting simultaneously, a fixed—not a revolving or rotating—magnetic field.

The rotating magnetic field produced by the undisturbed

action of the biphas alternating currents is constant and uniform.

(To be continued.)

Light and Electricity After Maxwell and Hertz.*

BY H. POINCARÉ.

At the time that Fresnel's experiments were forcing the scientific world to admit that light is due to the undulations of a very subtle fluid filling interplanetary space, Ampere was making known the laws and mutual actions of electric currents, and advancing the theory that this same fluid, the ether, is the means of electrical actions.

This supposition was strengthened by the unexpected fact that in passing from the system of electrostatic units to the system of electrodynamic units the factor of transformation used is precisely equal to the velocity of light.

But the nature of the relations between optic and electric phenomena was divined by the genius of Maxwell.

According to older writers, conductors permitted the flow of electricity, while dielectrics served only to oppose the flow. But Faraday showed that other conditions being the same in a condenser, the charge was different with different insulators.

If light is an electric phenomenon, then an insulating substance traversed by light must be the seat of this phenomenon; therefore, electric phenomena should be located in the dielectric.

But why are these currents evident under certain conditions, and yet not so under ordinary conditions? Because dielectrics do not simply oppose the flow of electricity with a resistance much greater than that of conductors, but with a resistance like that to be overcome in bending a spring, which increases with the amount of bending until it equals the applied force when movement ends, all the work of bending being restored when the force ceases.

Ordinary resistance is like that met with in displacing a body in water. It depends on the velocity of the body, but not on the total displacement. The movement ends when force ceases, and there is no tendency to restore work done, all being transformed into heat by the viscosity of the water. So conducting wires heat.

Thus, dielectrics have elastic resistance and permit displacement currents, while conductors have viscous resistance and permit conduction currents. Evidently, displacement currents are of short duration, and conductive currents exist as long as the producing electromotive force.

Electrostatic attraction is like the unbending force of the springs, and disruptive discharge like the breaking of some overstrained springs.

When the two poles of a battery are joined by a wire the current is regarded as closed; but when the two poles were joined in the two plates of a condenser the current was regarded as open, traversing the battery and the wires, but stopping on the plates of the condenser. Maxwell, however, supposes a displacement current to continue across the dielectric of the condenser. Thus all currents are closed.

Conduction currents produce heat, affect magnets and currents, and induce currents. Displacement currents do not produce heat, but should show the other effects. We cannot have in dielectrics continuous currents of long duration, nor alternating currents of long period; therefore, their effects are only observed with very rapid alternations.

A luminous wave is a succession of alternating currents produced in the dielectric, which change in direction a quadrillion times per second. The induction due to the high frequency produces other currents in the neighboring parts of the dielectric, and thus the wave is propagated from point

to point, the velocity of propagation being equal to the ratio of the units. If there are open currents, these vibrations are longitudinal, like those of sound; but if all currents are closed, electricity acts like Fresnel's incompressible ether, its vibrations being transversal.

The experimental proof of Maxwell's plausible theory was delayed twenty years. Older electrodynamics required electromagnetic induction to be produced instantly; according to the new doctrine it should be propagated with the velocity of light. This latter was established by the interference experiments of Hertz.

Two waves from the same source interfere when they meet at the same point after following different paths. If the difference of the paths is equal to a whole number of wave lengths, the vibrations are in the same phase and add; but if the difference of travel equals an odd number of half-wave lengths, the vibrations are in opposite directions and subtract. Interference is possible with all periodic phenomena propagated with finite velocity. But if the velocity is infinite, there can be no interference.

Imagine two conductors at different potentials united by a wire; a current flows to equalize the potentials, and owing to self-induction (like the inertia of a pendulum at the lowest point of the swing) continues until the conductors take charges opposite to what they had at first. Then the same operation is repeated, and we have an electric pendulum. The period of oscillation decreases with the capacity of the conductors. All this was made known by Lord Kelvin and Feddersen.

Given the electric pendulum, it is necessary to set it in motion. This requires the disturbing cause to act for a very short time relative to the duration of a period of oscillation. Conditions required these to be one hundred millions to one thousand millions per second; they were produced as follows by Hertz:

Take the electric pendulum and make a cut several millimetres wide through the connecting wire, separating the apparatus into two symmetrical halves, which are joined to the two poles of a Ruhmhorff coil. When a certain difference of potential is produced a discharge occurs across the air gap affording a path for the oscillations of the conductors. Under certain rather complex conditions studied by Hertz, suitable oscillations are produced. These very rapid oscillations of the exciter are detected by a resonator, which consists of two small spheres joined by a wire bent into a circle so as to bring the spheres very close together.

The induction due to the exciter puts the resonator in vibration the more readily when their periods are about equal. At certain phases of the vibration the difference of potential of the two spheres is great enough to cause sparking across the gap.

We may expose the resonator to the direct induction of the exciter at a great distance, reflection being produced by a mutual sheet as by a mirror; or we may let the exciter act at a short distance on a long wire, which the electric waves follow, and which will act at a short distance on the resonator, the reflexion being produced at the end of the wire. In either case the reflected wave interferes with the direct wave, and points are found where the sparks of the resonator are extinguished. These experiments show that the velocity of propagation of induction across air is finite, and that it is equal to the velocity of the wave along the wire, in confirmation of Maxwell.

In conclusion, the results acquired are these: The velocity of induction through air is finite, without which interference would be impossible. The length of the wave can be measured. The velocity of the wave along a rim has been measured directly by Blondlot and found to be equal to the ratio of the units.

* Abstract of an article in "L'Annuaire du Bureau des Longitudes pour 1894."

Rope Driving.—VII.

OF J. J. FLAHERTY.



ROPES made of the same hemp and the same weight per foot, but twisted respectively to two-thirds, three-fourths and four-fifths of the lengths of their component yarns, supported the following weights in two experiments made by Duhamel:*

	Pounds.	Pounds.
Two-thirds	4,098	4,250
Three-fourths	4,550	6,752
Four-fifths	6,205	7,397

The results of these experiments led Duhamel to make ropes without twist by placing the yarns together and wrapping them round to keep them together. The rope had great strength and pliability, but not much durability on account of the outer covering wearing away or opening when bent, thus admitting moisture to the interior, which rotted the yarns.

In general, the greater the twist the more hard and rigid the rope is, and the better it will keep its form; but it is not as strong nor as pliable, weight for weight, as the more loosely twisted rope; for this reason the latter is to be preferred for transmission purposes.

A very excellent transmission rope, known as the "Lambeth," is made in a somewhat similar manner to that just described, but it is not open to the same objections. In this case the rope, which is of cotton, is made of four strands twisted together in the usual manner, but the strands are themselves composed of a bundle of fine yarns and have scarcely an appreciable twist. Each bundle, comprising many hundred yarns, is wound spirally with smaller bundles of about 100 yarns each.

In this way the outside of the rope acts as a shield or covering to the cores which do the work. By this means a certain amount of the natural elasticity of the rope is retained, and its pliability is much greater than in ordinary hawser laid ropes.

Lubrication of ropes is provided for in various ways. Frequently the rope is laid up dry and a coating or dressing is given to the exterior, which is supposed to penetrate to the interior and lubricate the fibres. With some dressings this may occur, but with others the effect is merely local; the interior of the rope remains dry, and much bending soon wears it out. With cotton ropes, as we have already noted, the internal chafing and wear is very much reduced, and for this reason cotton ropes are laid up dry and are not usually lubricated; they are, however, generally coated with some form of dressing to prevent the fibre from rising or the rope fraying, and to protect it from moisture when exposed to the weather. According to the nature of the dressing, the interior may or may not be affected by the outer coating. Beeswax and black lead, with a little tallow, forms an excellent moisture proof covering for ropes; it fills in the spaces between the strands, and the rope soon assumes a perfectly round and smooth appearance, like a bar of iron; with this coating the interior remains dry and should therefore not be used where a lubricant is desired. Pine tar is much used on cotton ropes for the same purpose. Mixtures of tallow and black lead; molasses and black lead; equal parts of resin or beeswax, with black lead, tallow and molasses melted together, and applied hot; and various other compounds are in use for this purpose. Tallow, lard and other greases are used separately and are fairly satisfactory as a lubricant. When the rope runs out of doors a waterproof coating is necessary to preserve it from decay, and for this purpose, if it is also desired to lubricate the rope at the same time, there

is probably nothing better than tallow and black lead, or graphite, provided the rope is not twisted too hard, which would prevent the dope from penetrating. In certain drives that are subjected to hard service and are more or less exposed to the weather, boiled linseed oil is used very successfully. According to Mr. A. D. Pentz, the rope is treated every two weeks to about two quarts of the oil, dripped one drop at a time upon one of the sheaves, which is uncovered on top; the rope runs on the bottom of the sheave and slowly absorbs the oil. Although the rope is very materially weakened by this process, yet the greater freedom of the fibres permits a heavier working strain to be carried, for it is the relative wear of the fibres that determines the life of the rope. A manilla rope with the fibres properly lubricated will, under the same conditions, outlast from two to four similar dry-laid ropes which are allowed to run dry. Manilla transmission ropes are generally laid up in tallow, paraffine, soapstone, or a mixture similar to the above preparations.

A superior manilla transmission rope is that known as the "Stevedore," or black rope, which is made with both three and four strands, the latter being laid up about a central core. The yarns of this rope are each coated with a mixture of graphite and tallow, so that when twisted up into strands the coating lodges in the hollows and uneven places among the fibres, and thoroughly lubricates the strands and individual fibres composing the rope, which is thus made practically waterproof; after it has been in use a short time its appearance is that of a black rod of iron, smooth and round, similar to the beeswax-coated rope previously mentioned, but perfectly flexible. A manilla rope thus made will last from three to eight years if not overstrained; when running indoors under favorable conditions the latter limit may be attained, but when exposed to the weather, or when working under less favorable conditions, its life will be shortened.

Hemp ropes intended for outdoor service are sometimes treated by passing the yarns through boiling hot tar, suitable machinery being used to regulate the amount of tar retained in the yarns so that the fibres may be coated over and thus preserved from decay. Tarring protects rope from injury by exposure to rain and immersion in water; but it makes its fibre rigid and impairs its strength; for this reason it is unsuitable for ordinary transmission purposes.

It has been shown by experiment:*

1. That white or untarred rope in continual service is one-third more durable than tarred. 2. That it retains its strength much longer when kept in stock. 3. That it resists the ordinary injuries of the weather one-fourth longer. With the exception of the outside yarns of large hawsers, manilla ropes are not tarred.

The breaking strength of a rope will depend both upon the quality of the material and the degree of twist given to the strands; for a loosely twisted rope of a given diameter the strength will be less than that in a hard twist of the same diameter, but compared weight for weight, the rope with the lesser degree of twist is the stronger.

As the hard-twisted rope is more rigid than the loosely twisted, it is not as suitable for transmission purposes, owing to the rapid wear which constant flexure produces.

In discussing the strength of ropes, which formerly was always given in terms of the circumference, there is a lack of uniformity among writers in the relation between the diameter and area of a rope. The circumference, as measured by a tape, depends upon the number of strands in the rope and their compression upon one another. If the strands still retained their circular section when twisted into a rope, the circumference of a 3-strand rope would be 2.86 times the diameter of the circumscribing circle, as given by Nyström; if the strands completely fitted the circle its meas-

* Tomlinson. Vol VII, p. 574.

* Capt. S. B. Luce, U. S. N.

ure would be π times the diameter as given by Unwin and others.

As neither of these conditions obtain in practice the true value lies between 2.86 and 3.14, and we shall assume 3 as the most suitable factor.

In the same way the area of the cross-section of the rope is variously estimated as that of the area of the circular strands, or as the area of the full diameter of the rope.

By assuming the rope to be made of three strands, the cross-section of each of which is a circle, the area of the rope would evidently be $3 \left(\frac{\pi}{4} \delta^2 \right)$ where δ is the diameter of each strand. If d represents the diameter of rope, i. e., the diameter of circumscribing circle, the area in terms of d will become:

$$A = 3 \left(\frac{\pi}{4} \delta^2 \right) = \frac{\pi d^2}{6.16} = 0.52 d^2.$$

The section of the strands, taken at right angles to the axis of the rope, is, however, not a circle, as can be seen from Fig. 27. The degree of twist given to the strands, and the compression of the latter upon one another, will evidently affect the area of the section; for the longer the spiral the more nearly will the cross-section of each strand approach a circle. It is obvious that the true value must lie between $0.52 d^2$ and $0.7854 d^2$. In determining this area the writer made a number of plaster casts at different points of six 3-strand manilla ropes, varying in size from 3-4 inch to 1 3-4 inches diameter. With these casts as dies, which were covered with printer's ink, impressions were made and the area obtained by using a planimeter. The area at several sections of each rope was found to be practically constant and varied between $0.61 d^2$ and $0.65 d^2$ —the mean value being $0.63 d^2$, from which we obtain the ratio:

$$\frac{\text{Area of section of rope}}{\text{Area of circumscribing circle}} = \frac{0.636 d^2}{0.7854 d^2} = 0.81;$$

that is, the actual area of a 3-strand rope equals 8-10 of the area of the circumscribing circle.

(To be continued.)

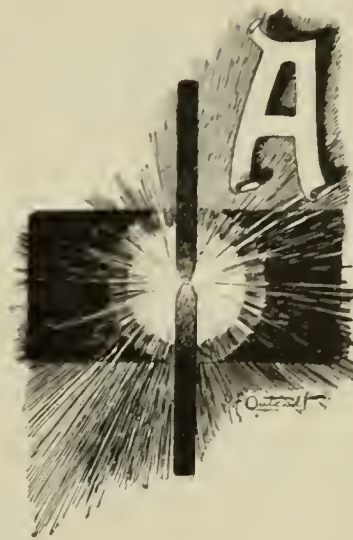
Moonlight Tables for March, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of March under his modified form of moonlight schedule.

TABLE NO. 1. Standard Moonlight. Philadelphia System.				TABLE NO. 2. Frund's New Moonlight System.			
Date.	Light.	Date.	Extng.	Date.	Light.	Date.	Extng.
1	6.20 P. M.	2	5.00 A. M.	1	6.20 P. M.	2	5.00 A. M.
2	6.20 "	3	5.30 "	2	6.20 "	3	5.30 "
3	6.20 "	4	5.30 "	3	6.20 "	4	5.30 "
4	6.20 "	5	5.30 "	4	6.20 "	5	5.30 "
5	6.30 "	6	5.30 "	5	6.30 "	6	5.30 "
6	6.30 "	7	5.20 "	6	6.30 "	7	5.20 "
7	6.30 "	8	5.20 "	7	6.30 "	8	5.20 "
8	6.30 "	9	5.20 "	8	6.30 "	9	5.20 "
9	6.30 "	10	5.20 "	9	6.30 "	10	5.20 "
10	6.30 "	11	5.20 "	10	6.30 "	11	5.20 "
11	6.30 "	12	5.20 "	11	6.30 "	12	5.20 "
12	11.00 "	13	5.20 "	12	6.30 "	13	5.20 "
13				13	6.30 "	14	5.10 A. M.
14	12.10 A. M.	14	5.10 A. M.	14	12.10 A. M.	14	5.10 A. M.
15	1.20 "	15	5.10 "	15	6.40 P. M.	15	12 M.
16	2.20 "	16	5.10 "	16	1.20 A. M.	16	5.10 A. M.
17	3.10 "	17	5.10 "	17	6.40 P. M.	17	12 M.
18	3.50 "	18	5.10 "	18	2.20 A. M.	18	5.10 A. M.
19	No Light.	19	No Light.	19	6.40 P. M.	19	12 M.
20		20		20	3.10 A. M.	20	5.10 A. M.
21		21		21	6.40 P. M.	21	12 M.
22	6.40 P. M.	22	8.40 P. M.	22	6.40 P. M.	22	12 M.
23	6.40 "	23	9.50 "	23	3.50 A. M.	23	5.10 A. M.
24	6.50 "	24	11.00 "	24	6.40 P. M.	24	12 M.
25	6.50 "	25	12.00 "	25	6.40 "	25	12 "
26	6.50 "	26	1.00 A. M.	26	6.40 "	26	12 "
27	6.50 "	27	2.00 "	27	6.40 "	27	12 "
28	6.50 "	28	3.00 "	28	6.40 "	28	12 "
29	6.50 "	29	3.40 "	29	6.50 "	29	1.00 A. M.
30	6.50 "	30	4.20 "	30	6.50 "	30	2.00 "
31	6.50 "	31	4.40 "	31	6.50 "	31	3.00 "
							3.40 "
							4.20 "
							4.40 "
Total hours, 206.30.				Total hours, 260.66.			

The Theory and Design of the Closed-Coil, Constant-Current Dynamo.—II.

BY HENRY S. CARHART



ASSUMING still practically constant speed, we next inquire into the methods employed to maintain a constant current without appreciable sparking by rocking the brushes round the commutator cylinder.

In one machine the brushes are moved automatically by means of a small electric motor and at the same time field coils are successively cut out as the brushes rock forward with a light load. A pair of brushes is used on each side and they are kept at a fixed distance apart. By these combined means the machine can be run on short circuit with the normal current and without sparking.

Another system leaves the field coils constantly in circuit, but employs two pairs of brushes and varies the angular distance between the members of each pair when the brushes are moved. The movement of the brushes is effected mechanically in response to any change in the main current till the current is brought back to the normal value. In these machines the spread of each pair of brushes, or what is sometimes called the overlap of the brushes, is lessened as they rock forward toward the polar centres. Very satisfactory results are secured in this way.

In the third class of machines only one pair of brushes is used, which lap over about two or three commutator sections, and the regulation of the current is effected solely by the movement of this one pair without change of overlap and without disturbance of the ampere turns on the field. The brushes are moved mechanically by means of an automatic regulating device. No less satisfactory results appear to be secured by this method than by the others, while the mechanism as a whole is somewhat simpler.

I have described these three methods for the purpose of pointing out their bearing on the theory and design of closed-coil Gramme rings for constant currents. The important question is not how to get the necessary E. M. F. with such a dynamo, but how to vary that E. M. F. in response to the varying demands of the external circuit, without injurious sparking at the brushes.

The E. M. F. is controlled in all three of these methods by rocking the brushes, and the other differences in the devices are made necessary for the suppression of the sparking. This brings us to a consideration of the most intrinsically interesting topic of the paper, viz., the conditions necessary to suppress sparking and the features of design required to furnish them.

If we assume that the armature is well balanced electrically and magnetically and that the brushes have a proper bearing in contact with a smooth commutator, the conditions required to commute the current without sparking are known to be as follows: With a two-pole dynamo, the current is divided through the armature, one-half going from brush to brush through one side and the other half through the other side. Hence, when an armature coil is carried past the brush it is transferred from the one circuit through the armature to the other, and at the same time the current through it reverses its direction. This constitutes the act of commutation. But the sudden decay of a current through a coil in one direction and its growth to an equal value in the other gives rise to an E. M. F. of self-induction opposing the change. This E. M. F. will prolong the flow of the current on one side of the brush and will oppose its rise on the other side. Hence, if the coil is short circuited by the brush

lapping over the two consecutive commutator segments to which its ends are connected, even when the coil passes the neutral plane of the dynamo, the E. M. F. of self-induction produces a local current through this coil; and when the one end of the coil slips past the brush and becomes a part of the other half of the divided circuit, the current which should reverse through it meets the opposing current and breaks over the gap to the brush with a spark. Hence the commutation must not take place at the neutral plane, but in advance of it, and in a field where the induced E. M. F. in the coil shall be just sufficient to offset the self-induction, and in addition reverse the current in the coil while it is passing through the brush or pair of brushes, and cause it to grow to the normal value at the instant when one end of it passes out from under the brush. The induction from the field must be sufficient to bring the one current to zero and to set an opposite one of equal value flowing in the coil during the time it is under the brush. Then the commutation will be sparkless.

Now if the current is kept constant in strength the field induction required to accomplish the results described is approximately the same whether the coil is short circuited at one angle or another in advance of the neutral plane. It would appear at first thought that, unless the induction in every part of the field from the neutral plane to a point nearly 90 degrees in advance of it is substantially uniform, terrific sparking must result when the brushes are shifted far forward to vary the electric pressure to suit the requirements of the circuit; for if the induction is in excess of the requirements to accomplish the result described in the commuted coil, then the current will circulate through it during the short circuit, and the rupture of this on leaving the brush will cause sparking. I have illustrated this action in the following manner: Separately excite the field magnets of a machine, which can run on short circuit even, with a forward displacement of the brushes without sparking. Then leaving the armature on open circuit, rock the brushes forward; the sparking will increase with each advance till it becomes terrific and endangers the machine. The induction to which each coil is subjected in an excited field produces a large current in it while it is under the brush, since there is less self-induction in the coil to offset the induction from the field than there is when the machine is self-excited and working in the normal way. There is another reason to be described later.

Considerations of this kind have led some writers to say that sparkless commutation for any position of the brushes can be accomplished only when the induction in the field is made uniform. The Statter constant-current machine in England is made on this principle. Portions of the pole pieces are laboriously cut away at such points as to make the density of the lines of force entering the armature over a given angle equal. Of course, a machine built in this way will permit of shifting the brushes through a considerable angle, in order to vary the potential difference without introducing sparking. But while a uniform field accomplishes the result, no such uniformity is required; the same result may be secured in other ways. The first method, already described, weakens the field when the brushes move forward by cutting out ampere turns in the field magnet. This reduces the induction to the proper amount at each point without changing the overlap of the brushes. It is made necessary by the very high saturation of the armature core in this machine. It has the advantage of greater economy with small loads, because field resistance is cut out, but it requires a more complex arrangement of parts on the machine than suffices for the mere movement of the brushes.

The second method diminishes the overlap of the brushes as they are rocked forward. In the first place, this has the

effect of diminishing the time allowed for the reversal of the current, but it also diminishes the number of turns of wire in the coil or coils included between the two parts of each brush. The curtailed time interval increases the self-induction of each convolution of wire, because it increases the rate of change of the current in the coil undergoing commutation; but this increase is counterbalanced by the diminution in the number of turns of wire short circuited by the brush. Hence, the total self-induction during commutation remains not far from constant. When the brushes shift forward into a denser field, however, the diminution in the overlap decreases the number of turns of wire included between the pair of brushes composing either the positive or the negative, and so cuts down the total field induction in those coils during commutation to the amount required to suppress sparking. The overlap of the brushes must therefore be inversely as the induction in a coil under the brush in different parts of the field, for the presence of the pole of the armature at any point reduces the induction. This point is a complicated one and needs further experimental study.

But in the third class of machines the overlap of the brush is constant and the field is not weakened by cutting out coils on small load. Neither are the pole faces cut away to produce uniform induction. Attention is given to the thickness of the pole pieces, so as to avoid unnecessary crowding of the lines of force toward the central portions. It is also desirable to avoid thinning of the polar horns, lest they become saturated. In the old Sperry machine, which I have investigated quite carefully, each pole piece is cut quite in two. In fact, as is well known, the field has four cores. At the same time the horns, or pole tips, are rather blunt. But this machine shows the violent sparking when separately excited, with the brushes far forward and the circuit through the armature open. The induction round the armature is not uniform, but the sparking is small for any position of the brushes with the normal current. The brush bears on about three commutator segments. I refer to this machine as an illustration of the class and not as a model of excellence. It is no longer built.

In this machine the induction to which a coil is subjected near the brush is not the same in different parts of the field, but diminishes as the brushes are worked forward, the current being kept constant. With the exploring coil before described and the two extra brushes bearing on the insulated copper ring and the fibre collar with brass segment, respectively, the external circuit connecting the two small brushes was carried through a d'Arsonval galvanometer in shunt. The two extra brushes were attached to the two main brush holders, but were insulated therefrom. With one brush making contact with the small brass segment, two and then three commutator bars in advance of the upper main brush, the following deflections were obtained with the galvanometer from maximum to minimum load, the steps being about equal:

Deflection, 2 segments.	Deflection, 3 segments.
26	63.5
24	56
22	49
20	41
18	34
16.5	32
13.5	28
12.5	
10.5	

The steps were not the same in the two series of observations. No trouble was found in obtaining a steady deflection of the galvanometer, the dynamo making about 1,200 revolutions per minute. The exploring coil was therefore subject to a diminishing induction near the brush, as it moved forward with the brush toward the centre of the polar surface.

(To be continued.)

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE
PRINCIPAL FOREIGN
ELECTRO-PHYSICS.
ELECTRICAL JOURNALS.
BY CARL HERING.

Thermo-Electric Phenomena.—"Electricity," Jan. 12, quotes from a paper by Mr. Steele from "Science," describing briefly some of his researches in the generation of electromotive force by the heating of a single metal; the highest effect observed was with gold, in which he obtained nearly half a volt for a short length (presumably a few inches); a clay tube (tobacco pipe stem), containing lead, gave 0.3 volt; in general the E. M. F. was unsteady and irregular.

Aurora Borealis.—It is suggested in "La Lum. Elec.," Jan. 6, that the following experiment by Mr. Rimington may lead to an explanation of the phenomena; he found that a vacuum tube becomes illuminated if rotated while near a rod of rubber or sealing wax which has been electrified.

Atmospheric Electricity.—The Lond. "Elec.," Jan. 12, describes briefly, though not very clearly, the apparatus used by Mr. Andre for measuring the difference of potential of the atmospheric electricity by means of a balloon; the results of these tests were mentioned in the Digest Jan. 2.

Dynamical Theory of the Electric and Luminiferous Medium.—The article by Mr. Larmor, mentioned in the Digest last week, is concluded in the Lond. "Elec. Rev.," Jan. 12.

Dielectric Constants of Biaxial Crystals.—"La Lum. Elec.," Jan. 6, reprints at some length an extract from a thesis by Mr. Borel on this subject.

MAGNETISM.

The Pull of Magnets.—The serial in "Ind. and Iron" is continued in the issue of Jan. 12; the law that the pull of a magnet on its armature varies as the square of the induction and the area is stated and its application to telephones and measuring instruments is discussed; if the area of the poles of an electromagnet be halved, the total induction remaining the same, the force per square centimetre will be quadrupled, but as the area is halved the force on the armature will be doubled; with a given induction, therefore, it follows that the force varies inversely as the area; the pull of a magnet may therefore be increased by tapering the pole pieces down, provided the total induction is not diminished thereby; such polar surfaces could be cut up into a number of small poles, separated by shallow grooves; this method should be adopted in magnetic brakes, magnetic friction clutches and similar machinery. As very minute inaccuracies in the faces of a magnet and its armature make very great differences in the force, it is not possible to make accurate measurements of the induction in iron by means of the pull.

Transformation Produced in Iron by a Strain.—A translation of Mr. Charpy's article, mentioned in the Digest last week, is given in abstract in the Lond. "Elec.," Jan. 12.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Kruppin, a New Resistance Metal.—The "Elek. Zeit.," Jan. 11, contains additional information about this material, which was described in the Digest Jan. 6. Results of a series of elaborate tests made by the Imperial Institute are given; prior to the tests the metal was heated for two hours to 200

degrees C., and the measurements were made at 150 degrees, 100 degrees, 50 degrees and normal temperature; the results are as follows: Specific gravity, 8.102; tensile strain, 60 kilogrammes per square millimetre; elongation, 22 to 25 per cent.; specific resistance, 85.13 microhms per centimetre per square centimetre at 20 degrees C.; mean temperature coefficient 0.0007007. The resistance is quite appreciably higher than that of the usual resistance metals and only 10 per cent. less than that of mercury; it can be kept at a temperature of 600 degrees C. without suffering any change in its structure, while for other metals a much lower temperature is sufficient to make them brittle; it is specially adapted to starting resistances for motors, regulating resistances, etc.

Phase Meter.—Referring to the apparatus of Prof. Puluj, mentioned in the Digest Dec. 23, the Lond. "Elec. Rev.," Jan. 12, states that a similar method was tried by Mr. Rollo Appleyard some six months ago, but it was found to be quite impracticable, owing to the vibration of the spring, but Prof. Puluj claims to have met this by a preliminary tuning of the spring; it suggests that a twisted strip with a single half-turn might possibly replace the two springs, in which case only one mirror would be required.

Price Indicating Meter.—The "Elek. Rundschau," No. 7, describes and illustrates an instrument resembling an amperemeter, the reading of which at any moment indicates the cost of the current which is being consumed at that moment.

Thallium.—The following data are given in a paper by Mr. Steele mentioned in the Lond. "Elec.," Jan. 12. Specific electrical resistance, 20,200 C. G. S. units at 20 degrees C., with a coefficient of variation of resistance 0.00392, in the neighborhood of this temperature; "the absolute thermoelectric height of thallium is 216 — 0.79 T , where T is the temperature on the centigrade scale.

Influence of Deformation on Resistance.—"La Lum. Elec.," Jan. 6, reprints an abstract of a Royal Society paper by Messrs. Gray and Henderson.

DYNAMOS AND MOTORS.

A New Method of Coupling Motors.—Mr. Guilbert in "La Lum. Elec.," Jan. 6, describes a new method for coupling two non-synchronous multiphase motors, so as to obtain variable speeds, devised by Mr. Siemens and called the cascade coupling. The field of the first motor is connected directly to the mains; the three armature circuits, supposing it to be a three-phase motor, are united in common at one of their ends, the other ends leading through contact rings and brushes to the field of a second similar motor, whose field connections are identical with the armature connections of the first: the armature circuit of this second motor is closed through adjustable resistances and has no connection with any other circuit; thus the induced currents in the armature of the first motor supply the field currents for the second motor, the armature currents of which are induced by the field currents. At starting the frequency in the second motor is equal to that in the first, but as the speed increases the frequency diminishes until the sum of the revolutions is theoretically equal to the revolving field in the first motor;

they will regulate to run at a speed equal to a few per cent. below half that of synchronism. For variable speeds the two movable parts of the motors are keyed to a common shaft, and they are connected in cascade or in parallel, according as the speed is to be ordinary or half speed; when so coupled, it is best to connect the armature of the first and the field of the second to a common shaft, as this avoids sliding contacts. The efficiency is said to be the same for all the speeds; for 1-3 of the synchronous speed three motors are thus coupled. When not coupled mechanically the two motors may be made to have speeds relatively different. The article contains a good illustration of the connections.

Improvements in Dynamos.—An illustration is given in "La Lum. Elec.," Jan. 6, of the curious modification of the field used by Mr. Dobrowolsky, consisting of uniting the horns of the pole pieces by a yoke piece of iron, thus connecting them magnetically and forming a magnetic shunt or strong leakage around the armature; the intention is to diminish the sparking at the brushes and the losses due to Foucault currents; the change of magnetic polarity at the neutral line is thus made less sudden; the waste of magnetism is doubtless of small consequence in comparison to the advantages gained, especially as the field current itself is but a small fraction of the output of the dynamo.

Dynamos.—"La Lum. Elec.," Jan. 6, begins another instalment of the well illustrated article by Mr. Richard, in which 66 illustrations of various recent improvements in dynamos are given, taken presumably from patent specifications.

Irregularities in the Action of Dynamos.—The serial on this subject is continued in "L'Elec.," Jan. 6. A translation of the portion referred to last week is given in the Lond. "Elec. Eng.," Jan. 12, including several illustrations.

Cranes.—The article on this subject, mentioned in the Digest last week, is concluded in the Lond. "Elec. Eng.," Jan. 12, in which well-illustrated descriptions of several different cranes are given, some of which are of American make.

ARC AND INCANDESCENT LIGHTS.

Projectors.—In "L'Elec.," Jan. 6, Mr. Sciama describes a new projector made by Breguet, which, like those of Schuckert, have a parabolic mirror; in comparing these with the Mangin reflectors he states that the focal distance is much less, being for a reflector of 900 millimetres equal to 680 millimetres for the Mangin and 340 millimetres for the parabolic mirror; they are also much lighter, having only about half the weight for the complete apparatus; an arrangement is described for operating them from a distance by means of two electric motors.

Blackening of Lamp Bulbs.—The Lond. "Elec. Rev.," Jan. 12, contains a short editorial on this subject, without, however, giving anything new.

ELECTRIC RAILWAYS.

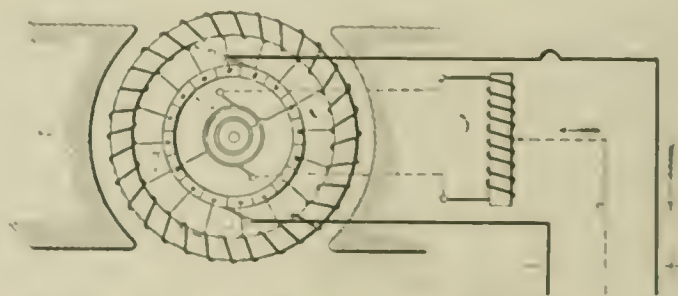
Electric Traction.—Mr. Epstein's article, abstracted last week, is concluded in the Lond. "Elec. Rev.," Jan. 12. Regarding the cost of fuel, he states that for fairly representative conditions 80 watt hours are required to be put into the motors per ton mile propelled for the trolley and conduit systems, which, after allowing for the various losses, corresponds to .24 indicated h. p. hour; for eight tons per loaded car this corresponds to 1.92 h. p. hours, and at a consumption of three pounds of good coal per indicated h. p. hour at \$5 per ton the price of fuel per car mile will be 1.234 cents; with accumulator cars the engines and dynamos will be worked at a more uniform rate, and therefore have a higher combined efficiency, and the corresponding figures will then be .177 indicated h. p. per ton mile propelled, which for ten tons per car costs 1.14 cents for coal per car mile; notwithstanding the greater weight, the consumption of fuel is less; he

believes that American practice would show that owing to the great waste in the trolley systems, the comparison is much too favorable for the direct systems. He gives two large tables of details for the cost of converting an existing horse railway into each of the three electrical systems, the conditions being the same as those mentioned last week; for insulated wire feeders, and assuming that the existing permanent way may be used, his estimates for five minutes' headway and 24 cars are about \$35,000 for the trolley, \$50,000 for the conduit and \$23,700 for the accumulator system, all three being the cost per car per mile of double track. The results are summarized in another table. Another table contains detailed data of a number of tests on the Birmingham road; another table gives the estimated costs of working the three different systems, the average being about the same for all, namely, about 19.2 cents, which is due to the fact that the interest on the capital is less in favor of the accumulator system. In conclusion, he summarizes the results, showing that the cost of the installation for an accumulator line is less than for either of the others and represents a saving of about 20 per cent.; this is still more favorable in the construction of an existing tramway, in which case the outlay is about one-half of that for the trolley and one-third of that for the conduit; in conclusion, he summarized some of the most important advantages in favor of accumulator roads, all of which are already well known.

Electric Traction.—The Lond. "Elec. Rev.," Jan. 12, states that Mr. Rankin Kennedy has discovered a new method of electric traction, by which the great drawback to the present system is said to be overcome; the 25 to 40 h. p. motors will be replaced by motors of 5 to 10 h. p.; this method, it states, is being submitted to American experts.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Three-Wire System.—"La Lum. Elec.," Jan. 6, describes and illustrates a modification used in France devised by Mr. Dobrowolsky which enables a single dynamo to be used for a three-wire system. The arrangement is shown in the accompanying illustration; the modification of the dynamo



THREE-WIRE SYSTEM WITH SINGLE DYNAMO.

consists in connecting two diametrically opposite points of a Gramme winding together through a good self-induction coil to the middle point of which coil the neutral wire is attached; when this induction coil can be attached to the armature itself the single connection may be led out through the shaft; but if there is no room, the arrangement shown in the figure is used, which requires two sliding contacts; the induction coil must have very great self-induction and low ohmic resistance; the alternating E. M. F. at the terminals of the induction coils prevents all but a small current from passing; the difference of potential between the ends and the middle is the same; an excess of current, which returns through the neutral wire, passes back to the armature through the two halves of the coil, the ohmic resistance of which does not oppose the passage of a continuous current. The same arrangement can be used as a regulator for a three-wire system, and if placed at sub-stations it avoids the necessity of leading the neutral wire back to the station.

Solar Motors.—In "L'Elec.," Jan. 6, a motor proposed by Mr. Ayme, of Algiers, is described and illustrated, in

which the heat of the atmosphere is to be used; it consists of a large flat iron tank, painted black, about 65 feet long, 25 feet wide and 11-2 feet deep, filled with water and exposed to the rays of the sun; it is connected with a cylinder 61-2 feet long and about 11-2 feet in diameter, containing a piston, on which the pressure developed will be about 110 pounds per square inch; for a rise of 20 degrees C., which takes place between sunrise and noon, the number of calories generated will be 1,540,000, of which he thinks about half can be utilized, thus generating about 75 kilowatts during six hours; owing to the very slow motion of the piston, about one-fourth of an inch per minute, and to the great speed of the dynamo, a long train of gears is required; in case of rain the receptacle is heated by means of petroleum residues; in very cold climates the water must be mixed with salt to prevent it from freezing. (It appears to be only a proposition.)

Rotary-Phase System.—The "Elek. Rundschau," No. 7, publishes a conclusion of the mathematical article on the three-phase system.

Flush Snap Switch.—"La Lum. Elec.," Jan. 6, describes and illustrates a switch of Messrs. Gartside and Wood.

Rectifiers.—The Lond. "Elec. Rev.," Jan. 12, contains an article by Mr. Kennedy, giving, however, nothing new.

Wakefield.—The Lond. "Elec. Rev.," Jan. 12, publishes a report by Mr. Hammond for the proposed lighting of this city, containing comparative tables and data. A much more complete extract is given in the Lond. "Elec. Eng.," Jan. 12.

Liverpool.—The London "Electric Plant," Jan. 1, publishes a double-page plate of an interior view of the Liverpool central station.

WIRES, WIRING AND CONDUITS.

Explosions in Electric Conduits.—An editorial on this subject in the Lond. "Elec. Rev.," Jan. 12, states that in the Glasgow conduits there were four serious explosions within six weeks; it discusses the subject, stating emphatically that the infiltration of gases from the soil is altogether inadequate to account for the presence of the gas; it believes the influx of gas is more probably due to the subsiding of the soil below the conduits and their consequent pressure on gas pipes beneath them, which causes ruptures of the pipes. It also advocates the electrical connection between the sections of the culverts in order that they form one large earth plate; another mistake was the dragging of the wires through cast iron pipes without properly protecting them. (That the infiltration of gases might be quite adequate, at least in the streets of New York, would appear from a statement recently made by an employe who has spent many years in laying such conduits; he stated that almost anywhere in New York one could make a hole in the street with a crowbar and explode the gases which collected by igniting them with a match.)

A correspondent of the Lond. "Elec. Eng.," Jan. 12, proposes as a remedy the introduction of escape pipes at every manhole and at intervals between them, laid underground up to the house wall and then up the fronts of the buildings to above the roof, where they are suitably capped to prevent the rain from entering; at the bottom of these pipes traps might be placed to collect and carry away any water that might be deposited by the gas.

Insulation Resistance for House Wiring.—The Lond. "Elec.," Jan. 12, compiles in the form of a diagram the rules of a number of companies and institutions in England reduced to a common standard of measurement; they follow more or less closely the logarithmic law, $R = k \div n$, in which R is the insulation resistance, n the number of lamps wired (presumably 8-c. p. lamps of one-third of an ampere) and k a constant which ranges from 130 down to 0.6 megohms per lamp; for 60 lights, which is considered a good

average number, the resistance in megohms is given according to the rules of the various companies, and it varies from 2.0 to 0.21, the higher ones being, as a rule, in London, and the lower ones in the smaller cities.

Resistances with Alternating Currents.—A translation of the article abstracted in the Digest Jan. 20 is given in the Lond. "Elec.," Jan. 12.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Protective Device Against Strong Currents.—The "Elek. Zeit.," Jan. 11, publishes an illustrated description by Dr. Passavant of his apparatus for protecting telegraphic, telephonic and other like apparatus against strong currents; it consists essentially of a small relay, which, when the current increases, closes a short circuit through a fusible wire, which then melts and breaks the circuit; a diagram of the arrangement is given. In a discussion Dr. Strecker remarked that the price, 50 cents, was still too great to permit its introduction on a large scale; he claims that such an apparatus should not cost more than 5 to 8 cents. Dr. Feussner described another apparatus, in which a horizontal wire through which the current passes has a weight attached to its middle point by means of an easily fusible hook, such as one made of shellac; the weight at the same time holds a contact closed; when the current increases to over 0.1 ampere the heat is sufficient to melt the hook; the release of the weight then opens the contact.

Mercury Contacts in the Wheatstone Rapid System.—"La Lum. Elec.," Jan. 6, describes and illustrates a device of Messrs. Price and Gray, intended to overcome the principal faults of the present Wheatstone rapid system, in which a perforated band is used; the contacts are made by means of jets of mercury, which are kept flowing continuously; at the receiver end the relay operates a small contact point, which makes or breaks contact with a continuous stream of mercury flowing horizontally directly above the contact point.

Autographic Telegraphy.—"La Lum. Elec.," Jan. 6, describes the Sheehy system, in which drawings or writing on a sheet of paper are transmitted to a distance, where a facsimile is reproduced; there is a revolving drum in each apparatus, over which a contact point moves, the two drums being revolved synchronously; it appears to require but one line wire.

Electric Winding Apparatus.—"La Lum. Elec.," Jan. 6, contains an illustrated description by Mr. Marcillac of an apparatus for rewinding, by means of a motor, the train of weights and gears used in the Hughes apparatus; the motor is controlled by a simple lever arrangement.

Working Speed of Cables.—The Lond. "Elec. Rev.," Jan. 12, states that the favorite idea of substituting an induction coil repeater for the mechanical apparatus has been tried, and the results show conclusively that no gain in speed whatever is obtained; an induction coil repeater on a telephone line produced a marked deterioration in the speaking.

Theatrophone.—"L'Elec.," Jan. 6, announces that the installation of the theatrophone at Bordeaux is completed; any subscriber of the municipal telephone system can now be connected with many of the theatres.

Telephone Statistics.—The Lond. "Elec.," Jan. 12, contains a large table compiled from the "Jour. Telegraphique," giving the statistics for 1892 for all the civilized countries (except the United States). The same number contains an editorial on this subject.

Swedish Telephone Statistics.—The "Elek. Zeit.," Jan. 11, gives a summary of the statistics for the year 1892, including some comparative figures for a number of years previous.

Central Telephone Station in Paris.—A translation of the article mentioned in the Digest Jan. 6 and 13 is given in abstract in the Lond. "Elec.," Jan. 12.

Water and Gas Pressure Indicator.—The "Elek. Zeit.," Jan. 11, gives a well-illustrated description of a new apparatus of Siemens & Halske for automatically indicating at a distance the readings of an indicator of the water level in a basin or the gas pressure in a reservoir.

ELECTRO-CHEMISTRY.

Action of Electrolyzed Sea Water on Iron and Lead Pipes.—"Ind. and Iron," Jan. 12, states that at Havre three months' experience has shown that lead pipes may be employed to distribute this fluid; in lead pipes a film of scale forms similar to that of lead peroxide, and with iron the film is not so dark, but in neither case does pitting or corrosion take place inside of the pipes, as the scale seems to protect them from further action; this, the editorial states, is at variance with the known properties of a solution containing free chlorine.

Electrolysis of Fused Salts.—Mr. Andreoli's serial is continued in "Ind. and Iron," Jan. 12; he continues his summary of what has been accomplished in this direction.

Waves in Electrolytes.—The Lond. "Elec. Rev.," Jan. 12, contains a short abstract of the article by Mr. Yule mentioned in the Digest Dec. 30.

Accumulators in Cold Localities.—According to "La Lum. Elec.," Jan. 6, Mr. Varennes places a small incandescent lamp covered with black varnish in the liquid in each cell, in order to keep the accumulator from freezing; an automatic device, including a thermometer, connects or disconnects these lamps when the temperature falls below or rises above the freezing point.

Aluminium.—According to "La Lum. Elec.," Jan. 6, 880 pounds of aluminium are produced daily in the factory at Saint Michel by the Minet process; a water power of 1,200 h. p. is used; although a current of 6,000 amperes is used, the voltage is only 7 to 8, of which 3 are required for the decomposition.

Silver-Plating Industry.—The illustrated serial in "Ind. and Iron" is continued in the issue of Jan. 12, where scratch brushing is discussed.

MISCELLANEOUS.

Progress During 1893.—"La Lum. Elec.," Jan. 6, contains a well-written article by Mr. Ledebour, in which he gives a general review of the progress made during the past year. For those who have read the journals it contains nothing new, as all the information has appeared in the journals; the review of the purely scientific research is interesting, but is limited chiefly to work done in France.

Institution of Electrical Engineers.—The first part of the inaugural address of the new president, Mr. Alexander Siemens, is published in the Lond. "Elec. Eng.," Jan. 12. It is chiefly of local interest, and is devoted mainly to a discussion of the retarding in the spread of the applications of electricity in that country.

Electrical Engineering and Limited Liability.—The Lond. "Elec. Eng.," Jan. 12, contains an article by Mr. Walker, in which he discusses the question whether the adoption of the limited liability principle conduces to the advancement of the best interests of those engaged; he thinks its adoption is very rarely of advantage to electrical engineers in general.

Electric Gyroscope.—The "Elek. Echo.," Jan. 6, in a well-illustrated article on gyroscopes, contains descriptions and illustrations of electrically driven gyroscopes.

Biographical.—A short biographical notice of Dr. Heinrich Hertz, by Prof. Oliver Lodge, is published in the Lond. "Elec.," Jan. 12. The "Elek. Zeit.," Jan. 11, also publishes a short biography.

Prizes.—"L'Elec.," Jan. 6, gives a list of the prizes offered by the French Academy of Sciences for the coming four years.

What Is Thought of the New Form.

I AM DELIGHTED with the new form.

Port Colborne, Ont.

M. RICHARDSON.

BY FAR THE BEST ELECTRICAL PAPER PUBLISHED, and decidedly better in its new form than in its old.

Columbus, Ohio.

R. J. M. DANLEY.

THE BEST ELECTRICAL PAPER IN THE WORLD. I like it better in its new dress.

Phoenix, Arizona.

WM. S. PICKRELL.

I LIKE THE ELECTRICAL WORLD in its new form, in its old form, or in any form. So long as I get the paper I am satisfied.

New Durham, N. J.

CHARLES BEEBEE.

I LIKE THE PAPER very much indeed and find it a great help in my work; I also like the new form, as it is much more convenient to handle and read.

Cambridge, Mass.

OSCAR S. WHITNEY.

THE NEW FORM makes the paper decidedly more convenient to handle and file, and I hope your continued efforts and enterprise will meet with proper appreciation.

Vicksburg, Miss.

WM. H. MCCOLLOUGH.

IN MY TWENTY-SIX YEARS with the Western Union, commencing in 1855, I have seen the beginning of all electrical literature in this country, and I consider The Electrical World an honor to you and a glory to the profession.

Pabst, N. Y.

W. H. JOHNSON.

A WEALTH OF INFORMATION. The Electrical World, established nineteen years ago, may fairly be considered the pioneer in electrical journalism. Published weekly, it contains a wealth of information as to all that is going on among electricians.

—Philadelphia Bulletin.

THE MODERN ELECTRIC SEARCH LIGHT. Among electrical journals The Electrical World shines out like a great electric search light. The size has been changed to a much handier one and the character of the matter, which has always been up to the standard, is now brighter than ever.

—Philadelphia Record.

FOR FIVE YEARS I have taken The Electrical World. I have always liked the matter it contained, but never the shape. In its present form, however, there is apparently nothing more to be desired, and if you continue to keep pace with the times as you have been doing you cannot fail to satisfy any reasonable subscriber.

Renfrew, Ont.

A. A. WRIGHT.

FROM THE TWENTY SUBSCRIPTIONS which I send you herewith from the professors and students of the University of Minnesota, you will agree with me when I say that The Electrical World is a general favorite here at the university, both among students and professors. I am sure your friends in the Northwest are pleased with the grand, good sheet you have given them during 1893. We appreciate the Digest and the hundred and one other things that are first class in every respect.

Minneapolis, Minn.

C. H. CHALMERS.

THE MOST POPULAR TECHNICAL JOURNAL. The vast importance which the electrical interests of the present day have assumed may be inferred from the fact that a recent issue of The Electrical World, the leading weekly journal devoted to electricity, contains no less than one hundred pages, and over 300 business announcements in its advertising columns, an amount of matter only exceeded by that of one other industrial or technical paper in the United States—the journal representing the iron interests. The Electrical World, which is an enterprising and handsomely illustrated weekly, is called "the most popular technical journal," and is said to have more subscribers among the general reading public than any other technical periodical.

—Albany Journal.

Windmills for Electric Lighting.

There are said to be no less than 500,000 windmills in actual daily operation in this country alone, and yet the economical value and thorough reliability of this prime mover is but little appreciated by the public at large.

The records of the Signal Service, U. S. Army, for the past fifteen years show that the wind may be relied upon to blow with sufficient velocity to drive a windmill to its average working capacity eight hours out of every twenty-four. But since there are hours of absolute calm the employment of a windmill is necessarily restricted to two classes of work. 1. To work admitting of frequent interruption. 2. To work where power can be stored for future use.

It is in work of the second class that windmills find their true field of usefulness, and they are already largely used for pumping and storing water, and for compressing air. Another use, which was first suggested by Sir William Thomson in 1881, and which has several times since then been tried with partial success, is in the production of electric light, the dynamo being driven direct from the windmill and a secondary battery being employed to store and distribute the electrical energy to the lamps.

The combination here suggested really forms an ideal method for isolated plant lighting, and it is likely to grow in favor as the advantages of the system become more generally known.

It is found by experience that it requires, on an average, a wind velocity of six miles per hour to drive a windmill, i. e., to overcome the friction of the bearings and transmitting gears, but that the mill will actually run at least eight hours per day. From this it is safe to assume that one-third the total movement of the wind is lost, so far as windmill work is concerned. The remaining two-thirds should be distributed over the eight working hours of the mill.

Mr. A. R. Wolff, M. E., in his excellent work "The Windmill as a Prime Mover," gives a table compiled from the official records of the office of the Chief Signal Officer, covering observations made at fourteen different places throughout the United States, which shows that the average monthly movement of the wind during the whole period of the observations was 5,769 miles per month. This, divided by 30, gives 192.3 as the daily movement. $192.3 \times \frac{2}{3} = 128.2$

and $\frac{128.2}{8} = 16 \frac{1}{2}$ miles = the hourly rate during the eight working hours.

Since windmills are always erected in places where the full force of the wind is felt and utilized, the above estimate of the average working velocity that can be depended upon is believed to be a conservative one.

The subjoined table shows the actual useful horse power developed by mills of different sizes manufactured by one of the leading firms in the world in this business:

Diameter of Wheel.	Weight of Mill.	Useful H. P.
14 feet.	1,600 lbs.	1
16 feet.	2,500 lbs.	1 3-5
18 feet.	2,700 lbs.	2
20 feet.	3,000 lbs.	3 1-5
25 feet.	3,600 lbs.	4 1/2
30 feet.	4,000 lbs.	5 1/2
36 feet.	7,000 lbs.	6 3/4
40 feet.	9,570 lbs.	8
50 feet.	16,000 lbs.	16
60 feet.	20,000 lbs.	26

This table is based upon the actual work done by these mills in a 16-mile per hour wind.

In the work on windmills before referred to figures are given which enable a comparison to be made between wind power, steam and gas for pumping purposes, which would equally apply to electric lighting, from which it appears,

taking all the factors into consideration, that the former is more than seven times as economical as either of the latter, even when they are worked under the most favorable circumstances.

As an example of the application of the windmill to electric lighting, we illustrate a plant installed in Jersey City by the Lewis Electric Company, 120 Broadway, New York, which has been in operation for some time, and embodies several new features of great importance.

Owing to the variable speed of windmills, the few attempts heretofore made to use them for charging storage batteries



A WINDMILL LIGHTING PLANT.

for lighting have not met with much success, owing to the inapplicability of the usual form of dynamo for this purpose. The Lewis dynamo is based upon an entirely new principle, upon which letters patent have been issued to Lieut. Lewis, U. S. Army, by the employment of which the E. M. F. of the dynamo used in the plant illustrated rises only 11-2 volts when the speed changes from 500 to 1,600 revolutions per minute. The importance of this invention is

obvious and adds windmills to the other sources of power for electrical purposes.

The mill in question, made by A. J. Corcoran, of Jersey City, N. J., has an eighteen-foot wheel, fitted with the well-known Corcoran side-vane governor and safety lever, and has developed as much as 4 h. p. in a stiff breeze.

The dynamo is a 1 kw. slow speed dynamo, entirely enclosed, and requiring no attention beyond oiling and occasional examination of brushes. The automatic regulation referred to, by means of which the voltage is maintained sensibly constant under great variations of speed, is attained by the method of winding the fields, the series winding being opposed to the shunt winding, as in compound motors. The machine is belted to the pulley on the mill countershaft and runs night and day, charging a storage battery of 16 cells of 150 ampere hours, which furnishes current for lamps.

The limits of speed within which the dynamo supplies current are 500 and 1,000 revolutions, the current varying between these limits from 0 to 35 amperes, and the pressure 1.1-2 volts. When the speed falls below 500 revolutions an automatic cut-out opens a switch and disconnects the battery, which is again cut in when the speed and voltage rises above an amount necessary to overcome the back E. M. F. of the cells.

The automatic cut-out and switch, with a voltmeter and



AUTOMATIC CUT-OUT AND SWITCH

an ammeter, are enclosed in a small box attached to the wall; but as everything is automatic in operation, inspection of them is unnecessary, and the two latter may be entirely dispensed with. The writer visited the plant on a gusty day, and it was most interesting to watch the automatic action of the apparatus and the manner in which the voltage was maintained, whether the mill was turning slower than its normal rate or being furiously driven by a squall; at a critical slow speed, when the battery was being cut out and in at short intervals, there was no sparking at the cut-out switch, as at that instant there is but little current in the circuit being broken.

The plant has been running night and day for more than a month, during which time it has been giving perfect satisfaction, and has demonstrated the perfect applicability of the means employed for the utilization of wind power for electric lighting.

Automatic Car Brake.

We illustrate a braking device, controlled by D. McFarlan Moore, 44 Broad street, New York, which is operated automatically by pressure upon the hinged projecting fender, or by the motorman at will. Either method moves the rod

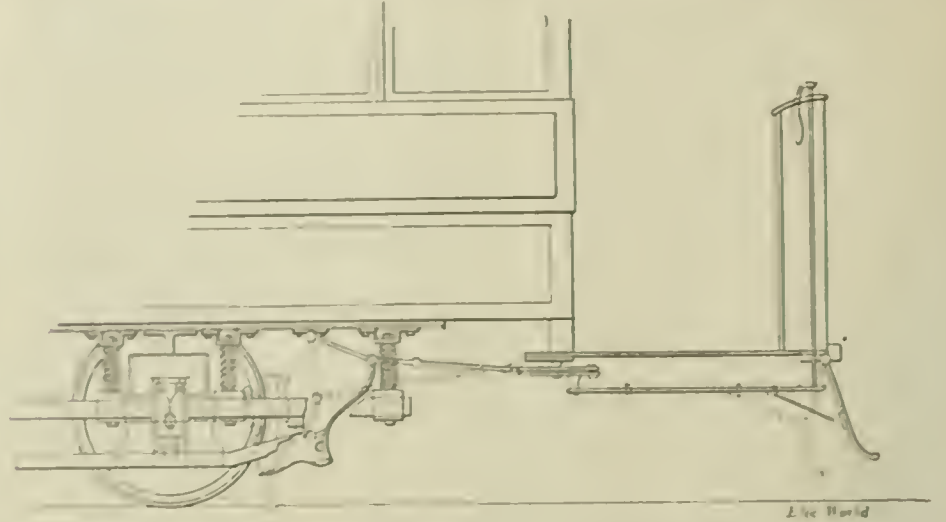


DETAIL OF AUTOMATIC CAR BRAKE

under the car platform, cuts off the current, or releases the cable and swings the shoes down upon the track under the wheels, which run up slightly on the shoes, blocking the car. It is evidently impossible for anything to get under the wheels, and it is equally evident that the car cannot be more effectually braked, practically, in any other manner, for the heavier the load the more effective the braking, particularly if the under surface of the shoe is slightly roughened, and for

this purpose the shoe may preferably be constructed so that the roughened surface bears upon any desired part of the rail to prevent excessive wear. The shoes on either side of the car may be connected with a light wire fender to keep anything from getting under the body of the car, or if preferred the usual board fender may be fastened directly upon the shoes.

The mechanism at the point directly under the front of the body of the car, where the rod running from the hinged



AUTOMATIC CAR BRAKE.

fender connects with the rod running to the shoes—separately shown in the cut—is a simple lever, for the purpose of obtaining greater movement and of throwing the weight of the shoes upon a dead centre, it being kept there by the slight spring shown in the cut. This arrangement keeps the shoes in their proper position when raised, offers a ready means of adjustment, both as to movement of parts and delicacy of action, and prevents any operation except in the manner appointed.

The shoes may be lowered, as already stated, or raised by the motorman by means of the lever upon the platform. The handle of this lever is hinged so as to drop into a slot to prevent it being turned accidentally, and this does not interfere with the operation by the hinged fender automatically.

Storage Battery Traction.

Experiments with a storage battery street railway car have been carried on over the Amsterdam avenue street railway line between 53d and 125th streets by the Astoria Electrical Manufacturing Company of New York at intervals for more than a year, and through the courtesy of Mr. W. M. McDougall, the general manager of the company, we are now enabled to publish some of the details.

The equipment consisted of an ordinary street car, fitted with a bipolar ring armature motor of high efficiency and 144 cells of the Acme storage battery, made by Kennedy & Diss, of Brooklyn. The plates of this cell consist of a central conducting plate of lead, faced on each side with rubber pierced with holes. The rubber on the two sides of the lead plate vulcanized together through interstices in the latter, which is also pierced with circular holes concentric with but smaller than those in the rubber faces. Active material is filled in the cavities thus left, the plug being held in place on account of the smaller diameter of the hole in the lead plate. Each cell has a capacity of 150 a. h., weighs 28 pounds and has an internal resistance of from .0012 to .0015 ohm.

The experimental trials were made from September, 1892, to March 1, 1893, and from May 10 to Sept. 15, 1893, the car being run daily during a good part of this time. No mishap occurred on any of the trials, and at the end the battery was apparently in excellent condition. There was a reserve of 35 cells for changes, but no cells were in a condi-

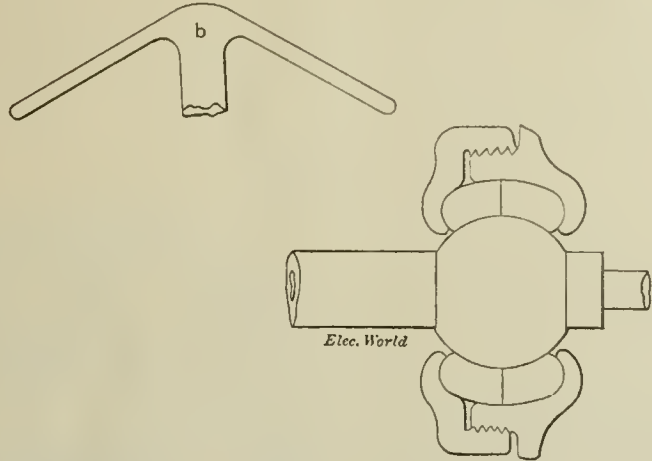
tion to be entirely discarded. The cells were connected in four sections in parallel, or two sections in series and two in parallel, or the four sections in series, corresponding to speeds of 3, 6 and 12 miles respectively. The average rate of discharge was 30 amperes, but on one section of the road, where there is a 6 per cent. grade, the discharge was 110 amperes, maintained during 3 1-2 minutes. While the battery used gave excellent satisfaction, it is proposed to employ Plante cells of an original design in the future.

From the data of these trials it was found that with 20

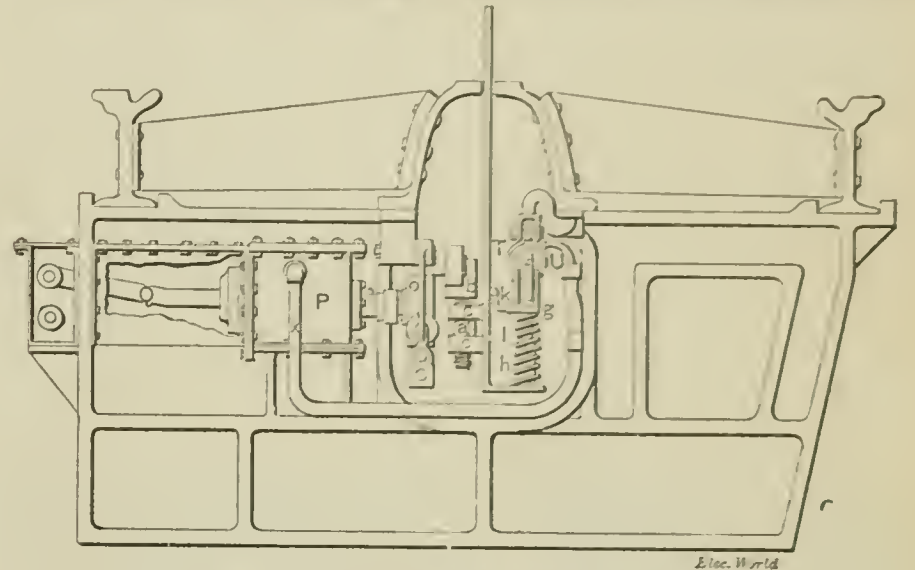
charge of 25 per cent., which is thought to be beyond what will be found necessary in any case.

A New Conduit Street Railway System.

In the system here described and illustrated, the invention of W. Stuart-Smith, Berkeley, Cal., it is proposed to have highly insulated mains and feeders carried in a cast iron box



STUFFING BOX AND BELL CRANK LEVER.

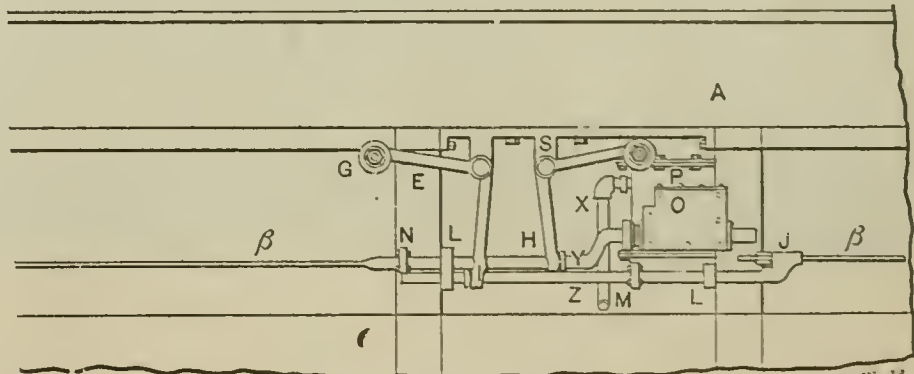
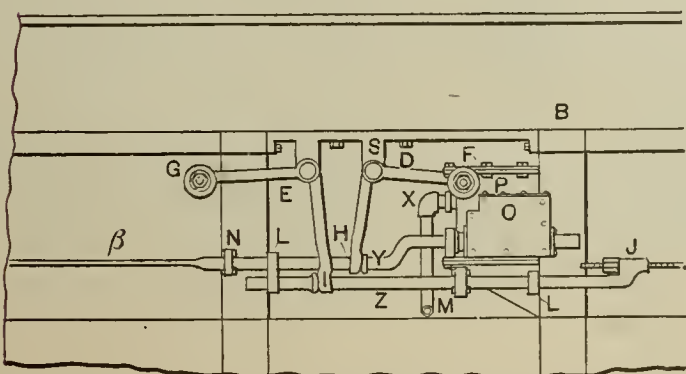
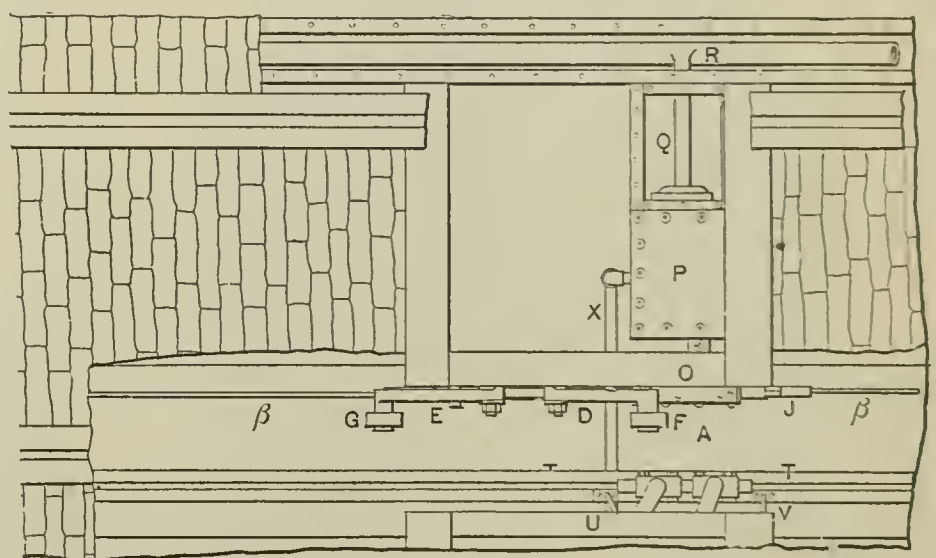
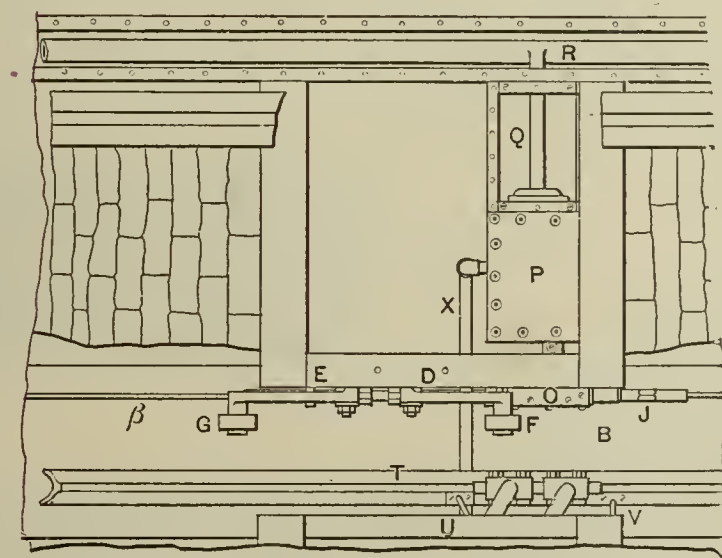


SECTION OF STREET RAILWAY CONDUIT.

similar cars on the road the entire cost of operation, estimated on a liberal basis, and for a daily mileage of 100 for each car would be 8.03 cents per car mile, distributed as follows:

	Cents per Car Mile.
Power	2.5
Charging and labor	2.0
Repairs to motors	0.5
Oil, waste and packing.....	0.25
Supplies	1.00
Depreciation	1.78
Total	8.03

resting on brackets on the outer end of the yoke, as shown in the cross-section. At intervals, which may be from 100 to 1,000 feet, switch boxes will be placed into which a short branch from the main leads, as shown, will pass through a stuffing box of ball and socket design. In the latest design a switch has been devised in which the wear will be so small as to insure indefinite working even if it opens and closes say 1,000 times per day. This switch is exceedingly important, and the latest one is the outcome of much thought and many designs, but as it is not yet protected, it is not here described. It is operated by suitable mechanical means,



PLAN AND ELEVATION OF STREET RAILWAY CONDUIT.

What data in the above were not directly determined from the trials are taken from a report of Mr. Charles Hewitt, of the General Electric Company, which was made for disinterested parties and not with a view of favoring the system. The figure for depreciation is based on an annual battery

no magnetic arrangement being employed. At each switch box are placed two bell crank levers, *E, D*, each carrying on one arm a steel roller, *G, F*, and having the other arm forked and bearing against contacts on two rods, *F, Z*. As drawn the car is supposed to be running between

junction boxes *A* and *B*. When it reaches *B* the double angular piece *b* (shown in the section), which is carried by the car, runs under roller *F* and raises it two inches, thereby pushing the rod *K* forward two inches and closing the switch, thus making connection between the insulated main and the previously dead section of the trolley conductor *T* beyond *B*. The car then passes on this section and a moment later the roller *G* is raised, and by means of the wire β , which runs back to box *A*, opens the switch at *A* and puts the lever *D* at *A* in position to be raised by the next car.

If the cars were kept at the proper distance apart the connections as above would be all that is necessary, but when several are bunched on section *AB* the first car to pass off would (as above shown) cut out section *AB* and leave the remaining cars stalled. This can be avoided by having a split conductor (with the two parts insulated) leading from the switch boxes to the trolley conductor and have the two parts lead to two contiguous sections of the trolley conductor, as shown at *UV*; then when the moving car lifts the roller and closes the switch at *B*, both section *AB* and the following section will be connected to the main and for a moment section *AB* of *T* will be connected to both the boxes *A* and *B*. A moment later this section is cut out at *A*, but still left connected at *B*, so that stalling of bunched cars is impossible. When the first car reaches the next following box section *AB* will be finally cut out and left dead.

The trolley conductor is to be made of iron rolled as a half cylinder, with a thin, deep rib on the back, thus giving great stiffness with small weight, and the highly insulated

bare conductor will be dead even at times of heavy load.

In the section the parts lettered *a, b, c, d, f, g, h, i, k*, are carried by the car, *a* being the trolley carrier secured to the truck.

In the latest design of switch the normal movement of the rods *FZ* and wires β is supposed to be two inches, but a variation of 25 per cent. either side of this will not affect the operation of the switch, and consequently a rough adjustment of lifting piece *b* is all that is necessary. This greatly simplifies the mechanism, as no means for taking up surplus motion, etc., are needed. The crossing of two roads is exceedingly simple and would require no attendant to be stationed there.

The Bain Induction System.

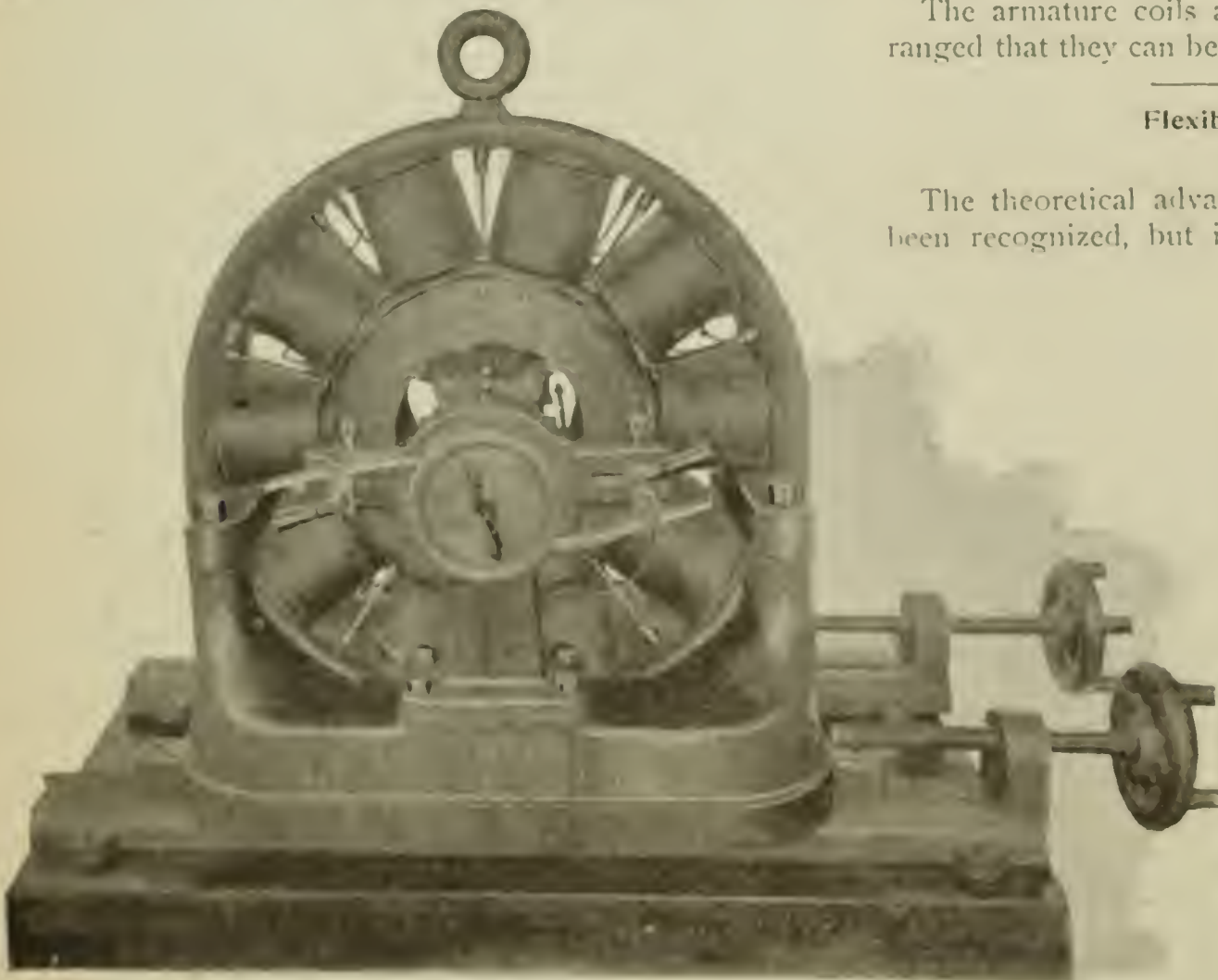
We illustrate herewith the new Bain alternating-current dynamo manufactured by the Great Western Manufacturing Company, of Chicago, at their Duluth works. In this construction Mr. Bain has followed the general lines of alternating dynamos, paying especial attention to important details which make the apparatus highly efficient.

As will be noticed, the centre of gravity is exceedingly low, which prevents vibration and insures steadiness of running. The regulation is so adjusted that it can be over compounded to any degree in a few moments, even while the machine is at full speed. This is accomplished by an ingenious arrangement whereby the strength of the field is automatically adjusted through the exciter. This gives close regulation, and one that can be relied upon to adapt itself to any conditions of practice.

The armature coils are wound of copper ribbon, so arranged that they can be easily replaced.

Flexible Roller Bearing.

The theoretical advantages of roller bearings have long been recognized, but it is only in recent years that they



50 KW. ALTERNATING-CURRENT, CONSTANT-POTENTIAL DYNAMO.



FIG. 1.—ROLLER BEARING.

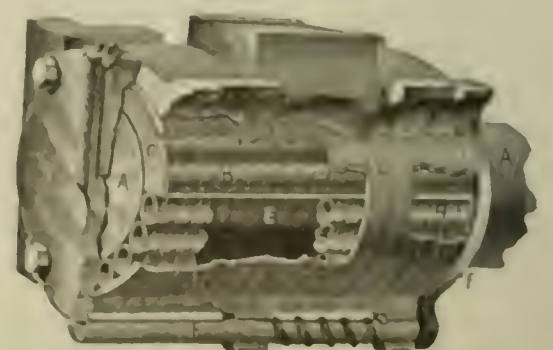


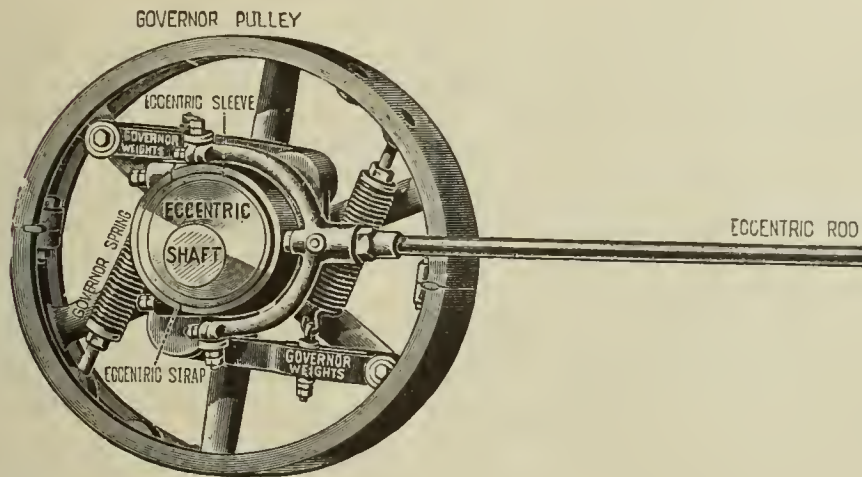
FIG. 2.—ROLLER BEARING.

supports can be placed at considerable distances apart, and thus reduce the points of leakage to a minimum. In order to insure a clean conducting surface for the trolley wheel, it is proposed to put a crown of hard rolled silicon bronze in the iron, as shown. The trolley conductors will be cut into sections of the same length as the distances between boxes. With this arrangement, by properly proportioning the distances between boxes, a considerable portion of the

have come into use for larger machinery, and as yet to only a comparatively small extent. The elastic steel roller bearing which we illustrate, made by the Hyatt Roller Bearing Company, 77 Liberty street, New York, obviates, it is claimed, the disadvantages which have restricted the use of other forms by adapting itself to every inequality of the axle or bearing, thus preventing distortion by side strains in the bearing or bending strains on the journal.

The rollers are made from a single ribbon of untanned, open-hearth steel wound on a mandrel to form a close spiral. It requires no grinding or turning and rolls in a box and on a journal finished with only ordinary care. Fig. 1 shows a bearing ready for use and Fig. 2 the Hyatt bearing as applied to a motor truck, where a sleeve made of a spiral coil, in the same manner as the roller itself, is slipped over the axle and a similar but larger sleeve is slipped into the box. The rollers travel between these sleeves, which obviates the necessity for a specially finished surface on the journal or on the box, and form a wearing surface much more durable than wrought iron.

With this bearing an electrical car is started with a small fraction of the force required when it is equipped with ordinary



bearings. Thus the heavy strain on the motor at the start, which is such a prolific cause of burned out armatures, is relieved, less power is wasted in the rheostat, and the car starts with less shock and jerk to the passengers. The saving in power due to the use of such bearings may save overloading a central station or a line wire, and may thus avoid expensive burn-outs or the replacing of the line wire by a larger size, which has been found necessary on many roads. For trolley wheels the Hyatt roller bearing is particularly applicable, as it is more durable than the bushings ordinarily used and will save the trouble and annoyance caused by ordinary trolleys. The wear on the line wire is also reduced owing to the easy running of the trolley.

An Improved Automatic Engine.

An automatic engine with an unusually interesting valve gear has recently been placed upon the market by the Ameri-

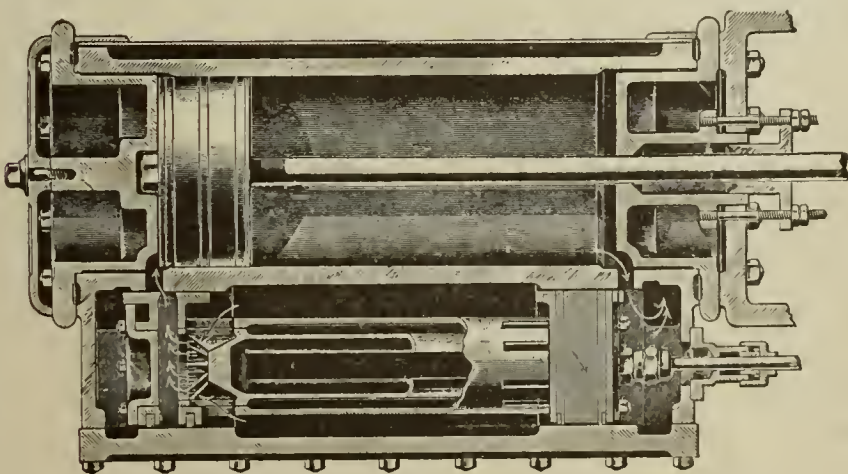


FIG. 1 —CYLINDER, VALVE AND VALVE CHEST.

can Engine Company, Bound Brook, N. J. Both main and cut-off valves are worked by one and the same eccentric and valve rod, the former by the motion of translation, and the latter by a vibratory motion of the rod.

Figs. 1 and 2 show the two valves, the cut-out being within the main valve. Steam is admitted into the middle of the valve chest and is allowed to pass into one or the

other end of the main valve by the cylindrical interior cut-off valve through the openings shown, and thence passes into the cylinder. The exhaust passes directly into an exhaust opening at either end of the cylinder.

Figs. 2 and 3 show the eccentric and method of obtaining the vibratory motion of the valve rod. On the eccentric is a sleeve controlled by a usual form of flywheel governor, but instead of the eccentric strap being at right angles on this sleeve, as usual, it is fitted at an angle, so that with the revolution of the sleeve it passes from the extreme angle shown in Fig. 3 to a corresponding angle on the other side of the vertical position. A V-shaped groove is turned in the sleeve, so that a plane passing through it is at an angle to a plane perpendicular to the sleeve, and the eccentric strap is fitted in this groove, which enables the vibratory motion just described to be obtained.



FIG. 2 —VALVE GEAR.

The main and cut-off valves have the same motion of translation, and at the proper moment, which is determined by the governor, the longitudinal ports in the main valve are opened by the cut-off valve turning, thus admitting steam to the cylinder through the main ports.

By the means here employed the compression and release are maintained constant at all loads and all of the advantages of a separate cut-off obtained with the use of only a single eccentric and valve rod; other features are the small clearance space and the exit of the exhaust steam without passing over surfaces outside of the ports, which are afterward in contact with live steam.

Mechanically, the engine is well designed and well made.

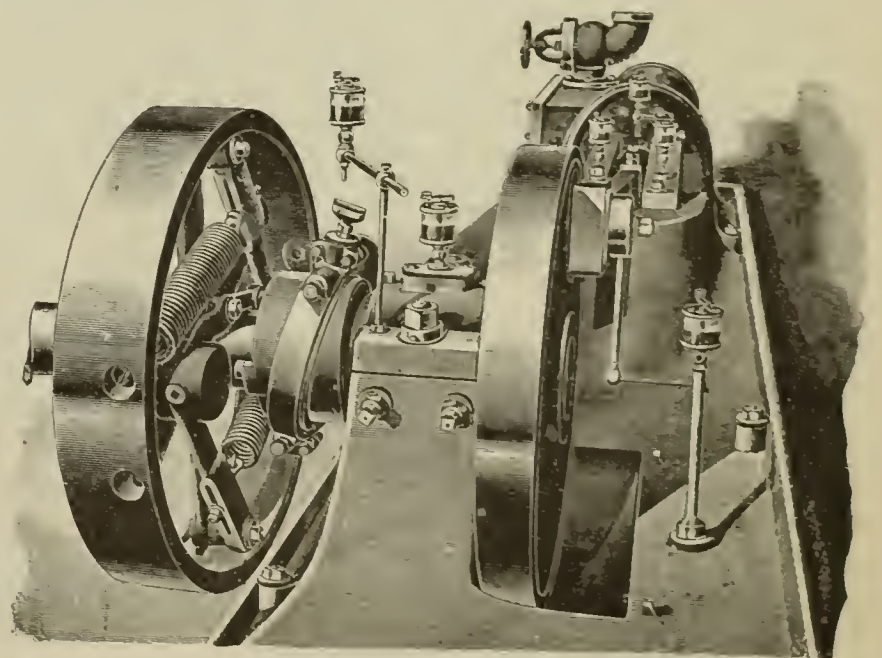


FIG. 3.—GOVERNOR AND ECCENTRIC.

and promises to take a leading place among high-speed engines.

Rather Peculiar.

It is perhaps curious that though many newspapers give prices current, they do not include prices for current.—London "Electricity."

Financial Intelligence.

The Electrical Stock Market.

New York, Jan. 2, 1904.

THE ELECTRICAL STOCK MARKET has presented a dull and uneventful week. There have been no transactions of any note and the market has seemed to be devoid of any life or interest. Now that the silver and bond questions are settled, Wall Street has another subject for the cause of hard times in the tariff issue. It is now said that until the revenue policy of the government is established, financial depression will prevail. Whether it is legislation or an over production and greedy speculation amongst the business community is a question with financiers.

ONE OF THE OLD TIME BROKERS in electrical stocks said the other day that low as electric securities now are and with every reason for their appreciation in the future, it was almost impossible to make any sales. When there are unquestionable securities, as government bonds, offered for sale, the public grabs at the opportunity, but is still very loath to invest funds in any industrial securities, good as the intrinsic values of some electric stocks are.

GENERAL ELECTRIC. This week's transactions in General Electric are in marked contrast with those of last. While in the preceding week it was foremost in the list of active industrials, this week it has hardly been mentioned in any of the great sales, and closes 14 points lower than the closing quotation of a week ago. The chief cause affecting the quotation was the general stagnation and lagging of all industrials. There were no outside rumors of financial troubles of the company which might cause a decline.

THE DECISION OF JUDGE RICKS, of the United States Circuit Court of Ohio, declaring the Edison incandescent lamp patent expired on Nov. 10, is rather an offset to the recent favorable decisions the General Electric people have received. The Ohio suit was one of the Edison Electric Light Company against the Buckeye Electric Company. Judge Ricks holds that the correction of the patent made by the Patent Office at the request of the Edison company limiting the American patent to the term of the English patent constituted a dedication to the public of the remainder of the term of the American patent after the English patent expired. He further holds that the Edison company is estopped by procuring this correction from claiming that the American patent runs longer than the English patent. It seems as if the General Electric people were under the utmost difficulties to hold on to their incandescent lamp monopoly.

THE WESTINGHOUSE ELECTRIC COMPANY is now making great strides in the business world. Despite the hard times the company is reported as doing a business of \$6,000,000 per annum, and has now 2,000 hands employed at its Pittsburg works. From the great competition and keen rivalry among the big electric companies, the Westinghouse gains have not been large, yet it is making a fair manufacturing profit, and the company's future is as bright, if not brighter, than any other electric concern. The new plant which the Westinghouse company has already contracted for will enlarge the company's facilities enormously, as besides having all modern improvements the location permits the establishment of all departments under one roof, thus reducing running expenses. The big electric plant which the company built for the Niagara Cataract Construction Company was tested during the week with satisfactory results. This and other triumphs which the Westinghouse people have attained in the electrical engineering field must ultimately make the stock one of the most valuable of electrical securities. The present quotations, 24 1/2 for the preferred and 43 for the common, have been the ranging prices of the stock for the last three months. As the par value of the stock is 50, these figures, low as they are, compare favorably with other electrical stocks.

THE NEW YORK AND NEW JERSEY TELEPHONE COMPANY has increased its capital stock from \$2,535,000 to \$3,500,000. The amount of capital of the company actually paid in is \$2,535,000, and the whole amount of the debts and liabilities is \$1,735,000. The increase of \$965,000 in its capital is made to meet business extensions in the ever-growing telephone field.

THE NEW ENGLAND TELEPHONE COMPANY has declared a quarterly dividend of \$1.25 per share.

ELECTRICAL STOCKS.

	Par	Bid	Asked
Brush Ill., New York	50	29	40
Detroit Electrical Works	10	2	3
Cleveland General Electric Co.	—	85	90
East River Electric Light	100	—	65
Electric Con. & Supply Co., pref.	15	15	16
" "	15	15	17 1/2
Edison Electric Ill., New York	100	68	71
" " " " "	—	104 1/2	105
Edison Electric Ill., Brooklyn	100	90	101
" " " " Boston	100	112	117
" " " " Chicago	100	115	117
" " " " Philadelphia	100	120	125
Edison Electric Light of Europe	—	—	5
" Bonds	—	80	85
" Ore Milling	—	5	11
Fort Wayne Electric	—	4	6
General Electric Company	100	41 1/2	45
Interior Conduit and Ins. Co.	100	75	77
Mount Morris Electric	—	—	65
Westinghouse Consolidated	50	41	43
" " " " pref.	80	28 1/2	29 1/2
Western Union Telegraph	—	84 1/2	84 1/2

New Incorporations.

SALT LAKE CITY, UTAH.—The Jordan River Generating Company, with \$50,000 capital, has been incorporated. Charles S. Walker, Frank Harris and Frank Knox are interested.

THE HUBLEY MANUFACTURING COMPANY, of Lancaster, capital stock \$200,000, has been formed to manufacture, electric, steam and mechanical toys, etc. J. E. Hubley, F. H. Steacy and D. B. Shenk are interested.

C. AND P. MANUFACTURING COMPANY, Brooklyn, N. Y., capital stock \$20,000, has been formed to manufacture electrical, steam and other machinery and appliances. M. T. Davidson, William D. Parry, William A. Drewett, all of Brooklyn, are the interested parties.

CENTRAL ELECTRIC SERVICE COMPANY, Milwaukee, Wis., capital stock \$100,000, has been formed to manufacture and deal in heat-regulating apparatus, electrical and pneumatic specialties, etc. The promoters are Francis Hinton, William F. Powell and William D. Van Dyke.

CENTRAL MASSACHUSETTS ELECTRIC COMPANY, Palmer, Mass., capital stock \$150,000, has been formed to manufacture, buy, sell, use and transmit electricity for the purpose of furnishing light, heat and power. The promoters are A. M. Young, Chas. B. Fiske and Rufus Flynt.

THE NEW SHARON ELECTRIC LIGHT AND POWER COMPANY, New Sharon, Iowa, capital stock \$12,000, has been formed to construct and maintain an electric light and power plant at New Sharon, Iowa. The promoters are L. H. Ong, J. Watland and P. Batliff, all of New Sharon.

THE ELECTRICAL ANNUNCIATOR COMPANY, Portland, Me., capital stock \$500,000, has been formed to manufacture, deal in and use all kinds of electrical and mechanical apparatus. The organizers are E. W. Mann, Norfolk; E. S. Taylor, Quincy, Mass.; and A. C. Allyn, Rochester, N. Y.

THE CARD ELECTRIC COMPANY, Mansfield, Ohio, capital stock \$100,000, has been formed to manufacture and sell electric street railway equipments, stationary electric motors and dynamos, street car heaters, etc. Reid Carpenter, H. M. Weaver, B. F. Crawford and S. A. Jennings are interested.

THE SLATINGTON STREET RAILWAY COMPANY, Allentown, Pa., capital stock \$30,000, has been formed to construct and operate an electric railway in Lehigh county. The promoters are R. W. Mosteller, Henry Bitner, John W. Ballitt, Slatington, Pa., and Morris Hoats, 618 Hamilton street, Allentown, Pa.

THE CHICAGO ACCUMULATOR COMPANY, Chicago, Ill., capital stock \$300,000, has been formed to acquire patents concerning inventions for the improvement of electrical storage batteries, appliances for furnishing electrical motive power, etc. G. E. Plumb, F. W. Moore and C. E. Ridpath are the promoters.

THE GENERAL ELECTRICAL CONSTRUCTION AND SUPPLY COMPANY, Dayton, Ohio, capital stock \$10,000, has been formed to manufacture, purchase and deal in electrical appliances and supplies. G. B. Butterworth, H. H. Heathman, W. F. Breidenbach and H. W. Pleasant are the interested parties.

THE WOLF ELECTRICAL PROMOTING COMPANY, Cincinnati, Ohio, capital stock \$15,000, has been formed to purchase letters patent and manufacturing and selling improvements in electrical fabric cutting machinery, etc. Jacob Block, J. Wolf, Jr., F. Elsbach, A. Bloch and J. B. Frenkel are the incorporators.

WEST WATER POWER AND LIGHT COMPANY, West, Tex., capital stock \$25,000, has been formed to supply the public with water for all purposes, and also to supply heat, light and electric motor power to the public. John Brazelton, J. J. Holt, T. M. West, J. B. Cook and W. W. Glasgow are the organizers.

THE METROPOLITAN ELECTRIC EQUIPMENT COMPANY, New York, N. Y., capital stock \$20,000, has been formed to equip and install electric plants. M. T. Ward, 515 E. 161st street; St. Darius Columban, 78 W. 48th street, New York, and J. F. Hughes, 67 Patchen avenue, Brooklyn, N. Y., are the promoters.

MADERA ELECTRIC COMPANY, San Francisco, Cal., capital stock \$100,000, has been formed to construct, operate and deal in electric works, waterworks, gas works and in the producing thereof. The promoters are F. W. Krogh, Charles A. Krogh, George G. Buckland, San Francisco, Cal., and Sol. Lazar, H. K. Olsen, Madera, Cal.

RAILROAD ELECTRIC SAFETY APPLIANCE COMPANY, Kittery, Me., capital stock \$1,000,000, has been formed to do a general business in appliances for the protection of life and property on railroads. Edward L. Orcutt, Somerville, Mass.; John R. Green, Everett, Mass., and Elmer N. Hutchins, Somerville, Mass., are interested.

KEYSTONE ELECTRIC CONSTRUCTION COMPANY, LTD., New Orleans, La., capital stock \$25,000, has been formed to buy, sell, or erect machinery of every kind, and to make contracts for doing everything connected with the erection of steam and electric plants. William I. Mathews, Alcide Bouchereau and Emile Jordy are the interested parties.

BRADDOCK AND HOMESTEAD STREET RAILWAY COMPANY, Pittsburg, Pa., capital stock \$7,500, has been formed for constructing and operating an electric railway from Rankin

Borough across the Monongahela River to Munhall Station, Allegheny county, Pa. W. C. Jutte, E. K. Morse and Geo. W. Thels are the interested parties.

THE METROPOLITAN CONSOLIDATED ELECTRICAL COMPANY, New York, minimum capital stock \$500, has been formed to manufacture, use and sell all kinds of mechanism and manufactured products, including various kinds of electrical goods, machines, etc. H. C. Andrews, W. J. Meagher and J. H. Bartlett, all of New York, are the incorporators.

BROOKLYN, N. Y.—The C. & P. Manufacturing Company, of Brooklyn, \$20,000, has been incorporated to manufacture certain electrical, mechanical and other appliances owned and controlled by A. Churchward and William D. Perry. The directors are Marshall T. Davidson, Joseph F. Scholes, Harry H. Starkey, William D. Perry and William A. Brewett, of Brooklyn.

THE FOGERTY GAS AND CHEMICAL COMPANY, Chicago, Ill., capital stock \$10,000,000, has been formed for operating works for manufacturing and distributing gas and electricity; operating plants for manufacturing such chemical salts, elements, etc., for making coal gas; dealing in patents and patent rights, etc. The promoters are Ambrose A. Worley, John C. Satterlee and N. H. Hanchette.

THE PEOPLE'S LIGHT AND POWER COMPANY, Newark, N. J., capital stock \$2,000,000, has been formed to construct, purchase, lease, sell and operate works and plants for the manufacture and distribution of electricity, steam and gas for light, heat and power. The promoters are James K. Corbiere, Caldwell, N. J.; Joseph L. Munn, James E. Reynolds, East Orange, N. J.; Thos. A. Nevins, Orange, N. J., and Elisha B. Gaddis, Newark, N. J.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, Jan. 29, 1894.

PROF. F. B. CROCKER lectured before the Franklin Institute, Philadelphia, on Jan. 20, on "The Electric Motor."

BROOKLYN ELECTRICAL LABOR UNIONS are at war and their contentions threaten to embroil 60,000 wage-earners, including other trades.

DR. S. S. WHEELER delivered the second lecture of the University extension course at Cooper Union on Jan. 22, the subject being "Dynamoes and Motors."

THE WILSON PLAN of rapid transit by underground trains continues to gain in favor, but it is hinted it will be eventually killed by Manhattan elevated influence.

THE PHILADELPHIA EDISON COMPANY has sent a bill to the General Electric Company for \$61,000, the amount it claims to have lost through not being protected against infringers selling lamps in its territory.

MAYOR SCHIEREN, of Brooklyn, proposes to take vigorous action in order to prevent trolley cars running faster than the speed permitted by law. Recently Prof. Plympton reported that he found from actually timing cars that many were running at rates from 12 to 19 miles per hour.

MR. THOMAS C. PERKINS, vice-president and general manager of the Mather Electric Company, of Hartford, Conn., was in New York on Saturday on business. The reorganized Mather Company includes among its officers and stockholders some of the best known and most successful business men of Connecticut. The company will soon be ready to place upon the market some of its latest design machines, which it is thought cannot fail to attract considerable attention among the electrical fraternity.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Jan. 27 1894.

THE WASHBURN & MOEN WIRE WORKS, of Worcester, Mass., have largely added to their working force this week.

THE UNDERGROUND WIRES question and municipal lighting are still in active agitation by the Massachusetts legislative committees.

THE GAMEWELL FIRE ALARM COMPANY'S offices on Pearl street, Boston, were slightly damaged by smoke at the recent fire in their building.

KEENE, N. H., has about made up its mind that it ought to have a street railway, and that, if it has one, it must be one run by electricity.

THE EDISON ELECTRIC ILLUMINATING COMPANY, of Boston, recently declared a dividend of 1½ per cent., which is a reduction from 8 to 6 per cent.

THE NEW ENGLAND TELEPHONE AND TELEGRAPH COMPANY has expended more than a million of dollars on its underground cable conduits.

THE SUBWAY COMMISSIONERS of Boston report that they will soon be ready to present a bill before the Legislature, and estimate that the total cost of the subway will not exceed \$5,000,000.

MR. F. C. BREWSTER, of the Elson & Brewster Engineering Co., 141 Liberty street, New York City, and Mr. P. C. Burns, of the Laclede Carbon and Electric Company, of Kokomo, Ind., were recent Boston visitors.

GARDNER, ME.—An electric railway is now practically a certainty. The necessary 500 shares of stock have been subscribed for, and directors will be elected as soon as the requirements of the law have been fulfilled.

A NEW ELECTRIC RAILWAY SYSTEM.—The legislative committee on street railways visited Salem on Jan. 22, and inspected E. H. Brown's magnetic electric railway. This is a recent invention, and many remarkable features are claimed for it.

H. C. DEANE, machinist and manufacturer of special machinery, No. 1 Main street, Fitchburg, reports business as improving and that there is an excellent demand for the Deane improved reducing wheels for slow or high speed upright or horizontal engines.

MR. HERBERT P. BROWN, brother of Mr. Maybin W. Brown, succeeds Mr. E. O. Johnson as travelling representative of the Brown Electric Company. He is well and favorably known to the electrical trade, understands thoroughly its wants and will undoubtedly prove a successful outside representative.

THE BRADBURY-STONE ELECTRIC STORAGE COMPANY, of Lowell, manufacturers of the "Ideal" storage battery, has just issued a new illustrated catalogue, No. 4, with price list. The catalogue is replete with valuable information as to the merits of its manufactures, which is abundantly substantiated by testimonials.

ON PETITION of the General Electric Company, because of a claim of \$60,000, Judge Edgar Aldrich, of the United States Court for the District of New Hampshire, has appointed William F. Brewster receiver for the Consolidated Light and Power Company, of Dover, N. H. Mr. Brewster, who is a Boston electrician, filed a \$10,000 bond.

MR. MAYBIN W. BROWN, of the Brown Electric Company, leaves Boston next Tuesday for Florida, from which point he will make an extended Southern trip in the interest of his company, presenting particularly its well known street railway supplies and specialties. He will be absent about six weeks, returning by way of Washington to be present at the meeting in that city of the National Electric Light Association.

THE W. S. HILL ELECTRIC COMPANY, 133 Oliver street, Boston, has just received another large order for switches from the Philadelphia Traction Company, the third one it has received in quick succession from this company. The Hill company is as busy as it very well can be with general electric work, to keep up with which it has been compelled to add to its facilities, and it looks now as if it might very soon outgrow its present location. Messrs. Hill, Poor and Everett, the management of the company, are to be congratulated over the success which is attending their efforts.

THE ELECTRIC HEAT ALARM COMPANY, of Boston, has recently contracted for the installation of its automatic fire alarm system in the building housing the live stock of Hon. Levi P. Morton at his summer residence at Rhinecliff, N. Y. The contract was effected through Architect Charles C. Haight, representing Mr. Morton, who spent a great deal of time examining the various fire alarm systems and finally selected that of the Electric Heat Alarm Company because of its superior thermostat and system of wiring.

THE COLUMBIA ELECTRIC COMPANY, of Worcester, Mass., has purchased the business of the Worcester Electric Engineering and Construction Company, of that city. Its business office will hereafter be in the Burnside Building, 339 Main street, continuing the manufacture of dynamoes and motors, for the present at least, at 180 Union street. It would seem that this company is on the eve of a successful business. It is just about completing a very important installation in connection with the Chemical Precipitation Plant of Worcester. The Columbia company has also recently installed a 600-light plant for Isaac Prouty & Co., of Spencer, Mass., and other smaller installations. Messrs. John P. Coghlin and Frank E. Gilbert are the managers of this company.

ON SATURDAY EVENING, Jan. 20, at Young's Hotel, a very happy little dinner party was given by Mr. W. R. Watters, who severed his connection with The Electrical World as its New England representative on this date, to the representatives in Boston of the electrical journals. There were present H. G. Tuckerman, of "The Electrical Review"; A. C. Shaw, of "The Electrical Engineer"; W. S. Key, of "Electricity"; R. F. Ross, of "The Electrical World," and G. M. Angier, of the Mather Electric Company, a personal friend, not only of Mr. Watters, but of all present. A very pleasant evening was enjoyed, the interchange of kindly sentiments as brother journalists and congratulations to Mr. Watters rendered the occasion a particularly enjoyable one. Mr. Watters will hereafter represent "The Street Railway Journal" in New England.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD.
536 Monadnock Building, Chicago, Jan. 27, 1924.

THE COLUMBIA LAMP COMPANY, of St. Louis, is enjoying a season of unparalleled business. The factory facilities of this company, which from time to time have been increased, are today taxed to their utmost capacity. This popular company continues to furnish the well-known Columbia lamp in large quantities to purchasers on shortest notice.

THE CENTRAL ELECTRIC COMPANY sells one of the oldest and probably best known commutator conservers on the market—that known to the trade as "Gales." The Central people state that this conserver has been largely used by central station men for the last five years, and that they know of nothing that has replaced it, and that the demands upon them for this article is steadily increasing.

THE STAR ELECTRIC LAMP COMPANY, Chicago, manufacturers of the "Sunbeam" lamp, has changed its name to The Sunbeam Lamp Manufacturing Company. The policy of this company is to furnish lamps superior in quality. Recently some discoveries have been made, as the result of the extensive experiments they have carried on, which they claim will greatly improve the quality and add to the value of their lamp.

MESSRS. P. THOMAS & SONS' COMPANY, manufacturers of porcelain standard goods, East Liverpool, Ohio, has opened an office at 115 Dearborn street, Chicago, under the management of Mr. J. E. Way, who is very popular and well known to the trade. Mr. Way will carry a complete stock of all kinds of standard cleats and insulators. This company has a warehouse at 142 Lake street, Chicago, where a full line of porcelain standard goods is constantly on hand.

THE AMERICAN ELECTRICAL MANUFACTURING COMPANY is introducing a new lamp which it calls the "Republic." This lamp is a high grade lamp equal to many so called lamps on the market. The guaranteed life of this lamp is 600 hours. Certain materials entering into the construction of this lamp not so expensive as those in the widely known "American" lamp, allow them to make it at a competitive price. The "American" will still be furnished to all desiring it with the usual guarantee of 1,000 hours.

THE HULINGS ELECTRIC COMPANY, of East Liverpool, Ohio, incorporated under the laws of the State of Ohio, for the purpose of manufacturing electrical supplies, is fast acquiring an enviable reputation in its section of the country though having commenced business only last July. This company makes a specialty of tablet boards, rosette cut-outs and switchboards, more especially the former. Notwithstanding the existing financial depression, this company has had all it could attend to since its advent. In addition to the specialties above mentioned, this company will, in a few weeks, also manufacture sockets and other electrical specialties.

News of the Week.

Electric Light and Power.

SUN PRAIRIE, WIS.—An electric lighting plant will be put in before spring.

CINCINNATI, OHIO.—The city hospital is to be ventilated throughout by electric fans.

BALDWIN, MICH.—F. L. Prindle and J. Schultz are projectors of the proposed electric lighting plant.

KALAMAZOO, MICH.—An ordinance has been adopted looking to the establishment of a city plant to cost \$15,000.

SAUGATUCK, MICH.—The business men are talking of putting in a small electric plant to light the business places.

ST. BERNARD, OHIO.—An election will be held Feb. 24 to vote on the issue of \$25,000 waterworks and electric light bonds.

YORKVILLE, PA.—Residents of Yorkville have asked the borough council to take action in the matter of an electric light plant.

ST. CHARLES, MO.—An ordinance is before the Council providing for the establishment of an electric lighting plant by A. Speirs.

CHARLESTON, S. C.—The Charleston Electric Light Company has been authorized to increase its capital to \$175,000 for improvements.

ADA, OHIO.—Owing to a misunderstanding between the Ada Electric Light Company and the Council of Ada the city is in darkness.

WHITEHALL, N. Y.—The plant of the Whitehall Electric Light and Power Company has been burned; loss, \$8,000, with no insurance.

DAWSON, GA.—Citizens are subscribing liberally to the proposed \$10,000 electric lighting plant which it is proposed to build and operate in Dawson.

POWELTON, PA.—The office of the Powelton Electric Company is at 108 South 40th street, Philadelphia, Pa., and J. B. Stauffer is secretary-treasurer.

MANCHESTER, MASS.—There is grave complaint of the lighting of the Town Hall, and residents are urging that an electric lighting plant be established.

MOUNT MORRIS, N. Y.—There is talk of organizing a stock company for the construction of an electric lighting plant, but nothing definite has been done.

CAMBRIDGE, MASS.—J. H. McNamee, of 418 Harvard street, Cambridge, Mass., will put into his new building a dynamo for power, light and elevator service.

NAPOLEON, OHIO.—Edward Sykes, of Minneapolis, Minn., has the contract to put in the electric lighting and waterworks plant, and work will at once be begun.

GLASSBORO, N. J.—The movement to supply Pitman Grove, Glassboro and Clayton with water and electric lights has been abandoned owing to the lack of water power.

CINCINNATI, OHIO.—The city authorities have ordered the local Edison company to carry out the terms of its contract with the city, which, it is asserted, have been violated.

EAST ORANGE, N. J.—Residents of East Orange have decided in favor of incorporation, which means that they will soon contract for an electric lighting and waterworks plant.

KALAMAZOO, MICH.—The City Council has adopted a resolution that a city lighting plant be built at a cost of \$145,000. The city now pays \$15,000 per annum for street lighting.

PORT RICHMOND, S. I., N. Y.—At a meeting of the Board of village Trustees, the question of purchasing the electric lighting plant was brought up again, but no definite action was taken.

WHEELING, W. VA.—The business men of Market street, from 12th to Alley 9, have made arrangements to put in an electric lighting plant for the purpose of supplying stores and offices in that vicinity.

MANKATO, MINN.—The City Recorder has been instructed to call for bids for lighting the city for ten years. If no satisfactory bids are received the Council will take steps to establish an electric lighting plant.

YORKVILLE, PA.—The Council of Yorkville is discussing the proposition of the Edison Electric Light Company, of Pottsville, to furnish electric lighting to Yorkville. Superintendent Halderman, of the Pottsville company, is interested.

WEST NEW BRIGHTON, S. I., N. Y.—Ordinance Officer Eichenberger has reported to the Board of Trustees that the present electric lighting service is most unsatisfactory, but no action has yet been taken officially towards improvements.

HAMPTON, IOWA.—J. M. Hemingway has presented the proposition of the Hampton Electric Light Company to sell their plant to the city for \$13,000, or to light the streets with 15 arc lights for \$75 each per annum. Both proposals were rejected.

CHATHAM, N. Y.—It is rumored that the Chatham electric light plant has not proven a profitable investment for the General Electric Company and that they propose to remove it. In that case, Thomas E. Syernes contemplates putting in a light and power machine at his mill.

THE LITTLE ROCK (ARK.) ELECTRIC LIGHT COMPANY at its recent annual meeting elected the following directors: James A. Fours, R. A. Edgerton and John G. Fletcher. James A. Fours was elected president, Philip Pfeifer treasurer and James T. Pullen secretary and superintendent.

BALTIMORE, MD.—It is now stated that the Baltimore and Ohio Railroad is back of the scheme to operate the Chesapeake and Ohio Canal by electricity. Charles K. Lord, third vice president of the B. & O., is one of the incorporators. It is proposed to haul heavy freight on the canal by trolley.

REEDSBURG, WIS.—At a special meeting of the City Council it was decided to push forward the project of establishing waterworks and the proposed electric light plant. Twenty-five thousand dollars in bonds have been issued. Plans and specifications have been prepared and bids will soon be called for.

NEW YORK, N. Y.—A delegation of New York members at Washington will ask for an appropriation of \$58,000 for improvements in the New York City Postoffice. At present the annual expenditure for gas and electricity is \$42,000, but with a smaller sum it is figured that the government could put in its own plant.

NEWARK, N. J.—The People's Light and Power Company, \$2,000,000 capital stock, has been incorporated to furnish electricity, steam and gas to Newark, Orange, East Orange, Bloomfield, Montclair, Harrison, Kearny and Jersey City. The incorporators are James K. Corbiere, Joseph L. Munn, James E. Reynolds, Elisha B. Gaddis and Thomas A. Nevins.

BRIDGEWATER, MASS.—Howard T. Marshall, of Brockton, Mass., a wealthy retired shoe manufacturer, proposes to supply East Bridgewater with electric lights, the power house to be located in the old Sheldon Mill, where he will locate an engine and a 150-h p boiler. The franchise for setting poles and running wires has been promised Mr. Marshall by Robert O. Harris, the present holder of the franchise.

The Electric Railway.

BRADDOCK, PA.—A charter has been granted to the Braddock and Homestead Street Railway Company.

CHICAGO, ILL.—Prof. J. P. Barret, of Chicago, is in favor of the perfected Love conduit system for use in Chicago.

BORDENTOWN, N. J.—Surveys are being made with a view to locating an electric line between Bordentown and Trenton.

WAVERLY, N. Y.—The Electric Street Railway Company has bought land for the erection of a power house on Cayuta avenue.

SAVANNAH, GA.—The reserve power house and car sheds of the Savannah, Ga., electric railway have been burned; loss, \$50,000.

HAVERSTRAW, N. Y.—There is talk of a trolley line between Haverstraw and West Haverstraw, but nothing definite has been done.

RACINE, WIS.—The street railway company has increased its capital by \$50,000 to defray the cost of an extension to Mount Pleasant and Caledonia.

LIBERTY, MD.—The Liberty "Banner" calls upon residents to take immediate action towards building an electric road from Union Bridge to Liberty.

CHICAGO, ILL.—The Lake Street Elevated Railroad Company, of 1,103 Security Building, will build an electric light plant at 1,331 West Lake street, to cost \$7,000.

BALTIMORE, MD.—Warrants have been issued for the presidents of five street railway systems for violation of a city ordinance requiring the use of car fenders.

HUNTINGTON, L. I., N. Y.—The Oyster Bay "Pilot" has again taken up the agitation for an electric trolley line to connect Oyster Bay, Huntington and Cold Harbor.

CENTRALIA, N. Y.—D. Putnam, of Centralia, is moving in the matter of an electric road from Jamestown to Brocton, but nothing definite has yet been done.

BRIDGETON, N. J.—The Council of Bridgeton has passed on first reading the ordinance granting a franchise to the Bridgeton, Cedarville and Port Norris Electric Railroad.

ALBANY, N. Y.—Assemblyman Gardiner has introduced a bill authorizing the Amsterdam Street Railway Company, of Amsterdam, N. Y., to supply light, heat and power.

YOUNGSTOWN, OHIO.—Some of the contracts for the plant of the Ohio Street Railway Company have been let. Fifteen electric motors will be required. Henry Wick is general manager.

BRISTOL, PA.—After a fight of over a year, the Council has granted a franchise permitting the Bristol, Trenton and Newtown Trolley Railway to lay tracks on many of the streets here.

BUFFALO, N. Y.—W. B. Cutter, of Buffalo, N. Y., has stated to the Buffalo "Express" that the proposed electric line to Depew will likely be built this summer. It could be built for \$75,000.

NEW BRITAIN, CONN.—The Street Committee has reported favorably on the petition of the Central Railway and Electric Company to extend their lines to Berlin, and the report was adopted.

McKEESPORT, PA.—The officials of the Versailles Traction Company are being urged to begin work at once on the proposed extension of their lines to Elrod, in order to give work to the unemployed.

NORWALK, OHIO.—Work on the West Main street extension of the Sandusky, Milan and Norwalk Railway will commence as soon as the weather will permit. S. E. Crawford and W. H. Price, of Norwalk, Ohio, are directors.

SPRING CITY, PA.—The Town Council of Spring City has granted a franchise to the Phoenixville Electric Street Railway Company to run cars through this borough. The road will connect Phoenixville, Valley Forge and Spring City.

MYERSVILLE, MD.—The company recently organized to build an electric road from Myersville to Middletown now contemplate making Brunswick the terminus, and they will soon complete the sale of \$25,000 in bonds to guarantee the building of the road.

DALTON, MASS.—Ben Clow, a prominent resident, proposes to call a meeting of taxpayers about February 1 to take action in the matter of an electric railway for Dalton. He states that \$15,000 can be raised in twenty-four hours for an electric railway to Pittsfield.

BALTIMORE, MD.—The contract for erecting the electrical equipment of the Edmonson avenue and Monument street lines of the Baltimore Traction Company has been awarded to J. G. White & Co., who have built all the other electric lines of the company.

HUMMELSTOWN, PA.—H. O. Koons, Dr. C. H. Smith, J. H. McIlhinney and other prominent citizens of Hummelstown accompanied a committee sent by the East Harrisburg Electric Motor Company to survey a route from the Jonestown road to Hummelstown.

SLATINGTON, PA.—The Slatington Street Railway Company, \$30,000, has been incorporated. The following are the directors: Henry Buttner, John W. Balliett, H. W. Harker, of Slatington, and Morris Hoats, of Allentown. The president is R. W. Mosteller, of Slatington.

JAMAICA, L. I., N. Y.—It is likely that the deal will be consummated for the purchase of the Hempstead and Jamaica Plank Road by the Long Island Traction Company, in which event a road would be built, forming a continuous trolley line from Hempstead to East New York.

BALTIMORE, MD.—A site has been selected at the intersection of Howard, Henrietta and Montgomery streets for a power house for the electric plant, which will supply the motive power which will be used in the Belt tunnel. Plans are being prepared and work will be begun in a few weeks.

PLAINVILLE, NORFOLK COUNTY, MASS.—Thomas Mears, John Kearn, Samuel Parquett and Herbert Britton, of Plainville, and Mr. Collinwood, of Holyoke, Mass., have been appointed a committee to canvass residents in the matter of an electric railway between Holyoke and Plainville.

FLUSHING, L. I., N. Y.—Residents of Flushing will attend a public meeting called by the Highway Commissioners for Feb. 6, in the matter of the application of the Brooklyn City Railroad Company for leave to build and operate a double-track electrical railway between the towns of Newtown and Flushing.

LEWISTON, N. Y.—The Lewiston and Youngstown Electric Railway Company will apply for right of way through the streets of the village, which will undoubtedly be granted, and they will light a portion of the streets free of charge. The capital stock is \$75,000, and it is expected to have the road in running order by July 1.

BENWOOD, W. VA.—The preliminary survey for the proposed Benwood-Moundsville Electric Street Railway has been completed by Surveyor C. C. Smith, and the Benwood authorities have granted the right to lay double tracks from Fourth street to the town limits, provided an electric light is allowed to be placed on every pole.

HARTFORD, CONN.—The Hartford and West Hartford Railway Company has asked for permission to build and equip and operate by electricity a street line entering the city by way of New Park avenue. The Hartford Street Railway Company has also asked permission to extend its lines and change its motive power to electricity.

MOUNT HOLLY, N. J.—The Burlington County Electric Company, capital stock \$125,000, has been organized to operate a trolley road between Burlington and Mount Holly. The incorporators are Jacob F. Burrows, James L. Greir and William B. Esler, of Philadelphia, Pa.; S. H. Morison, of Camden, N. J., and Robert B. Esper, Jr., of Ardmore, Pa.

BALTIMORE, MD.—A bill is being prepared for introduction at Annapolis for the incorporation of the Baltimore and Anne Arundel Street Electric Railway Company, \$50,000 capital, with permission to increase to \$500,000, and with permission to use electricity or any other motive power in use on railway lines. The upper terminus of the lines will be at Laurel, in Prince George county, Md.

FREDERICK, MD.—The bill to incorporate the proposed Frederick and Middletown electric road has been introduced by Senator Newman at Annapolis, Md. The capital is \$100,000, and the incorporators named are Peter W. Shafer, Thomas H. Haller, Dr. Upton A. Sharretts and Charles V. S. Levy. It is stated on good authority that capitalists have taken hold and will push the project.

WEST ORANGE, N. J.—Residents of West Orange are up in arms against the proposed extension of the system of the Consolidated Traction Company to the foot of Eagle Rock, where it is proposed to connect it with an elevator to be built for the purpose of carrying visitors to the Summit Hotel, at the summit of the Rock. Thomas H. Nevins, of Centre street, Orange, is at the head of the project.

WHITE PLAINS, N. Y.—Owing to the absence of members of the Board of Trustees, the special committee were not allowed to read their reports in the matter of the franchises asked for by the New York, Mamaroneck and White Plains Railroad Company and the New York, Elmsford, and White Plains Railroad Company for trolley lines. Unless President Husted calls a special session, there will be no meeting until Feb. 5.

MARTINSBURG, BLAIR COUNTY, PA.—The Martinsburg correspondent of the Altoona "Tribune" states: "It is now an assured fact that Morrison's Cove is to have rapid transit and a trolley line, which, beginning at Hopewell, in Bedford county, and terminating at Roaring Spring, in Blair county, will be built in the near future. The road will have two branches, one extending from the stone house to Enterprise, and another from Woodbury to Curryville. The title of the company will be the Morrison's Cove Electric Railway."

WASHINGTON, D. C.—All future incorporators of street railways in the District of Columbia, in the preparation of their charter, will have to conform to certain prescribed regulations laid down in a model bill just prepared by the Commissioners of the District. The feature about this measure that is of most interest to electrical readers lies in the fact that all future electric railways established there must furnish and maintain such electric lights along their lines as the authorities may direct, without cost to the District government, but no overhead wires shall be constructed or used within the limits of the city of Washington.

Legal Notes.

STATE PRIVILEGE TAX ON TELEGRAPH COMPANY.—A State privilege tax of a certain sum per mile of wires operated within the State, imposed on all telegraph companies therein operating in lieu of all other State, county and municipal taxes, and amounting to much less than the sum of a single ad valorem property tax, is not an interference with the interstate commerce of a foreign corporation. (*Postal Telegraph Cable Co. v. Adams*, Supreme Court of Mich., 14 S. Rep., 36.)

RIGHT OF ELECTRIC RAILWAY COMPANY TO REPAIR TRACK.—An order restraining a railway company, pending a suit, from entering on a road for the purpose of constructing an electric railway track, or incumbrance of any kind upon said road, or in any way preparing to lay such track, is not violated by operating and repairing a track theretofore built and used, the temporary removal of which has been required by the paving of a street. (*Detroit and B. Plank Road Company v. Detroit Citizens' Street Railway Company*, Supreme Court of Mich., 55 N. W. Rep., 549.)

Personal.

MR. WILLIAM MERTENS, president of the Cataract General Electric Company, is a member



of the foreign banking house in New York of L. von Hoffman & Co., which is well-known throughout Europe and America as one of the oldest and leading financial institutions. Mr. Mertens was born in Germany, and came to this country at an early age, after securing a liberal education at home. While still in his youth he entered the service of the banking house mentioned as foreign correspondence clerk, from which position he has been promoted, step by step, until he is now the head of the institution in this country in the absence of Baron von Hoffman. He is a man of middle age, of a commanding presence, and is regarded as one of the most conservative, yet energetic financiers in New York. He is found upon most of the leading reorganization committees, and his judgment upon all matters of finance and railroad management is eagerly sought by the most prominent operators. Mr. Mertens is greatly interested in the electrical development of Niagara, and devotes a considerable part of his time to the preliminary steps incident to the establishment of the great business which will follow the completion of the transmission line through the State.

MR. FRANK W. HAWLEY, vice president of the Cataract General Electric Company, is just 35 years of age, and but a few years ago was a poor boy in Rochester working 18 hours a day in order to conquer adverse circumstances. He was accustomed to rise at a very early hour, take care of horses and a furnace, and to do other work around the house, all of which was remunerated by his board. At 9 o'clock he entered a law office, where he was employed as clerk and where he studied law when his office duties would permit. In the early evening Mr. Hawley began his duties in connection with one of the Rochester newspapers, sitting at his desk or reporting in the evening until midnight, then turning in for a few hours' sleep. The capacity for such labor after a few years brought appreciation and with it responsible posts, in which he revealed executive qualities of the highest order. This victory, however, was secured at a very great price; the work had produced paralysis of the optic nerve of one eye, and a sympathetic trouble with the other, so that it has cost him partial blindness. Mr. Hawley owns the former country place of the late ex-Senator Jarvis Lord, from which, with a great herd of Jerseys, he supplies butter to various New York hotels, and in his herd possesses some of the most famous Jerseys living. On Sunday or Monday nights he is in a sleeping car, at his place of business in New York City the following morning, and on Friday night is again on a sleeper, on his way to the stock farm. In New York he associates with those who expect to solve the problem of the development of electricity at Niagara, as well as towing or propulsive force for boats upon



canals. It was he who recently conceived and demonstrated the feasibility of electricity for such purposes, as noted in our columns.

CHARLTON T. LEWIS, secretary and treasurer of the Cataract



General Electric Company, is a Pennsylvanian by birth, son of the late Joseph J. Lewis, who was Commissioner of Internal Revenue under Mr. Lincoln, and grandson of Enoch Lewis, the famous Quaker mathematician and author. Mr. Lewis was educated at Yale College, where he was graduated in 1853 in an unusually brilliant class, which included Wayne Macveagh, Senator Randall Gibson, Andrew D. White, Edmund C. Stedman, and many other men of note. He was Deputy Commissioner of Internal Revenue in 1863 and 1864, and came from Washington to New York to practice law. He has continued active in the profession for nearly thirty years, but after a serious interruption of work in 1867 by ill health, took

to editorial work for a while, and conducted "The Evening Post" for nine years, under the general editorship of William Cullen Bryant. Since his return to active work at the bar, he has found leisure to publish a number of works, among them a notable "History of Germany," and three widely used Latin dictionaries. At the New York bar, as a corporation lawyer, Mr. Lewis admittedly stands alone. His cloutage in wealth and influence is probably greater than that of any other lawyer in the United States. Mr. Lewis' connection with electrical enterprises is supposed to have begun with the organization of the International Bell Telephone Company, about 1880, of which he has been a director, general counsel and chairman of the executive committee for many years. He was also one of the founders and directors of the Thomson International Electric Welding Company, and has given long and careful study to the practical problems arising in the application of electricity to the useful arts, and expresses strong confidence in the future utilization, by transmitted and stored electric force, of most important sources of power now unused.

Miscellaneous Notes.

THE CLEVELAND (OHIO) SCHOOL FOR CORRESPONDENCE was visited by the delegates of the Ohio Society of Civil Engineers and Surveyors on Jan. 17, who found much of interest in this new system of technical teaching.

LEHIGH UNIVERSITY.—Some changes have been made in the school of engineering. The subjects of alternating currents and surveying have been introduced in the junior year in place of machine design, which has been put into the sophomore year.

A SINGULAR ACCIDENT.—The ohm sister of one of the large dynamos at the Wood Harvester Works became detached Thursday, thereby causing the ohms and volts to pass over the same wire. Had it not been for the presence of mind of Mr. King, the company's electrician, the automatic ampere controller would have been disabled.—Hazel Park, Minn., Times.

THE NEW ELECTRICAL LABORATORY AT PURDUE UNIVERSITY was dedicated with appropriate ceremonies on Friday, Jan. 19. This building was splendidly equipped for engineering work, and one of the finest in the country. On Tuesday, Jan. 23, the building caught fire and in less than an hour was all in flames. Practically nothing was saved but the instruments of the civil engineering department and the west wing of the building. The new laboratory represented a value of \$100,000 in the building itself and \$80,000 in equipment, on which there was a total insurance of \$45,500.

THE MAGNETIC CLUB held its winter meeting and banquet at Jaeger's, corner 59th street, New York, on Jan. 18. Speeches were made by President Cockey, William J. Dealy, Robert F. Straine, Theodore L. Culyer, Jr., Walter C. Burton, Francis W. Jones, and an otherwise interesting programme of entertainment, humor, songs, etc., was enjoyed. At the annual business meeting of this popular club on Jan. 11 the following officers were elected: Edward C. Cockey, president; William H. Baker, first vice president; John Brant, second vice president; Thomas E. Fleming, third vice president; George H. Usher, fourth vice president; George F. Fagan, secretary; W. C. Burton, treasurer.

Trade and Industrial Notes

LACONIA, N. H.—The Laconia Car Company announces its intention of engaging extensively in the business of manufacturing cars.

THE KEYSTONE ELECTRIC COMPANY, of Erie, Pa., will equip the extensive Brodhead woolen mills at Jamestown with motors and dynamos.

THE DELAWARE ELECTRIC AND SUPPLY COMPANY, Wilmington, Del., has just shipped an 80-h. p. boiler to Florida, and a 50-h. p. boiler to Washington, D. C.

F. A. CULIN & SONS, electrical contractors, 809 Provident Building, Philadelphia, are distributing among their friends and patrons a particularly neat calendar.

MR. DAVID CHALMERS, manager for S. H. Milbank, 67 Cortlandt street, New York, receiver of the A. B. & C. Co., is fast closing out the remainder of the stock of the late company.

I. W. NESS & CO., Montreal, Can., have issued a catalogue (No. 7) devoted to telephones, in which are described their main line, warehouse and automatic telephones, switchboards, and various telephone supplies.

JULIUS ANDRAE, 225 West Water street, Milwaukee, Wis., was burned out on the 13th inst., with a loss of \$12,000, which is covered by insurance. Temporary quarters have been secured adjoining the former ones.

CHAS. A. SCHIEREN & CO., 47 Ferry street, New York, have issued a new catalogue of their perforated electric leather belting, which, among other interesting information, contains a list of some of the unusually large belts that this firm has made.

MR. McLEOD, of McLeod, Ward & Co., 91 Liberty street, New York, reports the demand for the Kinsman Desk Lamp steadily increasing. Mr. McLeod is about to place upon the market a portable desk lamp, which he claims is far superior to any similar desk lamp now in use.

THE SHULTZ BELTING COMPANY, of St. Louis, Mo., has just received an order from England for 2,800 feet of belting, and an order from Russia for 15,000 feet of belting. It also reports that trade is looking up and orders are coming in freely, and that the outlook for business is fair.

BARTLETT & CUSHMAN, Concord, N. H., proprietors of the Granite State Electric and Machine Company, exhibited at their office, 31 South Main street, Thursday afternoon, Jan. 18, a new triphase motor manufactured for Messrs. Silsby & Son, and soon to be installed in their printing office.

MR. A. L. ELLIS, manager of the Snow Steam Pump Works, Buffalo, N. Y., reports that his company has not in any way experienced the "dull times" complained of by so many; on the contrary, the works have been constantly run to their full capacity, and a large annex, just completed, was built to better facilitate the prompt manufacture of this company's product.

THE ELECTRIC ENGINEERING AND SUPPLY COMPANY, of Syracuse, N. Y., reports an exceedingly lively time in special work, as its switchboard and large station switch department is particularly active in that line of work, although the lines in staple goods are reported comparatively dull. Many large and handsome switchboards have been recently turned out of its works, which do much credit to the high quality of work which this company is turning out.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., has received the contract for an iron roof for the boiler and engine room of De Land & Co., at Fairport, N. Y. The roof will be covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron. The new mill of the Diamond Mills Paper Company, Millbank, N. J., is being put in place by the same company, which has also received an order for an iron roof from the Citizens' Gas Company, of Brooklyn, for their new produce house.

THE ELECTRIC APPLIANCE COMPANY was well represented at the Milwaukee Convention of the Northwestern Electric Light Association by its president, William W. Low, and by Mr. Frank McMaster with samples of its leading specialties. The "Finest of the Wheat," a special circular for the convention, setting forth the merits of the Standard Push Switch, Washington Arc Lamp, Packard Mogul Lamp and Packard Transformer, attracted considerable attention, and was favorably received by the many station managers present.

MR. W. H. McKINLOCK, president of the Metropolitan Electric Company, Chicago, Ill., was in town last week, and left for the West Saturday. During his stay in New York Mr. McKinlock secured the Western agency for the sale of the P. & B. insulating compounds, manufactured by the Standard Paint Company, New York, and will hereafter keep a large amount of this company's

specialties in stock. Mr. McKinlock, who is also the Western agent for the sale of "N. I. R." wires and cables, reports large sales of the Metropolitan Incandescent lamp.

THE JOSEPH DIXON CRUCIBLE COMPANY, of Jersey City, about a year ago issued a pamphlet on lubricating graphite. It embodied an elaborate scientific opinion by Prof. R. H. Thurston on the value of graphite as a lubricant, and much interesting information on the subject from practical men. The pamphlet has had a large circulation, and the company has been enabled to obtain from well-known men a vast amount of additional knowledge on the uses of graphite. Another pamphlet, twice the size of the former, will be issued early in February.

QUEEN & CO., INC., Philadelphia, are about to bring out a line of standard voltmeters on the "hot-wire" plan, made under the fundamental "Cardew" and other more recent patents. These instruments prove extremely accurate for both direct and alternating circuits, which is confirmed by an award received at the World's Fair for "success attained in overcoming the defects of the ordinary hot-wire instrument, viz., lack of great range through which the instrument is sensitive, great correction due to change of temperature and inconstancy of zero point, and also for its compactness, portability and excellence of mechanical construction."

MR. FRANK S. DE RONDE, general sales agent of the Standard Paint Company, 2 Liberty street, New York, says that during the past year his company has sold more P. & B. insulating material than any preceding year. There is hardly a place in the country where insulating compounds are required but what you will find P. & B. Mr. De Ronde has lately made arrangements with Mr. William H. McKinlock, president of the Metropolitan Electric Company, Chicago, to act as Western agent, and Messrs. Pettengell-Andrews Company, of Boston, to act as New England agents. The specialties manufactured by the Standard Paint Company placed in the hands of two so well-known companies as the above, should increase the large and growing demand for the P. & B. insulating compounds.

THE LA ROCHE ELECTRICAL WORKS, of Philadelphia, Pa., put in the following installations during the month of December: Robert H. Forderer, Frankfort, Philadelphia, 1,500-light machine; Duncan, Hood & Co., Philadelphia, 400-light machine; Thomas Devlin, Philadelphia, 500; Allegheny Woolen Mills, Philadelphia, 300; Emery Hotel, Philadelphia, 300; Westborough Electric Light and Power Company, 1,000; Boloxi Electric Light and Power Company, 1,000; Quincy Electric Light and Power Company, Mass., 1,300; Yale College, laboratory apparatus; also motors aggregating 150 h. p. The company has also booked orders for January aggregating 8,000 lights and motors, amounting to 73 h. p., and is running day and night with double facilities in order to comply with the increasing demand for its lighting machines.

THE GENERAL ELECTRIC COMPANY has secured a large slice of the street railway car equipment contracts awarded during the last ten days in Philadelphia. Of 250 contracted for by the People's Traction Company, 125 equipments with the G. E. 800 motors and type K controllers were purchased from the General Electric Company, while the remaining 125 were allotted to the Sperry Company, of Cleveland. Of 80 equipments required by the Electric Traction Company, of Philadelphia, 70 will be furnished by the General Electric Company. The People's Traction Company had already contracted for three of the great 1,500 k. w. General Electric generators. It has also secured contracts during the past week covering 20 car equipments for the Union Railroad Company, of New York; 25 car equipments for the Steinway Railroad, of Long Island; one 700-h. p. generator for the Steinway Railroad, of Long Island; eight 300-k. w. generators for Cincinnati, and 10 car equipments for the St. Louis Street Railway, of St. Louis.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED JAN. 16, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

512,711. RAIL BOND FOR ELECTRIC RAILWAYS; H. R. Keithley, Chicago, Ill. Application filed Feb. 27, 1893. This comprises a bond rod or wire having tubular or thimble-shaped ends and secured to the rails by having its ends swaged into holes in the rails by means of a pin.

512,723. ELECTRIC INHALER; R. L. Larcom, Fandon, Ill. Application filed Sept. 29, 1893. This consists of a casing, tubes and

syringe bulb connected thereto, a slide fitting in the casing, a battery carried by the slide, and sponges connected to the terminals of the battery circuit.

512,744. ELECTRIC SWITCH; E. P. Warner, Chicago, Ill. Application filed Dec. 1, 1891. This comprises two pair of contact plates, and a switch-block sliding between the members of the pair to make contact therewith, the sliding block being provided with a handle.

512,754. RAILROAD SIGNAL; C. Selden, Baltimore, Md. Application filed Feb. 1, 1893. The combination with a stop-wheel

and connection rod of a semaphore, of a yielding tooth for permitting the stop to pass the connection rod freely in one direction.

512,757. PROCESS OF MAKING SECONDARY BATTERY PLATES; W. L. Silvey, Dayton, Ohio. Application filed Sept. 12, 1892. This consists in immersing anodes of lead alloy and cathodes of lead in a solution of ammonia and an acid and then disintegrating the anodes by an electric current and electrically depositing the parts thus decomposed in holes in the cathode.

512,769. MACHINE FOR WINDING ELECTROMAGNETS; R. Varley, Jr., Englewood, N. J. Application filed April 12, 1893. This comprises a turning head for rotating a bobbin, and a frame provided with guides through which the strands pass to the bobbin, the guides being placed in a plane transverse to the axis of the bobbin.

512,797. ELECTRIC HEATER; W. J. Bowen, Norwalk, Ohio. Application filed April 14, 1893. This comprises a series of vertical air tubes, each provided with an insulating jacket, a heating coil around the jacket of each tube having its terminals confined by clamps, to which are fastened insular blocks and conductors.

512,805. SWITCHBOARD; W. A. Childs, Englewood, N. J. Application filed Oct. 25, 1893. In an electric switchboard, a flexible cord conductor, both ends of which terminate in a block forming a part of the face of the board, the block being held in place by friction. (See illustration.)

512,820. MOTOR GENERATOR; J. C. Henry, Westfield, N. J. Application filed April 29, 1892. The combination of field magnets, two armatures carried by a single shaft and a single support for the shaft between the armatures.

512,821. CEILING FAN MOTOR; W. Hochhausen, Brooklyn, N. Y. Application filed Sept. 4, 1891. This comprises a supporting head, field magnet cores bolted thereto, a journal-bearing cap, closely fitted at its periphery to the field magnet, and an armature having its vertical bearing on the cap.

512,823. SECONDARY BATTERY; A. Hough, San Francisco. Application filed Sept. 14, 1893. The method of constructing active material consisting in mixing monoxide of lead, sulphate of ammonia and sulphate of magnesia, and when mixed decomposing the sulphate of ammonia and dissolving the sulphate of magnesia.

512,843. DYNAMO-ELECTRIC MACHINE; H. S. Rodgers, Hartford, Conn. Application filed Jan. 31, 1893. A dynamo provided with field magnet cores having pole tips or horns formed integral with the body of the cores and lying within planes bounding the external surface of the cores.

512,853. COMMUTATOR AND CONNECTION FOR DYNAMOS; G. Wilkes, Detroit, Mich. Application filed Oct. 2, 1893. In a dynamo, a cross-connection for the commutator consisting of an arm, provided with a slitted projection, and an elastic strip provided with a bent tip at one end and a straight tip at the other.

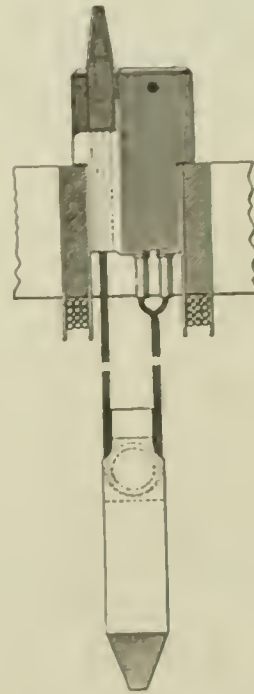
512,872. SEXTUPLEX TELEGRAPH; T. A. Edison, Menlo Park, N. J. In a multiplex telegraph, differential relay magnets in the

tem of distribution for electric railways consisting of a main circuit including in multiple arc two or more independent sets of batteries, a working circuit and means for automatically switching the sets of batteries bodily and individually from one circuit to the other. (See illustration.)

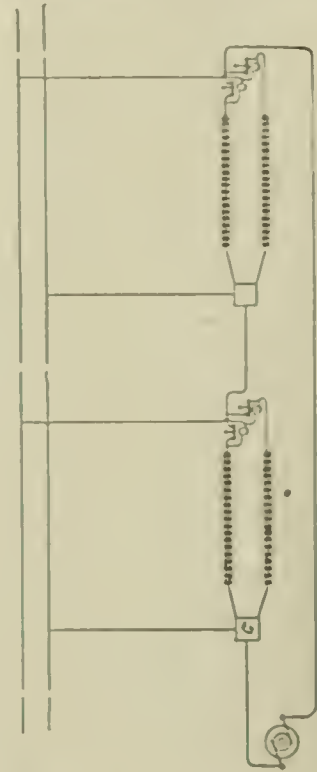
512,923. ELECTRIC RAILWAY TROLLEY; W. Van Benthuyssen, New Orleans, La. Application filed March 24, 1893. This comprises a pair of conical trolley wheels mounted in a swinging frame and oppositely arranged with respect to each other.

512,962. EXCITANT FOR VOLTAIC CELLS; G. Hewett, New York, N. Y. Application filed April 3, 1893. This consists of sulphuric acid, sulphate of soda and bisulphate of mercury prepared in a dry state.

513,006. CONTINUOUS CURRENT DISTRIBUTING SYSTEM; M. Von Dollivo-Dobrowolsky, Berlin, Germany. Application filed Nov. 24, 1893. In a system for distributing electricity to two series connected groups of consuming apparatus by the aid of two main conductors and a compensating conductor, the combi-



No. 512,805.
SWITCHBOARD.



No. 512,907.—BATTERY SYSTEM
FOR ELECTRIC RAILWAYS.

nation with the compensating conductor and a continuous current dynamo connected with the mains of a coil of high self-induction connected at both ends with diametrically opposed points of the armature winding of the dynamo, and in its centre with the compensating conductor. (See illustration.)

513,023. ELECTRIC RAILWAY TROLLEY; G. W. Mackenzie, Beaver, Pa. Application filed April 5, 1893. A trolley having independent rollers with inclined downwardly converging surfaces.

513,052. ELECTRIC SEARCH LIGHT; C. E. Ongley, New York, N. Y. Application filed Aug. 22, 1893. Means for supporting and adjusting a search light, consisting of a base upon which is seated and pivoted to move horizontally a bracket having two arms between which is pivoted to move vertically a reflector, the horizontal movement being controlled by a shaft passing through the base, and the vertical movement by a bar passing through the shaft and bearing upon the reflector at an eccentric to its pivotal point.

513,062. AUTOMATIC REGULATOR FOR DYNAMO-ELECTRIC MACHINES; W. A. Sperry, Cleveland, Ohio, and G. E. Mills, Ravenswood, Ill. Application filed April 25, 1892. In an electric machine, rotating magnet coils and frame constituting the field of the machine, a rotator therefor, a revolving part carrying the armature, and a connection from the revolving armature or part to the rotator.

513,065. AUTOMATIC ELECTROMAGNETIC SWITCH; H. P. White, Philadelphia, Pa. Application filed Sept. 25, 1893. The combination of a switch plate and its resistances, a swinging switch arm having an armature, a magnet mounted to rotate in proximity to the armature, and worm-gearing for rotating the magnet.

PATENTS EXPIRED JAN. 23, 1894.

186,453. ELECTROMAGNETIC TELEGRAPH APPARATUS; Robert K. Boyle, New York, N. Y.

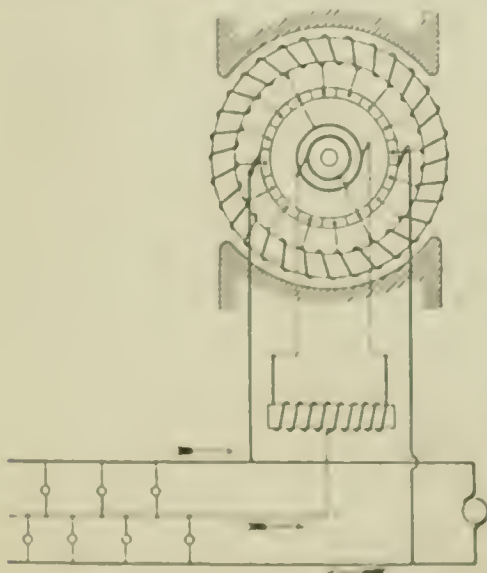
186,476. ELECTRIC TRAIN SIGNALS, L. L. Ferris, New York, N. Y.

186,548. TELEGRAPHIC ALARM AND SIGNAL APPARATUS, T. A. Edison, Menlo Park, N. J.

186,553. ELECTRIC THERMOSTATS; E. J. Frost, Philadelphia, Pa.

186,572. ELECTRIC RAILROAD SIGNALS; J. D. Hughson, Prairie City, Ill.

186,642. ELECTRIC MOTORS; D. Ward, Binghamton, N. Y.



No. 513,006.—CONTINUOUS CURRENT DISTRIBUTING SYSTEM.

respective circuits in combination with shunt connections in the respective circuits around the relay magnets and condensers of equal or nearly equal electrostatic capacity in the respective shunts.

512,880. ELECTRIC ARC LAMP; C. J. Hartley, Decatur, Ill. Application filed March 31, 1893. The combination of a spool having a derived circuit wire, a clutch carrying core controlled by and movable in the upper end of the spool, and a core adjustable in the lower end of the spool by means of a set-screw.

512,888. TROLLEY WIRE INSULATOR; H. H. Luscomb, Hartford, Conn. Application filed Oct. 18, 1893. This comprises a case and an insulated connection within the same, a cap within the case having recesses therein, and projections on the case, which are bent over the cap and received in the recesses therein.

512,907. BATTERY SYSTEM FOR ELECTRIC RAILWAYS; L. B. Rowley, Ashland, Wis. Application filed Feb. 15, 1893. The sys-

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AN IMPORTANT PATENT CASE.

What is perhaps one of the most important patent cases, as far as relates to the principle concerned, that has been brought before the courts in recent years is on the calendar of the United States Circuit Court of Appeals, now in session in New York, although the case may not be reached until the March session. The principle is whether in applying to a domestic patent the limitation as to its life through the expiration of a foreign patent, the date of application for the foreign patent shall prevail or the date of its actual issue. During the last ten years there has been a number of decisions on the point by the lower Federal courts, and all maintain that the actual date when the patent was issued should apply, but this is the first time it has been brought before a higher court. A reversal of these decisions would have an enormous importance in every branch of industry, and, among other electrical patents, would extend the life of the Edison microphone and incandescent lamp patents, the latter to 1897.

PRACTICAL EXPEDIENTS.

One of the qualities most conducive to success in practical work is that of devising expedients for accomplishing purposes that otherwise would be left undone through the lack of the usual material or instruments. The article by Mr. Hanchett in another column is devoted to this subject, and in it many practical hints will be found that may come in very usefully when most needed. Aside from the direct value of never being at a loss in devising means for attaining an end, there is an indirect value from the effect that such a quality has in increasing consideration for a person's professional qualities among those upon whose good opinion professional success may depend. Where they might not be able to judge as to qualities of much higher value, this, on the contrary, is one that comes within their scope, and for which they are likely to give undue credit, but none the less advantageous. The head of a great engineering school in his address to graduating students always took occasion to impress strongly on their mind the great truth of a saying to the effect that success in life depended not so much upon what one knows as upon what one is thought to know, and, it may be added, the man fertile of expedients is most likely to get most credit for professional knowledge and at the same time is most likely through this quality to really achieve his ends.

THE NOVAK LAMP CASE

While the recent argument in the Novak lamp case before the United States Circuit Court of Appeals contains little that was not brought out on the previous trial, several of the points are enlarged on, and one of the contentions of the Edison attorney—that the expulsion of occluded gases was not a vital part of the Edison patent—received an emphatic denial from Judge Lacombe. Another point of interest which the counsel have made an issue is whether the use of a carbon filament is an invention covered by the Edison patent. The defense claims that there is no patentable novelty in any separate part of the combination upon which the Edison lamp patent rests, and that Edison never ventured to claim the carbon filament, uncombined with other things, as his invention; that he had disclosed the filament principle in his French platinum lamp patent, and that on account of the prior use of carbon in incandescent lamps there could

therefore be no invention in a carbon filament. While the complainants admit, and this seems to be significant, that the employment of an inert gas will reduce blackening of the chamber, they claim that this has long been known, and not only deny that any other benefit accrues from the use of bromine gas, but assert that the efficiency and life of the Novak lamp is reduced, and to such an extent as to more than nullify the benefit derived from less blackening. The Novak counsel, on the other hand, contend that there is great improvement in the two latter respects, as shown by the testimony of their experts and the experience of the public, who, moreover, have been paying a higher price for the Novak lamp on this account. They claim that the bromine atmosphere is not a mere addition to Edison's "nearly perfect vacuum," which means and intends the exclusion of all the gases, not only oxygen and nitrogen, which make up atmospheric air, but other gases as well. While up to a certain point both Edison and Waring proceed together in the exercise of a prior art, they there separate, Edison adding a genuine vacuum and Waring an inert gas. The one diminishes the gaseous contents from 1-600 of an atmosphere to at least 1-30,000, while the other adds to the gaseous contents of the chambers until they weigh four times what they did before. The question of the expiration of the Edison patent through that of the English patent, on Nov. 10, 1893, is brought up, but as this point as here made has been frequently decided in the negative, that part of the argument seems to have little importance. On the other hand, the point recently decided by Judge Ricks—that by the endorsement of the Edison attorneys of the above date on the patent, it was dedicated to the public after that endorsement—is one of extreme importance, and the view the court will take of it will be awaited with the greatest of interest.

THE ELECTRIC IMPOSTOR.

It might be said that not the least important progress in the electrical field has been the more rapid decline of the electric impostor. But although the number of impostors and the mischief they do is growing less every year, the electrical industry cannot yet congratulate itself on being free from this annoying and injurious parasite. He still turns up every now and then in one form or another, and after fleecing numerous widows of their mites, children of their inheritances and uneducated capitalists of the money which they do not know how to guard, he retires with his easily earned gains, priding himself on his skill as an unscrupulous rascal. We have little sympathy for men and women who encourage such an impostor by subscribing to his worthless stock, but even if they cannot be convinced of their mistake by people who have a real knowledge of the subject, they will do well at least to read over more carefully some of his claims. He usually claims to be "ahead of his time," and as examples of similarly "unfortunate" men, he cites some who made really great inventions which in those early times were pronounced by some to be impossibilities. This favorite claim often has the desired effect on the ignorant and sceptical, but if they will look into those historical cases they will usually find that the knowledge of that time was not sufficient to enable one to really prove the impossibility of those inventions. Before the first steamboat was built there was no knowledge in existence regarding steamboats, and although it may have been said at that time that such a thing was an impossibility, yet it cannot have been anything but a mere opinion. However much there may be yet unknown in the electric science, there are some things which are known definitely and are beyond question, having been proven beyond a doubt; that any such knowledge will ever be revolutionized completely is as absurd as to claim that two and two are not four, and any one who makes such claims is nothing less than a self-exposed impostor. Those who are

anxious to assist such claimants with their money should first find out whether he intends to revolutionize our real scientific knowledge or only our suppositions and beliefs; if the former, they will do better to give their money to the deserving poor. Many of the usual impostor's claims are more like those of a man who claims that the earth is flat or that it did not move, contrary to knowledge about which there is no longer the shadow of a doubt. If he were to claim that our suppositions about the constitution of the interior of the earth were wrong, he might deserve some respect.

FARADAY, MAXWELL AND HERTZ.

In another column we commence the publication of a paper by Prof. Pupin, of Columbia College, which will be found both of remarkable interest and unusual value, on the new conceptions introduced and developed in science by Faraday, Maxwell, Hertz and their school. Although glimpses of the philosophical ideas and methods there treated may be found in the writings of some of the sages of antiquity and had begun to take form several centuries ago, it is shown that their important consequences were first developed by the great mind of Faraday and by his no less wonderful experimental methods. The part of Maxwell in recognizing the full importance of Faraday's work, and the use he made of it, and, finally, the experimental demonstration by Hertz of the truth of what otherwise would have remained merely hypotheses, all of this forms a story of intense interest, and the admirable manner in which Prof. Pupin narrates it is in keeping with the loftiness of the subject, while his special competence to treat the ideas of this new school follows from the fact that he is one of its most competent representatives. The review of the subject brings out the transcendent value of the physical as opposed to the mathematical method of investigation; for, although Maxwell made use entirely of mathematics, yet he drew upon the stores of experimental data of Faraday as from nature, and his treatment was that of the physical mathematician, if we can use the expression, rather than of the mathematical physicist in its accepted sense. As the categories of Aristotle were accepted through long ages as the expression of all knowledge, and the labors of the learned were merely devoted to deducing new consequences, so the mathematical physicist is apt to merely accept facts in order to submit them to his mathematical processes, regardless of the immense physical meaning there may be behind them—his mathematical mechanism being of more importance than the physical mechanism with which the former is incompetent to deal at first hand. When dealing with continuous currents the theories of this school seemed to have only an indirect interest, but with the alternating current it is different, and with high frequencies they alone will give an insight of the phenomena involved. It will not be long before the electrician who wishes to maintain his standing will have to be as well acquainted with the modern developments of the Faraday-Maxwell theories as he had previously become with the older electrical ideas. As an introduction to these modern theories and as a broad discussion of their basis and significance the paper we print is therefore a most timely contribution, and one which none of our readers should fail to study.

Professors and Consulting Engineers.

In a discussion in the foreign journals regarding the advisability or inadvisability of the placing of the Niagara plant in the hands of a professor, one of the professors taking part in the discussion said that he thinks that a man who has gone through the mill must of necessity have become a practical engineer in the process. To this another correspondent replied that perhaps the professor had forgotten that there is more than one shoot in a mill, and that the products, such as flour and bran, for instances, differ widely in quality.

The Novak Lamp Case.

The arguments in the United States Circuit Court of Appeals for the second circuit in the Novak lamp case were heard in New York on Jan. 30, and it is thought that the decision of the court will be handed down about March 1.

The complainants in their arguments maintained that the single important question in the case is whether or not the defendants evade the Edison patent by making a lamp in all respects like those which have been uniformly held to infringe the Edison patent, except that, while exhausting the air from the enclosing chamber to an extreme degree, they introduce into the chamber a minute trace of bromine vapor. As to the presence of the bromine gas being an advantage or a disadvantage, the advantages or disadvantages are trivial and superimposed upon the entire Edison invention, which is present in its full extent. It was claimed that the courts had decided that it was an invention to originate the filament, and that what the courts meant by a high vacuum was one that would avoid the evils of both combustion and air washing, and that a vacuum of 1-30,000 of an atmosphere is now sufficient on account of the harder filament used than when Edison specified the higher vacuum. It was asserted that the use of bromine gas was not a novelty and no benefit to the lamp; that the use of inert gases was well known before Waring's alleged invention, as well as their prevention of blackening, and that the alleged saving in exhausting is a trivial matter.

In the oral argument the complainant's counsel stated that driving out occluded gases had nothing to do with the Edison patent, when he was interrupted by Judge Lacombe, who said very emphatically that it was a part of the Edison patent, and that, after the delivery of his opinion in the Edison case, when he had read a similar claim in the newspapers to that just made, he had called the counsel together and specially instructed them on this point.

The argument further claimed that while, as was known long ago, an inert gas does prevent blacking, it does not prolong the life of the lamp, but reduces it. The point of law was cited that the courts look with disfavor on attempts to evade a patent by those who deliberately adopt the substance of an invention and endeavor to conceal the infringement by a plausible but formal change, and that in the present case the defendants are successor to a company previously enjoined from infringing the Edison patent and have resorted to the use of bromine gas as an evasion. Also the points that he who uses the invention of another is an infringer, even though he may make a patentable improvement upon the original invention; that the degree of vacuum required by the Edison lamp must be determined by its function and purpose, and that the addition of a useless or inert element to a machine has never relieved the defendant of the charge of infringement. The complainants also claimed that the defendants had not made the full disclosure of details or a consistent explanation of seeming divergencies from the methods which they profess to employ. As to the point in reference to the expiration of the Edison American with the English Edison patent, it was submitted that the law is clear and fully settled in regard to the date of sealing and not the active date of the patent being the determining one. Regarding Judge Ricks' decision, it is claimed that the English patent neither in fact nor law had any effect upon the term of the Edison patent; that the action of the parties and the Commissioner of Patents in attaching the certificate of correction was void and of no effect; that there was no dedication to the public, because there was no intention to dedicate, and if there was it related only to a period after Nov. 10, 1893, before which period it was revoked; that no estoppel could arise, as the reference to the date of the English patent was a clear mistake, and equally within the

knowledge of both of the parties; and that the whole transaction was simply an endeavor to bring the patent under section 4,087 of the Revised Statutes, and not a dedication. A final plea is made based upon the great expenses incurred by the complainants and their licensees and the short life left to the patent, which expires in November, 1894, or January, 1897.

The defendants, in their argument, claimed that according to the decisions of courts there was no patentable novelty in any of the separate elements of the Edison lamp. That an all-glass receiver, conductors passing through glass and a nearly perfect vacuum were not patentable; that the prior disclosure of a platinum filament in the French Edison patent rendered a filament unpatentable, and as carbon had previously been used, a carbon filament could not be patented nor a high resistance in a filament. The elementary rule was cited that inventors of a combination cannot suppress subsequent improvements substantially different, whether a new combination of the same ingredients or a substitution of a newly discovered ingredient, or of some old one performing some new function not previously known as a proper substitute. It was claimed that a nearly perfect vacuum is a necessary element of the Edison patent, and that such a vacuum cannot be produced by a mechanical air pump, such as used by defendants. The Edison "nearly perfect vacuum" means "an empty space" and the exclusion of all gaseous contents from the lamp chamber, including oxygen and nitrogen and other gases as well, and gases occluded in the filament and on the wall of the lamp chamber, and requires a degree of rarefaction exceeding at least 1-3,000 of an atmosphere. None of these points are necessary in the Novak lamp, which uses a mechanical pump that cannot give a vacuum higher than 1-1,000 of an atmosphere, which does not expel the occluded gases, and which uses bromine gas in a degree of rarefaction exceeding at least 1-3,000 of an atmosphere is a substantially new invention, and not a mere addition to Edison's "nearly perfect vacuum," and that it brings substantial improvements in ease and cheapness of manufacture, efficiency, durability and freedom from blackening of the bulb. It was further claimed that the Edison lamp patent expired on Nov. 10, 1893. Complaint was made of the complainant's lack of good faith in attempting to have the court to understand that they were forced to procure Novak lamps by indirection. It was finally contended that complainants were guilty of laches in delaying to bring suit, and that the Waring company were wrongfully accused of being identical with the Perkins Electric Lamp Company.

Judge Acheson and Judge Hallett.

In the recent proceedings in the Federal court at Philadelphia, on an application by Edison attorneys for injunctions against several alleged infringing users of electric lamps, the question of Judge Hallett's decision at St. Louis was brought before the court in a request to exempt from the operation of the injunction certain lamps manufactured by the Columbia Lamp Company of the State of Missouri.

The judge, after referring to the Beacon lamp decision and that of Judge Seaman, says that as no evidence in support of the Goebel defense had been submitted to him, he was without means of forming an independent opinion as to whether it rests upon a substantial basis under all the circumstances, and therefore to give to Judge Hallett's refusal to grant an injunction the effect here claimed for it would be to carry the principle of judicial comity to a most extravagant length.

The Edison Electric Light Company, of Philadelphia, vitally interested here, the judge stated, is not a party to the Missouri suit, but aside from that consideration the owner

of a patent undoubtedly may maintain suits for infringement against the manufacturers and users of the patented device simultaneously. True, he added, pending a test suit against a manufacturer involving the validity of a patent in which a preliminary injunction against him has been decreed, courts in other jurisdictions have declined to enjoin preliminarily the users of the device. But the Edison patent has been sustained under circumstances which entitle the adjudication to high regard. It is the accepted doctrine that the decision of the Supreme Court, after exhaustive litigation upon the merits sustaining a patent, will ordinarily be regarded as conclusive on a motion for a preliminary injunction, the presumption against the existence of any valid defense against the patent prevailing at that stage of the case. As a consequence, the judge thought that the same effect ought here to be accorded to the decision of the United States Circuit Court of Appeals for the Second Circuit sustaining the Edison patent.

A preliminary injunction was allowed against each of the several defendants.

A Proposed Elevated Electric Railway.

An ordinance has been presented to the Philadelphia Council for an elevated electric road eight miles long, from Filbert and Eighth streets to Cheltenham. The conditions offered are that the piers will be of iron, the structure fourteen feet above all streets and twenty feet above any railroad crossing. The best methods of deadening sound are to be employed. Cars are to be run not more than ten minutes apart. The fare is not to exceed five cents for a continuous ride within the city limits between 6 and 9 A. M. and 5.30 and 7.30 P. M., and at all other hours is not to exceed ten cents. There shall be hourly cars from 1 A. M. to 5 A. M. The work is to be begun within six months and completed within three years. The company shall give \$50,000 bonds for the faithful performance of all engagements and another bond of \$50,000 to secure the payment of one-half of 1 per cent. of the gross receipts, which shall be sworn to quarterly by the officers of the company before the city controller. No freight cars shall be run on the road under penalty of \$100 for each trip. Bonds of \$200,000 will be entered to secure property owners for property "taken, injured or destroyed."

Award of the John Scott Legacy Premium and Medal.

The John Scott legacy premium and medal, which is awarded by the city of Philadelphia upon recommendation of the Franklin Institute, has been bestowed upon Mr. Nelson W. Perry for his method of series electric traction. The following is an abstract of the award:

Without entering into a discussion of the relative merits of the series and multiple arc systems of railway electric traction, it may be said that the very ingenious system presented by Mr. Perry seems to be well worked out in detail, and appears to overcome the difficulties arising in previously suggested series systems. Both the series and the usual multiple arc systems have their advantages and their disadvantages. While the former will not nor is it intended to replace entirely the multiple arc system at present in use, it has very decided and indisputable advantages in special cases, which cases are, however, by no means unusual. Its principal field of usefulness is in long lines, and the present introduction of railways leads to the belief that such railways will soon become very numerous.

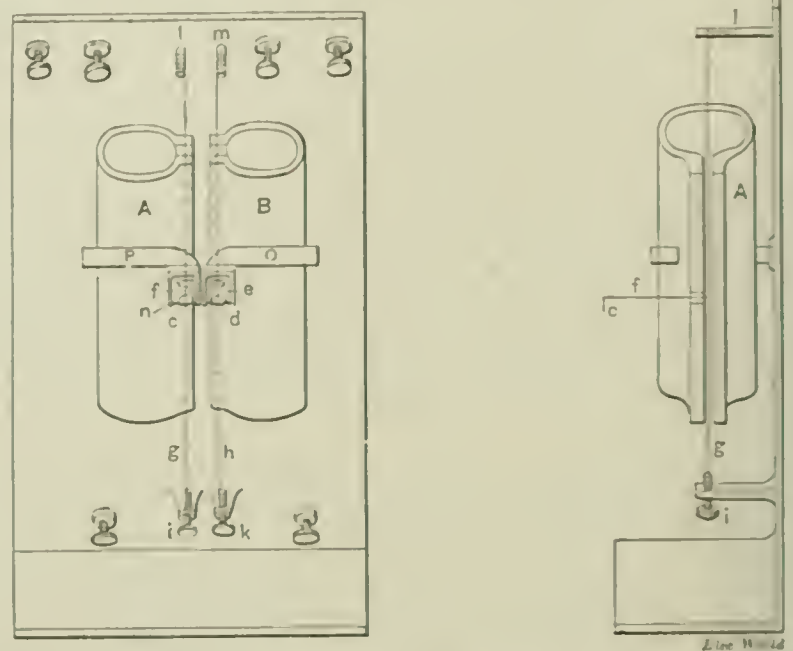
As far as can be determined of a thing that exists, so far as the knowledge of the committee extends, only on paper and subject to the risks which invariably attend reduction to practice, in the opinion of the committee a railway may be practically operated by the series system under Mr. Perry's plan, and with the safety due to a perfectly served and constantly signalled block system, for the current which drives the car not only sets the signal but refuses to work when two cars come on the same block. The Institute therefore recommends the award of the John Scott legacy premium and medal to Nelson W. Perry for his system of series electric traction.

An Instrument for Measuring Phase Difference.

BY W. STUART-SMITH.

I have for some time had in mind an instrument for showing directly in degrees the phase angle between a current and its impressed E. M. F. and at the same time showing the shape of the two waves. It has been my intention to have this made, but I have not found it convenient, and as it will be essentially a laboratory instrument, and hence of little commercial value, I give here a description of it.

As the sketches will show, the principle is the same as Ewing's magnetic curve tracer. In Fig. 1 *A* and *B* are two electromagnets energized by a steady current, the poles of which are so shaped that wires *g* and *h* can be stretched in



FIGS. 1 AND 2.—MEASURING PHASE DIFFERENCE.

the space midway between them. Fig. 2 shows one of these magnets; *c* and *d* are two very small mirrors, each supported by two horizontal needle points, *n*, so that in their normal positions the mirrors will rest in a vertical plane, as shown at *c*, Fig. 2. It will probably be best to pivot them near the bottom. Two short wires, *e* and *f*, are secured to the top of the mirrors and to the middle points of the stretched wires *g* and *h*. When the magnets are energized, but no current is flowing through wires *g* and *h*, the mirrors will be still and points of light reflected from them will simply show as points on a screen. If now an alternating current be sent through the wires, they will be attracted toward one pole or the other of the magnets, according to the direction of the current through them, and this movement being communicated to the mirrors through wires *e* and *f*, will cause them to rock slightly, and the spots of light on the screen will be drawn out into vertical lines, the length of which will depend upon the displacement of the wires, which in turn will depend upon the current passing through them. By properly adjusting the positions of the mirrors the two lines of light will coincide. If while the mirrors are thus vibrating the screen be given a rapid motion sideways, the two vertical lines of light will be drawn out as curves, the ordinates of which will depend upon the displacement of the mirrors at any instant and the abscissae upon the speed of the screen. The screen is, of course, supposed to carry a sensitive film and the exposure be developed to bring out the image. Such a high velocity can be given the screen by having it made as an endless band passing over the driving pulley of a small electric motor (set with its axis vertical) and over a guide pulley and stretched taut between them.

When no current is passing through the wires, if the mirrors are adjusted so that the two spots of light on the screen coincide and the screen then be put in motion, a

datum line will be drawn. If a third stationary mirror be employed and the three be adjusted so that all three spots coincide, then the spot from the stationary one will describe a datum line when the current is passing through the wires.

When all the mirrors are adjusted and the screen set in motion, if one of the wires, as *g*, be connected across the mains, the current passing through it will be in phase with the E. M. F., as the short, straight wire is without self-induction, hence the curve shown on the developed film will have ordinates proportional to the E. M. F., and will show the shape of the E. M. F. wave.

Wire *h* being connected in series with the main, its displacements will be proportional to the current, and the curve formed by the spot of light from mirror *d* will have ordinates proportional to the current, and hence will show the shape of the current wave. Both wires being connected at the same time, the two waves will be shown simultaneously and also the datum line from the stationary mirror. The two curves will be displaced, with respect to each other, an amount depending upon the phase difference.

By making several exposures at short intervals the variation of the shape of the two curves, together with the change in phase difference, can be recorded as the conditions of the circuit change.

Probably for very high rates of alternation the inertia of the moving parts will vitiate the shape of the curves, but by making them exceedingly light and having the wires stretched very tight, accurate curves can be shown for frequencies of comparatively high value. The mirrors will have motion in but one direction instead of two, as in Ewing's magnetic curve tracer, and this fact will tend to raise the frequencies, for which accurate results can be obtained. Probably frequencies found in modern power transmission plants would not be beyond the limit of accuracy, even if the connections were allowed to remain for some time, so as to permit several curves to be made while the conditions were changing. Frequencies of a much higher rate could be accurately registered by having the motor make connections and take an exposure at, say, the first or second vibration of the mirror.

Ewing says (see *The Electrical World*, Oct. 8, 1892) that with his curve tracer 20 cycles per second are not beyond the limit of accuracy, even when the mirror has a double motion and the wires sufficiently slack to give a diagram of good size, and that for very high frequencies the mirror should have but one motion. His instrument traces a curve depending upon two variables, hence a mirror having a double motion is necessary, but with the instrument here proposed, one of the elements, time, is a constant, hence this component of the curve can be supplied by the moving screen.

For parts of the curve above the datum line the mirror *c* will be vibrated by a pull on the wire *f*, Fig. 2, and for the part below by a push; this can probably be accomplished, as wire *f* can be very short, and the force it exerts need be but slight. If this is not found practicable, it will not be difficult to give the necessary motion.

If at the time the mirrors were being vibrated, as above, further motion should be given them, so as to displace the spots of light in a horizontal direction also, luminous curves would be shown on the screens, and if the third mirror was also similarly vibrated, the datum line would also be shown. This being the case, if a straight scale be graduated in degrees and an illuminated image thrown on the screen through a lens, then by adjusting the lens the 0° and 360° marks can be made to coincide with the points where the E. M. F. curve cuts the datum line, and if the graduations extend beyond these marks the phase difference between the two curves can be read directly in degrees.

This double motion would complicate the apparatus so much that inertia would be a more serious defect, and the connection between the stretched wires and the mirrors could not be as simply made. The limit of accuracy would be found at much lower frequencies than when the mirrors had but one motion and a photographic image was made.

If the screen be painted with sulphide of calcium and the light from the mirrors allowed to fall upon it, light will be absorbed and a luminous image of both curves, the datum line and the scale will be shown when the mirrors have but one motion, and this luminous image will not vanish at once, but will last probably for several minutes, so that it can be examined and even fixed by marking with a pencil. Such a surface would not require constant renewal, as the sulphide of calcium when of good quality will retain its property of absorption of light with after illumination for three or four years. With the short exposure to which it would be subjected in this case, probably the image would disappear after a few minutes, but if submitted to diffused daylight for say ten seconds it will shine for ten hours or more.

Unless it was desired to obtain a permanent curve on photographic film, this luminous surface would be of great advantage. It could also be used with Ewing's curve tracer where a permanent record was not desired, but a few minutes required for examination, as when testing iron in a workshop where a specimen was to be compared with a standard.

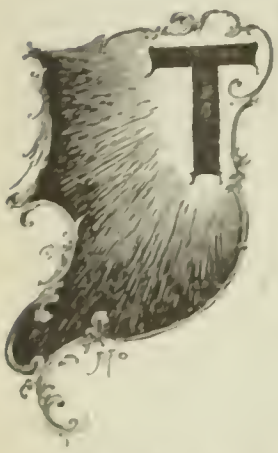
This is essentially a laboratory instrument, but I have designed one on totally different principles, which will give the angle of phase difference in degrees directly but not show the shape of the curves. This instrument is extremely simple, has no parts requiring special adjustment, and is as easy to connect up and read as a Weston voltmeter. It is essentially a central station instrument, and requires no adjustment other than approximate leveling. Placed in a central station beside the voltmeter and ammeter, the phase difference would be read (after closing a switch for a moment) and recorded in the hourly records and add greatly to them, as it would enable the power at any time to be quickly determined. It can be used for either high or low frequencies.

Progressive Evolution of the Telephone System of To-Day.

Mr. T. D. Lockwood recently delivered a lecture before the Electric Club of Harvard University on the "Progressive Evolution of the Telephone System of To-day." After a few happy introductory remarks, Mr. Lockwood proceeded to trace the invention of the telephone and its development into the modern perfected instrument. He said it was essential that the nature of sound should be clearly understood; that the physiology of the organs of speech and hearing be well known before the invention of a practical telephone was a possibility, and, in addition to this, a man thoroughly equipped for the invention was necessary. Such a man was Alexander Graham Bell, whose preparation for this work Mr. Lockwood commented upon. He described briefly the magneto telephone and its principles of operation. He then took up the subject of transmitters, and considered also the various elements of the telephone outfit. The question of disturbances on the line was next taken up, and it was shown how these may be obviated or decreased. The central station and its method of operation was considered by the speaker and briefly and clearly treated. A brief outline of what has been accomplished in commercial long-distance telephony, with interesting information in regard to the New York-Chicago line, was next given, and the lecture was concluded by some remarks in reference to possible future telephone work.

A Brief Review of the Faraday-Maxwell-Hertzian Epoch.

BY M. I. PUPIN.



THE death of the late lamented Prof. Heinrich Hertz brings to a close the most important epoch in the history of the electrical science of our times. The future historian of this most fascinating of all sciences will certainly record the names of Faraday, Maxwell and Hertz as the representative names of this wonderful epoch.

The essential features of the researches of these most eminent investigators are too well known to need a review, even from a pen guided by more experienced judgment and deeper penetration than I could even pretend to possess. But these are the days of mourning for the loss of rare Heinrich Hertz, and the thoughts of sorrow cause us to pause and reflect even more than ever before upon the wonderful discoveries of the departed young physicist. Yet who, while passing in his imagination through the wonderland which these discoveries disclosed before our view, does not feel that he is called upon to contribute a word or two to the memory of the man who opened our eyes and helped us to see as clear as daylight those visions which were first discerned by the penetrating eye of Faraday and which soon after agitated the poetic soul of Maxwell!

What are these visions, and why had we to wait in anxious suspense for nearly a quarter of a century until the magic touch of Hertz opened our eyes and made these visions as clear to us as they must have been to Maxwell, probably as long as forty years ago, when he first drew his inspiration from the study of Faraday's "Experimental Researches in Electricity"? When I speak of the visions of Faraday and of Maxwell, it is far from me to suggest, even, that there is a single sentence in the writings of these prophets of science which could at any time have appeared to any well trained scientific mind as pure speculation. I simply refer to the radical difference of their views of electrical phenomena from the generally accepted views of their time, so radical, indeed, that nothing short of new and startling experimental discoveries could tear us completely away from the old scientific faith in which we were brought up and lead us to the new, the faith of Faraday and Maxwell. In Hertz we found this leader, and we followed him, because it was through him that we first saw the whole truthful simplicity of the new scientific faith.

Every new physical truth appears to us first as a vision. It is brought then into harmony with our existing knowledge and finally becomes an essential part of our mode of thinking. We call it then simply a physical fact. Sir Humphrey Davy's and Rumford's experiments transformed the visions of Boyle, Leibnitz and Bernoulli concerning heat into a physical fact; the fact, namely, that heat is a form of energy. *So the experiments of Hertz transformed the visions of Faraday and of Maxwell into a physical fact; the fact, namely, that electrical phenomena, both static and dynamic, are ultimately due to a peculiar state or activity of the same medium to whose undulations we owe our sensations of light, and that light itself is an electromagnetic phenomenon.* The process of transformation of the visions concerning heat lasted over a hundred years. In the case of electricity it was more rapid; only fifty years elapsed between the first dawn of the visions of Faraday and the experimental discoveries of Hertz. Over two thousand barren years dragged their slow length along between the crude dynamical visions of Aristotle and the publication of Newton's Principia.

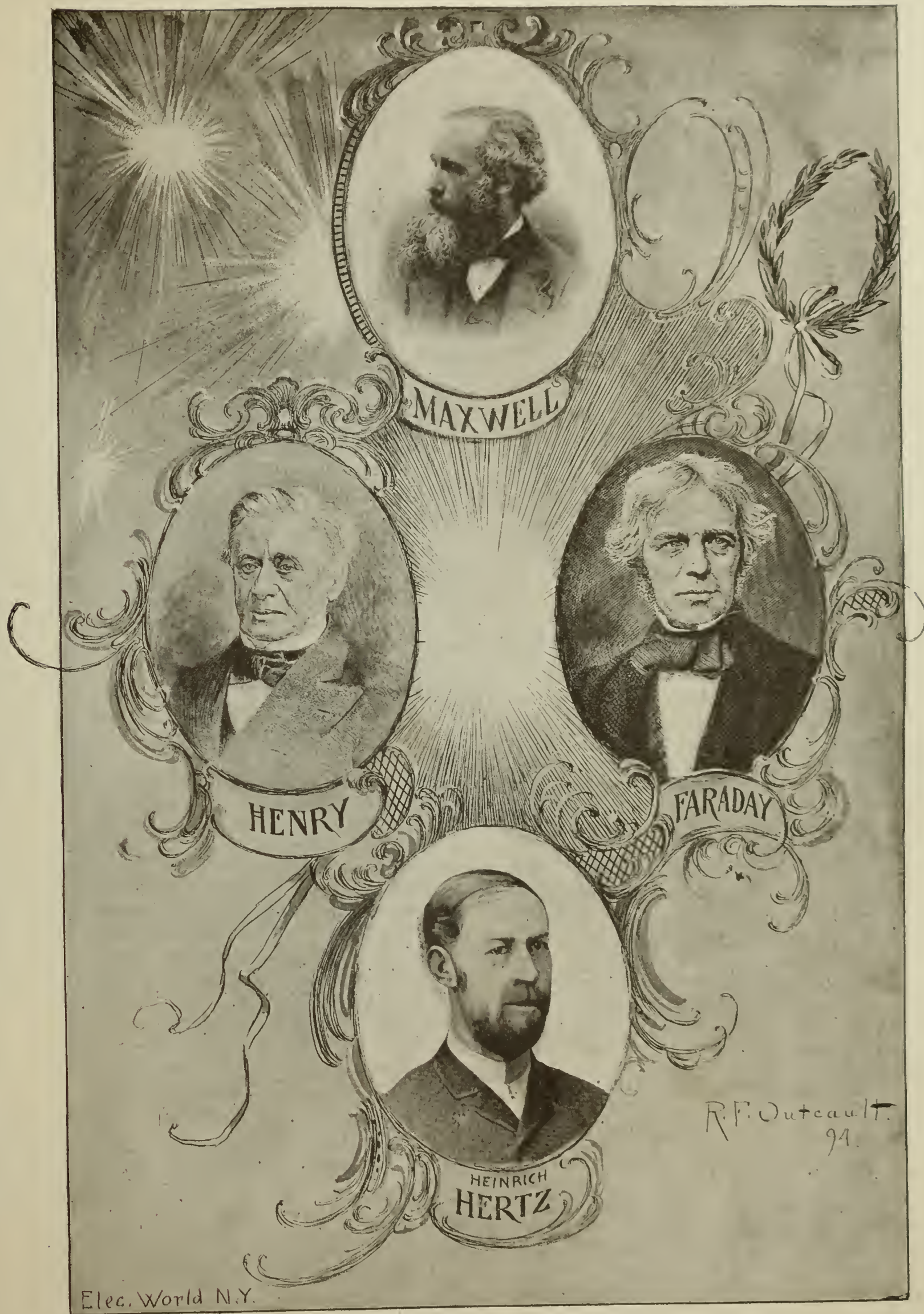
But during the period which intervened between the time

of Aristotle and that of Newton the human mind was in matters of exact scientific thought just like an untutored child. It had to be trained in the correct conception of the ideas of numbers, space, time, motion and matter before the seeds of the idea of force could find there a congenial soil. Arithmetic, algebra, geometry, astronomy and alchemistry had to precede the science of dynamics. So, again, the somewhat faint outline of the idea of work and energy as it existed in the minds of Boyle, Leibnitz and Bernoulli had to develop gradually into a strongly defined mental concept, such as we find it, for instance, in the writings of Young and Faraday, before the human mind was ready to pass from the visions of these prophets of science to a definite formulation of the dynamical view of heat and the general principle of conservation of energy. I purposely mention the name of Faraday in this connection, because it is important to observe that the ideas of force and energy were just as clearly defined in Faraday's mind as they are in our own minds today. That remarkable argument in volume II., page 103, of his researches, by which he strives to refute the contact theory of electricity, on the ground of its violating the principle of conservation of energy, shows clearly that as far back as 1840 he felt the whole force of this great principle. Faraday was, therefore, just as well equipped as any scientist of his time to make the next step in the advancement of the then existing ideas of force and energy. There was, indeed, great need not only for an advance, but for a complete reform; the time was ripe for it, and Faraday was the very man to take the leadership in this reform. He was not trained in the school of the great mathematical physicists of the eighteenth century. His mind rebelled against the more or less settled view of that time, that the ultimate analysis of the phenomena of electricity and magnetism can do no more for the electrical science than Newton did for celestial mechanics, and that is to reduce all the phenomena to the action of forces between the elements of electrified or magnetic bodies, which action is completely determined by the distance between these bodies. It is this rebellion, first started by Faraday, which constitutes the Faraday-Maxwell-Hertzian epoch in the history of electrical science. Maxwell gave it a complete organization and Hertz gained the decisive victory. But it must be observed that without the noble service which men like Henry, Thomson, Helmholtz, Rowland and others had rendered to the cause of this rebellion, Hertz's victory might have come much later.

It is important now to describe briefly the hostile elements which opposed the reforms at which this rebellion aimed.

The mathematical physicists of the eighteenth century had achieved great things by the application of Newton's law of gravitation and Newton's dynamical principles to the determination of the figure of the earth, to the theory of tides and to celestial mechanics; so great, indeed, that the conviction grew strong that a knowledge of the law of action of forces acting between bodies, that is, the mathematical relation of these forces and the distances of the bodies between which they act, was the only key by means of which an access could be gained to Nature's secret workshops. Coulomb's law of action of magnetic poles and electrified bodies formed the basis of Poisson's and Green's most profound mathematical investigations in electricity. No sooner had Oersted discovered the magnetic action of electrical currents than Ampere proceeded to reduce that action to forces acting between the elements of conductors, according to laws which depended upon the position of these elements, and he enriched the science of physics by another set of forces varying inversely as the square of the distance.

What could be more simple than the reduction of a whole class of physical phenomena to a few simple laws whose language is so plain that a child could understand it! For certainly nothing is plainer than the idea of a distance. The



FOUR MASTERS OF ELECTRICAL SCIENCE.

same elegance in form and completeness in logic is found in these electrical investigations as in the *Mecanique Celeste* of Laplace. It was evident that all this fascinating beauty of form and polished simplicity in logic was owing to the simplicity of the fundamental laws, the laws of inverse square, from which these investigations started. Hence, one cannot help thinking that these great mathematical works helped to foster the belief that, just as in the case of gravitating masses, so in the case of electric or magnetic bodies, the distance between them was the essential element to consider in investigating their mutual actions. *The belief in direct action at a distance which had somehow or other crept into dynamics of gravitating bodies was transplanted bodily into electrostatics, magnetism and electrodynamics, and thrived there splendidly.* To question this belief would have appeared at that time like questioning the perfection of the classical works of Poisson and Ampere, and even of Laplace. William Thomson, now Lord Kelvin, discussing in 1842 some of Faraday's researches in dielectrics, states very carefully (as if by way of an apology) that the new view of electrical action, the view of Faraday, does not in any way conflict with Coulomb's law of inverse square. This law seems to have been identified by many with direct action at a distance hypothesis; more than that, this very identification seems to have infused this belief with a wonderful vigor; otherwise it should have tumbled down into dust at the very first onslaught of Faraday's almost irresistible argument. But, as it was, it seemed even to grow stronger, owing to the splendid achievements of the electro-mathematical researches of Franz Neumann, Gauss, Weber and other contemporaries of Faraday.

Not that these investigators were pronounced champions of the action at a distance hypothesis, but simply because their mathematical theory gave what was considered at that time a complete account of the experimental observations, although the fundamental relations from which they started took no account of the mechanism by means of which one electrical or magnetic body acted upon another. Their silence on this point was interpreted, if not as a direct consent to the direct action at a distance hypothesis, then certainly as a consent to the generally prevailing opinion that this hypothesis is the simplest of all, and that it leads to no contradictions with actual observations.

Objections against this hypothesis had been raised many and many a time long before Faraday's time. Newton himself was decidedly against it. Ampere went even so far as to suggest that electrical and magnetic actions are conveyed by the ether, the same substance which, according to the magnificently worked out theory of his young friend, Fresnel, conveyed the luminous energy from point to point in space, not to mention the speculations of Descartes and Boscovich, both of which were pointed directly against the direct action at a distance theory. But all these objections and suggestions had little or no weight. They were all based on a more or less metaphysical foundation. The only real point in their favor was the fact that direct action at a distance passes beyond our understanding. *On the other hand, however, they all seemed to introduce additional difficulties into the mathematical analysis of electrical phenomena without offering any reward for this additional labor.* Necessarily so, because experimental science at that time had no wealth to offer in reward for this additional exertion, and it had no simple, plausible theory to substitute in place of the "direct action at a distance hypothesis." It was Faraday who added this wealth and made some vague promises of the reward; it was Maxwell who first discovered the hidden treasures of this wealth, and in most glowing colors described the reward that we would gain by abandoning our old scientific faith in the "direct action at a distance hypothesis" and embracing the new

faith of Faraday, and it was Hertz who first convinced us all that Faraday's and Maxwell's promises, though apparently too good to be true, were even more than true. A brief review of this wealth, of Maxwell's discovery and description of its hidden treasures, of the rewards promised by Maxwell, and of Hertz's first installment of these rewards is now in place.

(To be continued.)

Air-Core Transformers.

BY FREDERICK BEDELL AND ALBERT C. CREHORE.

In a paper on "The Behavior of an Air-Core Transformer when the Frequency Is Below a Certain Critical Value," read before the Physical Society, Oct. 27, 1893, Mr. E. C. Rimington has called attention to the case in which the primary current of a transformer falls off when the secondary is closed. This phenomenon was noted by us last spring and attention called to it in *The Electrical World*, June 17, 1893, in Article V., on the "Theory of the Transformer," where a curve is drawn (Fig. 14) showing the value of the primary current for different loads. We have not yet seen the full text of Mr. Rimington's paper, but from various references to it would infer that much of the same ground has been covered by him as was given by us in a paper before the Electrical Congress in Chicago last August entitled "General Discussion of the Current Flow in Two Mutually Related Circuits Containing Capacity," printed in full in the "Physical Review" for September-October, 1893. In a more recent communication Mr. Rimington calls attention to the fact that Mr. Kennelly, in an article entitled "The Impedance of Mutually Related Circuits" in *The Electrical World* for Oct. 21, covered some of the same ground as that given by him in his paper before the Physical Society above referred to. In a geometrical treatment of the same subject, "Theory of the Transformer.—VIII.," *The Electrical World*, Nov. 25, we showed the identity between analytical and graphic methods of solution, including that of Mr. Kennelly, and showed that the whole is derivable from the results given in the paper above referred to, presented by us before the Electrical Congress.

This decrease in the primary current of the transformer as a load increases, where the constants of the transformer have certain particular values, is certainly an interesting one, although the amount of decrease would always be small. Although the transformer has been the subject of a great deal of discussion, and its theory has been approached from all sides, and the instrument experimented upon by many different methods, it is still a fruitful source of study to the theorist and experimenter, and there is still room for the discovery of many facts interesting and unique.

Utilizing Tidal Power.

Another scheme has been advanced for utilizing the rise and fall of the tides as motive power. Experiments are reported by the London "Electrical Engineer" to have been made with the invention on the coast of Cheshire, where a tidal mill of about 4 h. p. has been used to supply power for driving a dynamo for lighting a house by electricity.

A Difference Between This Country and England.

In England all electric lighting plants and all methods of traction are in charge of "undertakers"; in this country the only plants with which undertakers are concerned are those which are planted in cemeteries on the graves of deceased relatives, and the only case of traction in which undertakers are interested is the old style horse traction applied to hearses and funeral carriages.

Some Unique and Useful Methods of Measurement.

BY GEO. T. HANCHETT.

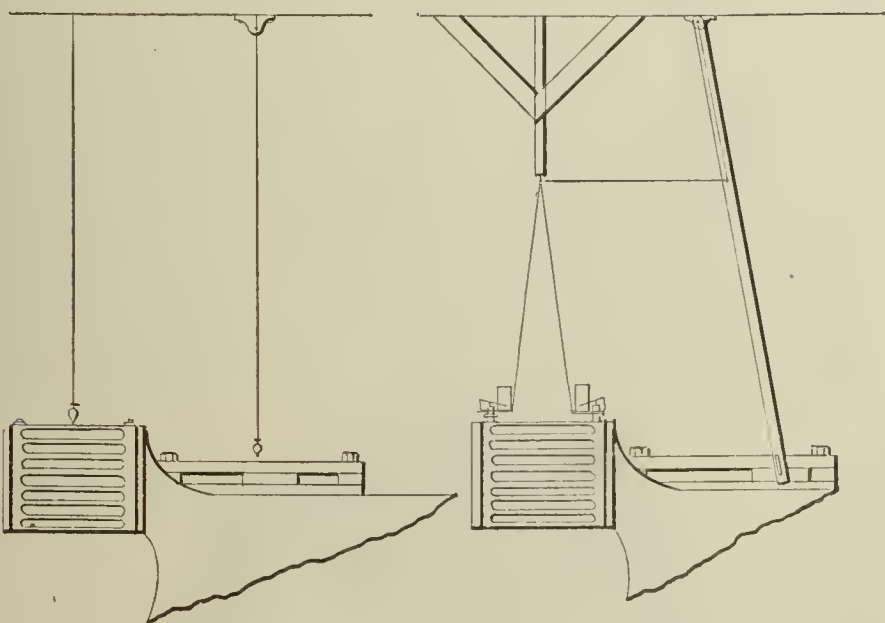


It very often happens that an electrical engineer finds the apparatus at hand inadequate to determine the value of a quantity which is of prime importance in calculating results. It is to such cases that this article is devoted, and while not all of these are covered, the writer hopes that the methods herein mentioned will suggest others.

In the case of an isolated plant, where the engineer appears upon the scene with a voltmeter and an ammeter in one hand, a pair of indicators in the other and having but one day in which to make the test, it too often happens that some such knowledge as the following is absolutely necessary:

With regard to the engine first: The writer is very sorry to say that in many cases the engineer in charge has never even heard of an indicator card, and the box of indicators is as much an object of open-mouthed wonder to him as an amateur photographer's outfit is to small children on a farm. Consequently there is no reducing rig on the premises. A reducing can be made cheaply, and, what is of more importance, quickly, from the following materials: A piece of scantling ten feet to twenty feet long, according to circumstances, and of about 2 inch by 3-4 inch cross-section; an 8-foot or 10-foot piece of about 2-inch by 4-inch plank; two small pulleys and a sufficient quantity of braided curtain cord, or something equally strong and non-elastic.

From these materials a reducing rig can be prepared thus:



FIGS. 1 AND 2.

Drop a plumb line from the ceiling to the middle point of the ways of the cross head and at this point in the ceiling a pivot must be provided for the long piece of scantling, as shown in Fig. 1. One end of the piece of scantling should be furnished with a bearing to receive this pivot on the ceiling. In the other end should be cut a slot to receive a screw or pin on the cross head. In almost all high-speed engines accommodations for this pin or screw are provided. From the ceiling drop a plumb line to the middle of the cylinder, and at this point in the ceiling firmly fix the eight-foot plank in a vertical position, with its width parallel to the head of the cylinder.

Having decided upon a length of card, measure the long piece of scantling and the stroke of the engine. Then, by the following formula compute the distance of a point on the rod to the pivot in the ceiling:

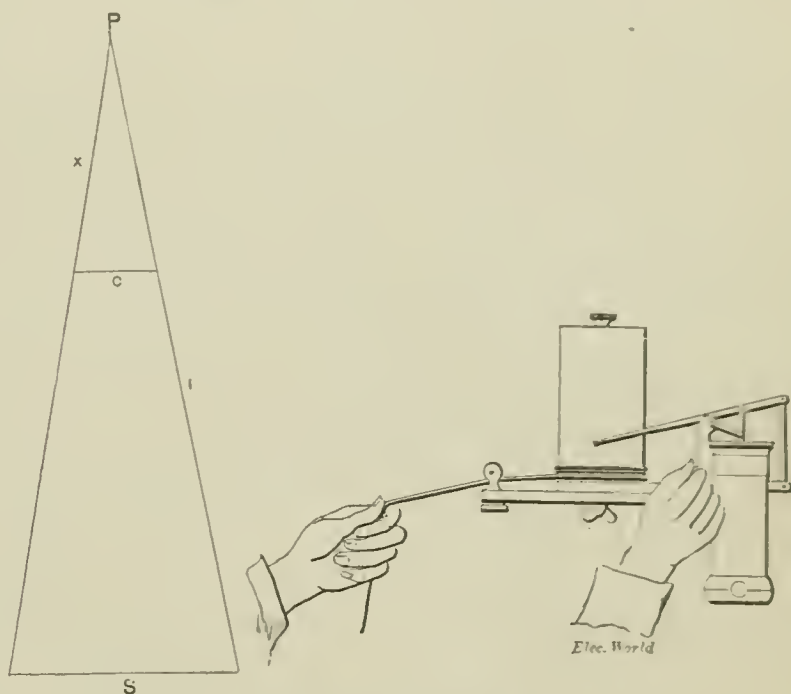
$$x = c \frac{l}{s}$$

when x is the desired distance; c the length of

the card; l the effective length of scantling in the position shown in Fig. 2; and s the length of stroke. (See Fig. 3.)

On the eight-foot plank, at a distance approximately x from the ceiling, attach the two screw pulleys in such a way as suitably to lead cords to the indicators at either end of the cylinder. Connect the cords to the indicators, as shown in Fig. 2, and a reducing motion is obtained whose errors are so small as to be masked by the greater errors of the indicators themselves.

The speed of the engine is a troublesome thing to determine, particularly if a man has forgotten his speed counter. In the case of any engine which has a speed lower than 200 revolutions the speed can be counted directly by allowing some one of the moving parts to touch one hand at every revolution, keeping the eye fixed on a watch held in the other. Another way is to turn one of the indicator cocks so



FIGS. 3 AND 4.

that intermittent puffs of steam are ejected through the hole in the side and count by ear instead of by touch. With a little practice the error should not exceed one revolution, even when the speed is as high as 150.

The speed can also be found, approximately, as follows: Let a quarter-minute interval be used, and a few seconds before the even quarter with one hand draw out one of the indicator cords slowly and as nearly uniformly as possible, and thus rotate the drum. On the even quarter apply the moving pencil motion to the drum, releasing it at the end of a quarter of a minute. The speed of the engine can now be obtained by counting the number of crests on the card thus formed and multiplying by four. (See Figs. 4 and 5.)

The writer does not wish to give the impression that these methods are to be desired in any carefully arranged test: they are fairly accurate substitutes when no other methods

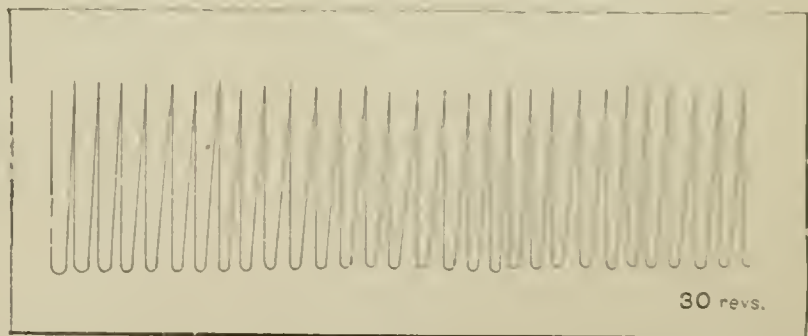


FIG. 5.

are at hand. For the sake of information, let us examine their accuracy. First, with regard to the reducing rig: Suppose the stroke of the engine to be 12 inches, the length of the oscillating scantling 10 feet, 120 inches, and the desired card length 3 inches. A little consideration will show

that none of these values is improbable. Applying the formula

$$x = c \frac{l}{s}, \text{ we have } x = 3 \frac{120}{12} = 30 \text{ inches.}$$

In order to be absolutely correct the cord should wind upon a specially shaped segment, which is very nearly the arc of a circle struck with x as radius and p as centre. An arc 3 inches long struck with a radius of 30 inches would be only 1.63 of the circumference. Consequently, a straight line such as is given by this device is very little shorter than the arc which it subtends. If it is wished to be more exact the length of the arc may be computed from its radius, and the difference between it and the subtending chord added to the length of the card; or, the arc may be described with a string and pencil and its length determined.

There is also a certain advantage over the circular segment in the crank and connecting rod motion of the cord, but it would be tedious to discuss it here. Suffice it to say that the writer is not alone in his opinion of the accuracy of this device, but could name several eminent steam engineers, some of whom are professors in our foremost polytechnic institutes, who have thoroughly indorsed it. One of these declares it good enough for a Hirn's analysis, were it not for the fact that some steam engineers, who have not investigated its errors and know nothing of its final effect on the card, would condemn it at once. It is to avoid such condemnation, and for this reason only, that he wishes his reducing rigs to be above criticism.

With regard to the method of indicating the speed: In the case of slow-speed engines the writer prefers direct counting, to the hand-speed indicator as the more accurate method. With high-speed engines the accuracy depends upon the practice of the engineer in such counting. Indicating the speed by the indicator is also a matter of practice. Of course all errors made on the card are multiplied by four. With a slow speed a half-minute interval may be used, and it then becomes so easy to obtain the speed exactly that an error of one revolution should be inadmissible. A series of ten or more indications and their mean should then render this part of the data above reproach.

"Waterpail Forge."

Mr. George D. Burton, of Boston, before the Franklin Institute of Philadelphia, last Wednesday, showed the method of heating by plunging the metal to be heated into a bucket of water and passing a strong current through it. The apparatus consisted simply of an ordinary wooden bucket containing a large sheet of lead which formed the positive pole and an iron bar laid across the bucket forming the negative pole; the metal to be heated was held in the tongs, which were rested on this iron crosspiece and dipped into the liquid as desired, thus avoiding all flexible connections with the tongs. Two ordinary nails held in the tongs and dipped into the liquid were heated to a welding heat in a few seconds, after which they were welded on an anvil with a few blows of the hammer. In another experiment they were welded by simply allowing them to fuse together. A large soldering iron was heated red hot in less than a minute. Pieces of clean steel were heated to redness to show that they were not burnt, as in the ordinary forge.

The solution which he found to be the best, after a long series of experiments, is made of a solution of ten parts of carbonate of soda and one of borax, dissolved in water until the specific gravity at 70 degrees is 1.150. The current was taken from the street mains and at about 240 volts. It appears that no means of regulating the current were used, as the metal itself and the depth of immersion acted as the regulator. He claims to have made the first public exhibition as early as October of 1890.

Rope Driving.—VIII.

BY J. J. FLATHER.



PRINT obtained with a plaster cast, showing the distortion of the strands from a true circle, is reproduced in Fig. 27. Fig. 28 is a similar print, showing the relation between the actual area of the cross-section and the area included between circular strands and the tangents joining them. It will be noted that the excess of area outside of the lines drawn tangent to the inner circles is but slightly greater than that between the tangents and the inner circles.

An inspection and tabulation of the results of numerous tests on manilla rope* shows that the strength per square inch increases as the diameter of the rope decreases. Form-



FIG. 27. ACTUAL SECTION OF ROPE.

ulas for the strength of rope based upon the circumference and a constant multiplier—as, for instance, $S = 800 c^2$, where S is the breaking strength and c the circumference—must be regarded as giving only an average value for diameters approximating those experimented upon. As the strength of good manilla rope varies from 10,000 pounds per square inch for a 2-inch rope to over 12,000 pounds for a half-inch rope, it can be seen that a more accurate determination may

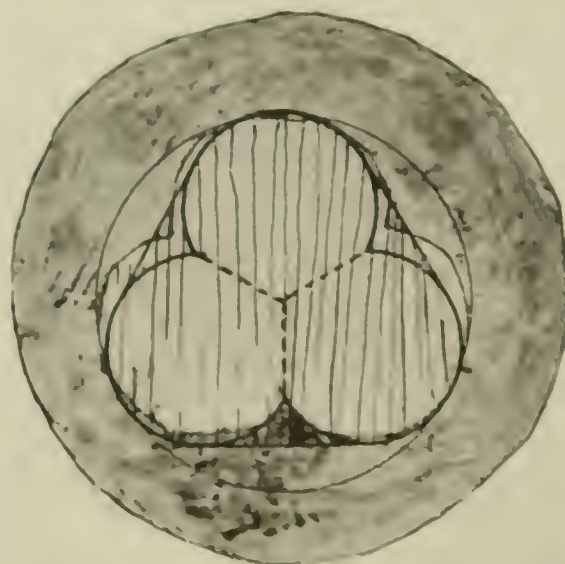


FIG. 28. CROSS SECTION OF ROPE.

be made if a variable is used in the formula. With the above assumption of area ratios, obtained by trial, the following expression has been deduced, which will give a very fair value of the breaking strength for new manilla ropes: $S_1 = 100 d^2 x$, in which x is a variable depending upon the diameter of rope; for manilla rope we may assume the em-

*Major Parker's report of tests made at Watertown Arsenal, 1885. Ex. Dec., No. 36. Experiments of M. Doboul in "Bulletin de la Société d'Encouragement des Arts," Paris, 1888. Riehle Bros.' laboratory tests; and others.

pirical value $x = 81 - 9d$, where d is the diameter in inches.

The ultimate strength per square inch of actual section will then be:

$$S = \frac{S_1}{0.8 \frac{\pi}{4} d^2}$$

From these formulas Table I. has been computed:

TABLE I.—STRENGTH OF MANILLA TRANSMISSION ROPES.

Dia. of rope = d .	Breaking strength, $S = 100 d^2 x$.	Strength per square inch, S_1
		$S = \frac{S_1}{0.8 \frac{\pi}{4} d^2}$
$\frac{1}{2}$	1,900	12,200
$\frac{5}{8}$	2,900	11,950
$\frac{3}{4}$	4,100	11,750
$\frac{7}{8}$	5,500	11,525
1	7,100	11,350
$1\frac{1}{8}$	8,800	11,125
$1\frac{1}{4}$	10,900	10,975
$1\frac{1}{2}$	15,000	10,625
$1\frac{3}{4}$	19,800	10,300
2	25,100	10,000

The above values are for new manilla ropes made of selected stock; ropes that are greasy or wet will be reduced in strength from 20 to 30 per cent., but when ropes are used for transmission of power, the lubrication of the fibres is of more importance than the actual breaking strength of the rope, as in any case the apparent working strain, as calculated from the power transmitted and the speed of the rope, should not be taken greater than 5 per cent. of the ultimate

strength; in many cases not more than 2 per cent. is used. If we wished to obtain the working strength we would usually divide the breaking strength by an assumed apparent factor of safety, but for a flying rope, in addition to this, it is necessary to provide a factor of wear; moreover, the actual strains are generally much greater than the normal as calculated from the power transmitted, due to vibrations in running, imperfect tension mechanisms, defects in construction, and other causes. As the strength at the splice is only 70 to 75 per cent. of the strength of the rope, the actual margin for wear and unknown strains is not as large as would at first seem apparent. In the first place, the strength of a lubricated rope is weakened about 25 per cent. by the grease, then 25 per cent. more must be deducted for the strength at the splice; this leaves only about 50 per cent. of the original strength of the rope which is available for transmission of power; to allow for possible imperfections in the rope, due to its manufacture or the material used, we must allow a further reduction of say one-fifth (that is 10 per cent. of the original strength of an unlubricated, unspliced rope); thus we have only 40 per cent. of the original breaking strength, which we may consider as the actual working strength. Allowing 10 per cent. of this as the apparent working strain (equals 4 per cent. of original strength), we obtain 36 per cent. as the actual margin for wear and unknown stresses which may be set up in the rope.

The working strain in executed rope transmissions will be found to vary considerably, as shown in the table herewith:

TABLE II.—EXECUTED ROPE TRANSMISSIONS.

H. P. of engine.	Diameter of rope.	No. of ropes or wraps.	Velocity of ropes. Ft. p. m. = V .	Driving force = P .	Probable ratio max. tension to driving force $\frac{T}{P} = \frac{1}{P} \cdot *$	Corresponding value of maximum tension = T_1 .	Assumed allowable strain from $T_2 = 200 d^2$.	Material of rope.	REMARKS
2,000	$1\frac{3}{4}$	30	5,089	367	1.66	608	612	Cotton.	English
1,350	$1\frac{3}{4}$	27	5,186	318	2.3	730	612	Manilla.	Waterwheel.
1,300	$1\frac{3}{4}$	32	5,338	251	2.35	590	612		English.
1,200	$1\frac{5}{8}$	36	4,398	250	2.12	530	528		English.
1,200	$1\frac{3}{4}$	27	5,277	278	2.35	680	612	Manilla.	In use 3 years; good condition.
1,200	$1\frac{3}{4}$	20	5,100	390	2.0	780	612	Manilla.	
1,100	$1\frac{5}{8}$	35	4,490	230	2.12	485	528	Cotton.	English.
1,100	$1\frac{3}{4}$	26	4,900	275	2.25	620	612	Manilla.	
1,062	$1\frac{3}{4}$	27	5,086	255	2.25	575	612		English.
1,000	$1\frac{3}{4}$	23	5,227	282	2.35	660	612	Manilla.	
800	$3\frac{1}{2}$	24	1,230	890	...	1,520	2,450	Cotton.	Used 3 yrs. without resplicing of ropes.
750	2.36	30	3,000	275	1.86	510	1,114	Hemp.	German.
450	$1\frac{1}{4}$	14	4,850	220	1.66	365	312	Cotton.	In use 6 years; good condition.
350	$1\frac{3}{4}$	12	5,166	186	1.66	308	612	Cotton.	English.
300	$1\frac{1}{4}$	16	3,342	186	1.9	355	312	Manilla.	In use 2 years; no signs of wear.
250	2	12	1,470	470	1.32	620	800	Cotton.	
200	$1\frac{1}{4}$	6	3,926	280	2.0	560	390**	Rawhide.	Wore out in 4 years.
200	1	12	3,078	178	1.86	330	200	Manilla.	
200	1	10	2,400	275	1.8	495	250**	Rawhide.	In use 3 years; good condition yet.
150	1	13	2,400	158	1.8	285	250**	Rawhide.	
150	$1\frac{1}{4}$	6	2,800	295	1.83	540	312	Manilla.	
150	$\frac{7}{8}$	18	3,190	82	1.86	152	190**	Rawhide.	In use $3\frac{1}{2}$ years; very little wear.
140	$\frac{3}{4}$	8	2,480	230	1.8	415	112	Manilla.	Three ropes worn out in 2 years.
100	$\frac{7}{8}$	5	4,333	152	2.1	320	190**	Rawhide	Worn out in 3 years.
80	$1\frac{1}{8}$	7	2,513	150	1.8	270	252	Manilla.	In use 3 years; good condition.
60	$\frac{3}{4}$	2	3,600	275	1.9	540	112	Manilla.	Would last from 4 to 6 months.
60	2	5	1,592	246	1.7	415	800	Hemp.	German.
50	$1\frac{1}{8}$	1	1,800	920	1.72	1,609	252	Manilla.	Broke 3 times 5 mos.; replaced in 5 mos.
50	$\frac{5}{8}$	4	2,513	164	1.8	295	78	Manilla.	Would last 6w. to 4m.; finally taken out.
45	$1\frac{1}{4}$	5	1,700	175	1.72	300	312	Manilla.	
40	2	1	5,000	265	1.66	490	800	Cotton.	In use 8 years; good condition yet.
35	$\frac{7}{8}$	9	1,318	97	1.7	164	153	Manilla.	In use $3\frac{1}{2}$ years; no signs of wear.
30	$\frac{5}{8}$	3	2,256	146	1.77	257	78	Manilla.	
25	$\frac{3}{4}$	1	3,140	262	1.86	490	112	Manilla.	Wears out in 1 year.
20	$\frac{1}{2}$	4	3,140	55	1.86	120	50	Manilla.	Quarter turn drive.

* Calculated from $\frac{T_1}{T_2} = e^{\Phi \alpha (1 - \epsilon)}$; Φ is assumed equal to 0.5 for cotton, and 0.3 for manilla and rawhide. The arc of contact on smaller pulley was taken as 165 degrees in all cases.

** The assumed allowable strain for rawhide ropes was taken at $250 d^2$ pounds. No distinction was made between manilla and cotton.

In determining the driving force, $P \left(= \frac{33,000 \times \text{H. P.}}{V} \right)$, no allowance was made for engine resistance, which will reduce the above values about 10 per cent. for the larger engines, but this refinement is unnecessary in view of the fact that engines are frequently run at a higher power than their normal rating.

but plants which have been successful, as well as those in which the wear of the rope was destructive, indicate that 200 d^2 pounds is an economical working strain.*

As this value is such a small percentage of the breaking strength, it is unnecessary to use a varying coefficient in this case, as the difference is not worth considering. From data furnished by the Messrs. Pearce Brothers, of Dundee, who have erected rope belting extensively, Prof. Unwin shows that in different cases in practice the driving force, or difference in tension, on the two portions of the rope is equal to 75 to 80 d^2 pounds; that is,

$$T_1 - T_2 = P = 75 \text{ to } 80 d^2.$$

where T_1 = tension on driving side,

T_2 = tension on slack side.

P = driving force.

It is probable that the value of the ratio $\frac{T_1}{P}$ varies from $1\frac{1}{2}$ to $2\frac{1}{2}$ in ordinary practice, depending upon the speed of the rope, the coefficient of friction and the arc of contact between rope and pulley.

Unwin assumes $\frac{T_1}{P} = 1.2$ when the belt embraces 0.4 of the circumference of the smaller pulley; hence the greatest tension would be

$$T_1 = 1.2 P = 90 d^2 \text{ to } 96 d^2.$$

This is based upon a coefficient of friction = 0.7 for a 45° groove, which we believe to be greatly in excess of its average value for running ropes. Moreover, the rope velocity was not considered in determining the above ratio; at speeds over 2,000 feet per minute the influence of centrifugal force cannot be neglected, as it produces a very considerable force in the rope, and for these reasons the value of the ratio $\frac{T_1}{P}$ will be greater in average practice than 1.2.

If we assume a speed of 4,000 feet per minute, the value of this ratio for greasy ropes may be taken equal to 2, from which there is obtained $T_1 = 2.0 \times 75 \text{ to } 80 d^2 = 150 \text{ to } 160 d^2$ —a value somewhat less than that which we have assumed as a suitable working strain, viz., 200 d^2 pounds. In a recent communication from Messrs. Combe, Barbour & Combe, of Belfast, who have been engaged in furnishing rope transmission for thirty years, it is stated that their basis of calculating the horse power is to assume that a rope 5 1-2 inches circumference (1 3-4 inches diameter) working on a four-foot pulley going 100 revolutions per minute will drive 8 h. p. under medium circumstances, and by "medium circumstances" they mean "that the ropes must work at a distance of at least 20 feet from centre of shafts and at a less inclination than 45° from the horizontal, at a speed not under 2,000 feet per minute. Should the ropes be working vertically or at an angle greater than 45°, instead of taking 8 h. p. as the basis, you should take 7 or 6 respectively, according as the conditions grow worse and worse. On the other hand, should the ropes work horizontally and at a greater distance than 20 feet from centre to centre, and with a speed up to 3,600 feet per minute, and the pulleys be fairly large, say from 5 to 7 feet in diameter, you may take 10 instead of 8 as the basis." From these considerations the working strain may readily be determined. If,

as before, we take $\frac{T_1}{P} = 2$, we find that under average condition the allowable working strain will be $T_1 = 135 d^2$ pounds. Under more favorable conditions and a higher velocity $\frac{T_1}{P}$ will be greater and T_1 will approach 200 d^2 .

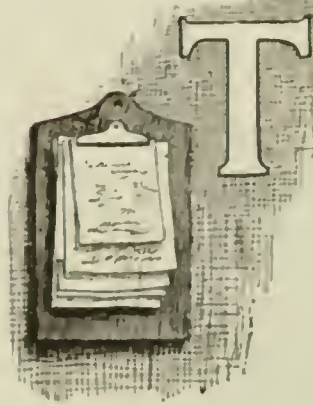
Although we have assumed the normal working load not to exceed 200 d^2 pounds, this must be considered as the

economical load for the lasting qualities of the rope; in many cases, however, the first cost, the more convenient adaptation of smaller ropes, and the use and lesser cost of smaller pulleys outweigh the greater economy obtained by the larger ropes, and loads are carried far in excess of that given. By the use of a greater number of wraps the working load on each will be reduced, but this adds to the first cost of the plant and many concerns prefer to put in a new rope every year or two, rather than put in more or larger ropes every six or eight years.

(To be continued.)

Laboratory Notes.—XVI.

BY LIEUT. F. JARVIS PATTEN.



HE supposed pulsating character of the rotary field, it was formerly thought, would be materially improved if not entirely overcome by using many currents of different phases instead of two, because as we introduce more and more currents, then rectify and superpose them again, we find the resulting current $w w$, Fig. 39, approaches nearer to a straight line, and the difference between the maximum and minimum ordinates becomes less and less, but all

this had nothing whatever to do with the rotary field effect, and as we shall see, three currents having a phase difference of 120 degrees or six currents having 60 degrees phase difference, or even 12 currents at 30 degrees difference, can in no wise improve the constancy and uniformity of the rotary field effect over that produced by two currents in quadrature. For to give a single illustration, suppose the triphase currents of Fig. 39 were introduced at the points 1, 2, 3 of the winding, Fig. 36. To determine their effect in this winding we lay off three axes, $X+X-$, $F+F-$, and $Z+Z-$, Fig. 40, and then proceed as before to lay off on these axes $X+X-$ and $F+F-$. The values of the ordinates of the curves of $x x$ and $y y$ of Fig. 39 and their resultant being found, it is combined with the ordinates of the curve $Z Z$ laid off on the axis $Z+Z-$.

Thus, to determine the points 1 and 2, Fig. 40, we lay the ordinate $a i$, Fig. 39, off on the axis $X+X-$, Fig. 40, in the positive direction, which gives us the distance $a b$.

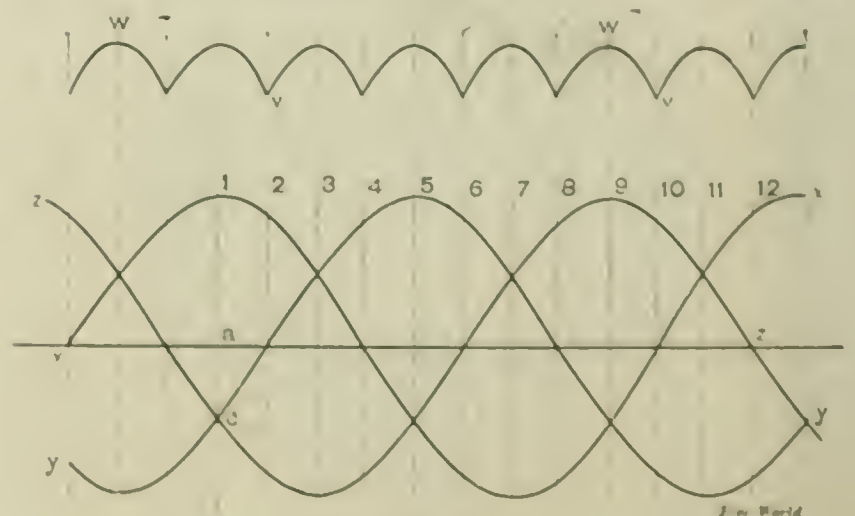


FIG. 39.

The ordinate $a c$, Fig. 39, belonging, as it does, to both $y y$ and $z z$ is laid off on both the axes $F+F-$ and $Z+Z-$ in the negative direction $a c$ and $a t$; through the extremities of these lines parallels drawn to $F+F-$, $Z+Z-$ determine the point a , which is the resultant of these two—it lies on $X+X-$ in the positive direction, and so must be added to the value of x previously found, $a b$, which gives the distance $a i$, and the point 1, as required. The other points up to 12 being plotted in the same way, we

*See paper by C. W. Hunt, Trans. A. S. M. E., Vol. XII., page 230.

shall find, as before, that they all lie on the circumference of the same circle, and that it is quite immaterial how many currents are used. The resulting magnetic effect is constant in its intensity with any number of multiphase currents, two or more, as long as the phase difference is an even divisor of 180 degrees and the maximum values of the currents are alike.

A pulsating effect in the rotary field is produced in an entirely different way, and may arise equally with two or

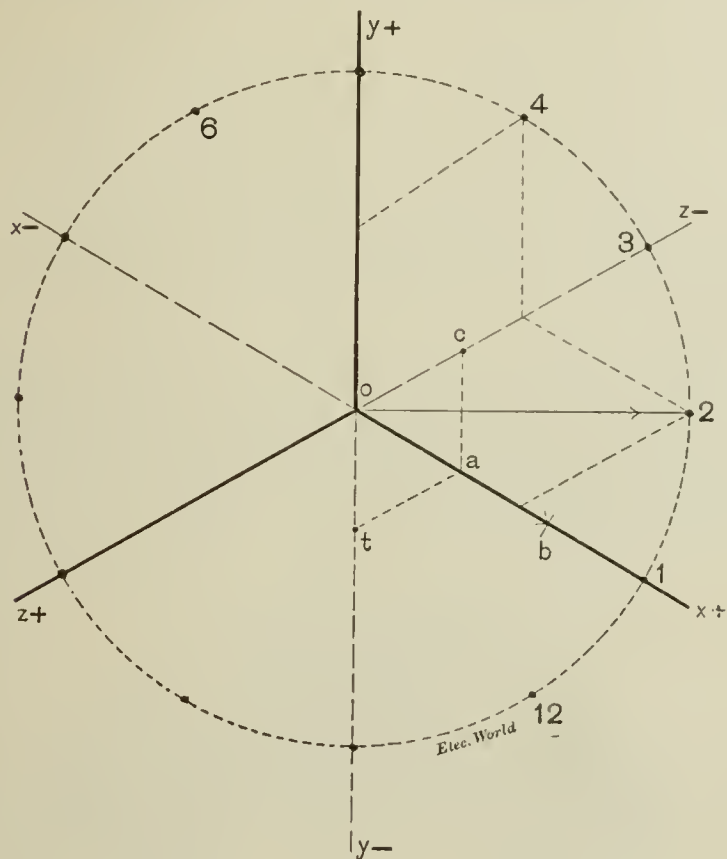


FIG. 40.

more currents. Thus, suppose one of the conditions named to be disturbed. Let, for instance, the two currents be in exact quadrature relation, but one as x , Fig. 41, have a greater maximum value than the other. If, now, we plot the rotating field effect as before, we no longer obtain a

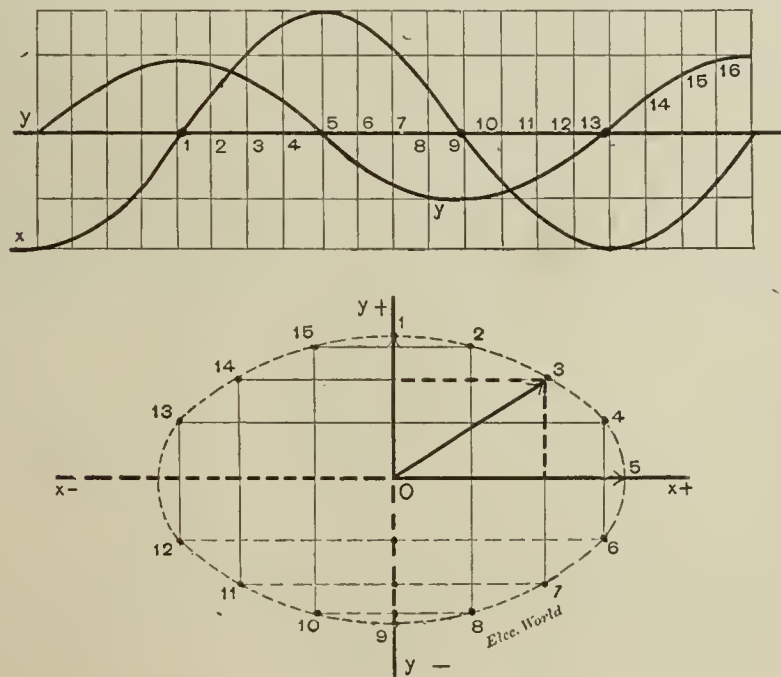


FIG. 41.

circle but an ellipse, which, of course, indicates a pulsating magnetic effect, the magnetism in the direction of the axis $X + X -$ being a maximum and in the direction $Y + Y -$ a minimum.

Currents in quadrature of different strengths give pulsating fields the greatest and least intensities, being coincident in position with the magnetic axes of the system.

Let us now suppose the two currents to have equal maximum strengths, but some other phase difference than 90 degrees—they are out of quadrature, as indicated in Fig. 42. We then find a pulsating field again, but one the greatest

and least values of which do not lie on the magnetic axes of the system as before, but on diagonal lines, $u u$ and $v v$, between these axes. The remaining case where the currents are

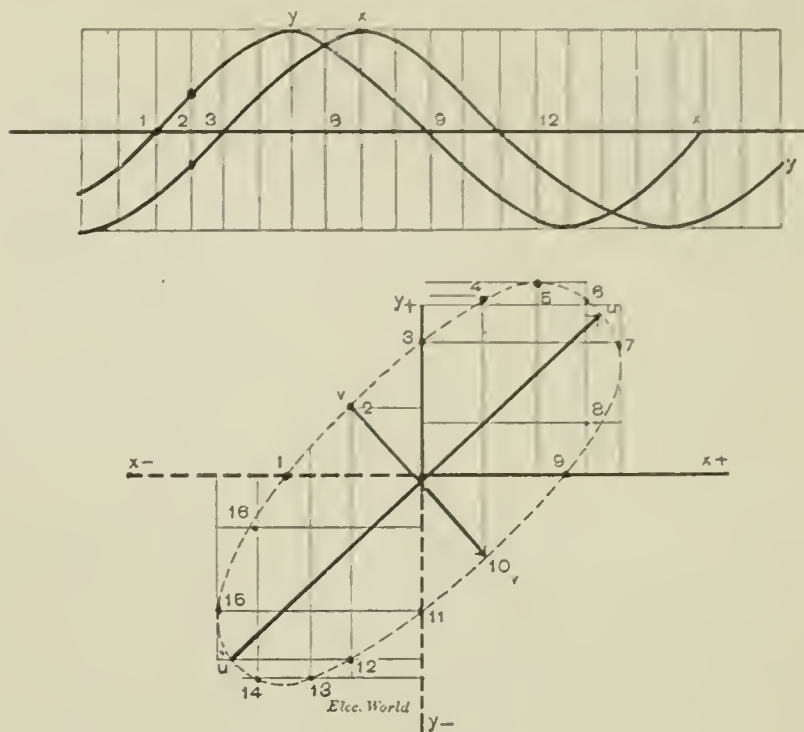


FIG. 42.

not only of unequal maximum strengths, but out of quadrature also, must necessarily give a pulsating field, having both the erratic characteristics of the last two cases considered. The case is indicated by Fig. 43, which is of course the extreme case for multiphase currents, as from it we pass naturally to the next step, which consists in the elimination of one of the currents altogether when we have the case of a single alternating current, and our ellipse indicating the

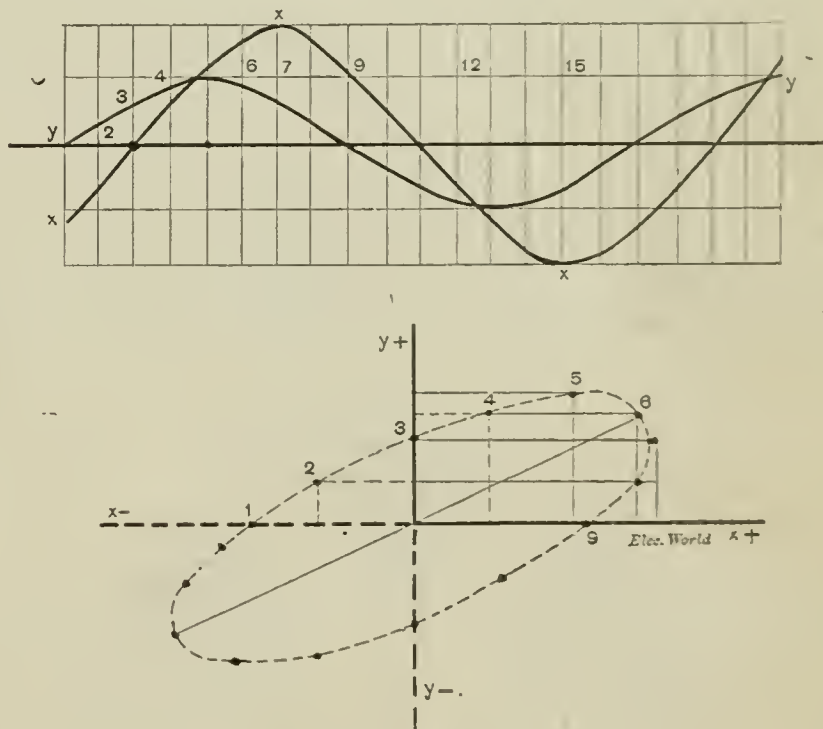


FIG. 43.

pulsating character of the rotating field is flattened down to a straight line, so that the field of the single alternating current is pulsating only without any variation from the right line action whatever, and may therefore be more accurately compared to a rapidly oscillating pendulum.

(To be continued.)

A New Departure in Electrical Journals.

Some of our foreign contemporaries are making a new departure by the introduction of colored illustrations. A London contemporary, for instance, starts its "Notes from Japan" with a colored illustration, apparently made by a native, representing "their special correspondent" in the act of writing, apparently with a spoon, and a box which contained what looks like blue and red rice.

The Calculation of Alternating Current Motors.—VI.*

BY E. ARNOLD.



Up to now I have made the usual assumption that the lines of force of the field form a rotary field of constant strength. The foregoing equations can, therefore, determine the behavior of the motor only when the above assumption holds good. I will now show in what follows that even without the adoption of such a rotary field the beginning of a torque and the starting of the motor can be explained.

At the time of the Exposition at Frankfort Mr. J. Sahulka had already drawn attention to the existence of secondary fields, or fields varying periodically, and considered their action harmful.

In every multiphase alternating current motor, with a magnetic field excited by an alternating current, there are present, according to my view, periodic magnetic fields, and in certain cases these are the predominant ones.

Under this assumption, the course of the lines of force corresponding to the momentary direction of the current is shown in Fig. 11. There are here present six periodic fields, whose lines of force link together single pairs of primary and secondary coils, and only a small part of the lines of force form a rotary field.

It appears from various phenomena that the periodic fields can be strongly formed. With certain arrangements of the primary and secondary windings, the pull with which the motor starts depends, for instance, on the relative position of these windings; in accordance with experience, it is even possible to have positions in which the motor not only develops no torque, but is also held fast.

The torque of a motor in which the number and position of the coils corresponds with the diagram in Fig. 11 will be almost nothing; if, on the other hand, the coils of the armature, A , lie between the field coils on the diameter $m_1 m_2$, they are in a state of minimum activity, and the armature will be held fast in this position. Furthermore, it can be shown from multiphase motors which have been constructed that the torque is a maximum when running near synchronism, and from that condition falls away almost

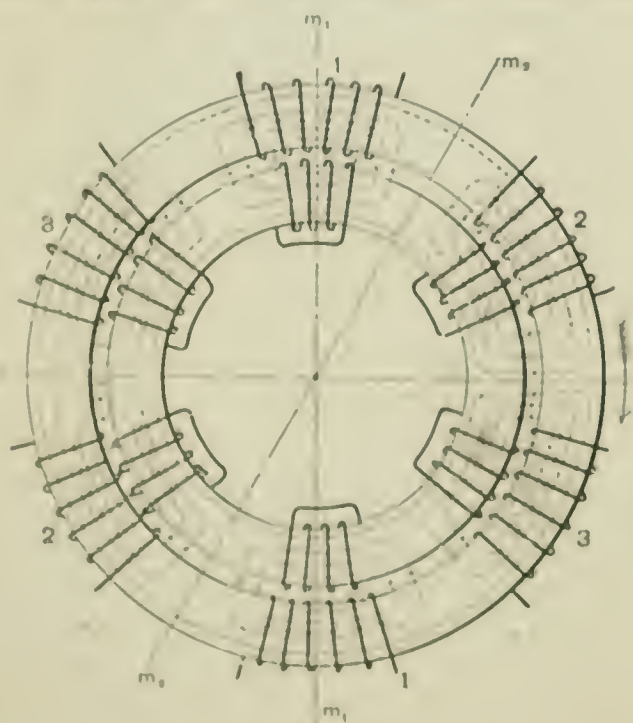


FIG. 11.

as rapidly as with single phase motors. The slip which a motor suffers depends substantially on the arrangement of the field and armature coils, and on the resistance, R_p , of the latter. If the iron of the rotating armature be not laminated, it will become heated very rapidly, even when running

nearly synchronously, while at complete synchronism and without this presence of periodic fields there would be no heating.

The appearance of dead points and positions of minimum attractive force can likewise be explained only through the existence of strongly developed periodic fields.

With a correct disposition of the field and armature coils, however, the periodic fields in the position of rest of the armature help to create a torque. Figs. 12, 13 and 14 serve to explain this assertion. The coils I, II. and III., in Fig. 12, belong each to one phase. We assume that no rotary field exists, but that each coil corresponds with a particular, periodically varying field. The space which the lines of such a field takes up grows with its intensity, and the field, which is increasing in strength, will supplant the weaker, or decreasing one. A large part of the armature windings will consequently be acted upon alternately by neighboring magnetic fields, and from this alternating induction there will result a torque.

In Fig. 12 it is supposed that the exciting current has reached its maximum value, I_1 , in the coil II.; in coil I. its strength is diminishing, and in coil III. increasing; in both the latter the current, $i_1 = I_1 \sin 30^\circ$. The field II., therefore, takes up the greatest space. After 1-12 of a period

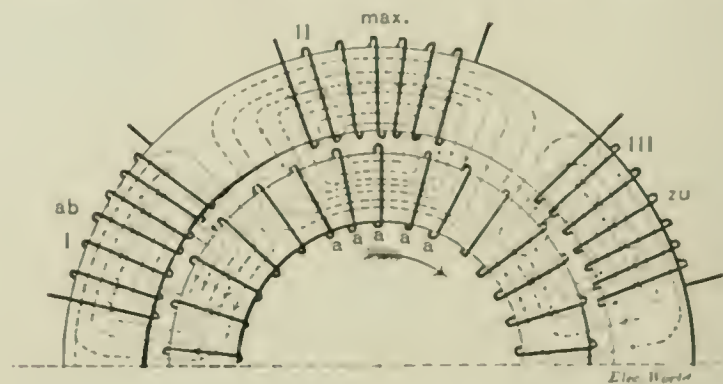


FIG. 12.

the strength of the current of phase I. will pass through zero, and in II. and III., $i = I_1 \sin 60^\circ$. With the assumed direction of current, the diminishing field II. will induce currents in the armature windings, $a a$, which in their period lag behind the inducing E. M. F. by an amount equal to $\frac{\pi}{2} + \phi$, and reach into the outspreading field of phase

III. There is, however, an attraction between the currents, $a a$, and field III. Field I. is equal to zero, and consequently produces no effect. After the lapse of another 1-12 period the current of phase III. reaches its maximum in I. and II., $i_1 = I_1 \sin 30^\circ$, and the current in I. has at the same time changed its direction. From the direction of the lines of force and the induced currents drawn in Fig. 12 it is apparent that the currents a, a, a , induced by field II. are attracted by field III. and repulsed by the outspreading field I. We obtain a torque which works in the same way as that generated by the assumed rotary field.

We need not enter into a discussion of the alternating actions between a periodic field and the currents induced by it; the attractive and repulsive forces cancel each other, and, as already shown for synchronous motors, the resulting torque exerted on the stationary armature is equal to zero.

The operations mentioned can be shortly summarized: A magnetic field, diminishing in intensity, induces, in the windings of the armature, currents which are either attracted or repulsed by the neighboring magnetic field of growing intensity, according as the magnetic fields concerned are opposed to each other or in the same direction. The attractive and repulsive forces act in the same way, and create a torque.

If the inducing currents follow the sinusoidal form, we can likewise represent the intensity of the magnetic field by sine

* For the last section of this article see The Electrical World, Dec. 30, 1893.

curves for low saturation of the iron. In Fig. 13 the curves I., II. and III. correspond to the three phases of the exciting current and show the course of the intensity of the

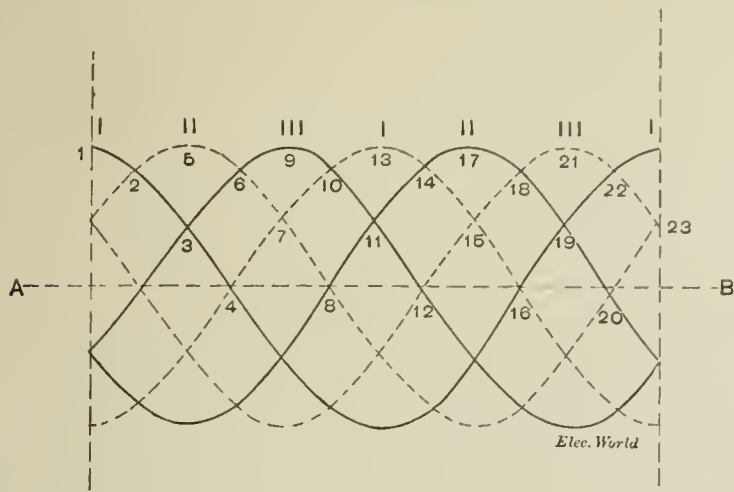


FIG. 13.

magnetism, as we represent the times by abscissae and the intensities by ordinates. By comparison of these figures it is found that when the magnetism passes through certain values either attraction or repulsion takes place, and so we have

between 5—7 and 3—9 attraction,
 “ 6—8 “ 4—10 repulsion,
 “ 9—11 “ 7—13 attraction,
 “ 10—12 “ 8—14 repulsion,
 “ 13—15 “ 11—17 attraction,

and so on. It is apparent, from the overlapping of these times, that a torque of constant strength will be exerted on the armature.

The pulsations of the magnetic fields encroaching upon each other's space, together with a maximum which moves in a definite direction, suffice to explain entirely the starting of the armature with a torque.

With this, however, it is not denied that part of the lines of force really form themselves into a so-called rotary field. The intensity of the rotary field will depend substantially on the construction of the motor and the arrangement of the exciting windings. The six and twelve-coil windings designed by Mr. D. v. Dobrowski favor the formation of a rotary field. It is even more essential, however, to plan the motor so that the interlocking of the periodic fields is promoted. This relation of the periodic fields to each other can be especially hindered or greatly weakened by the use of projecting teeth in the iron of the armature and the mag-

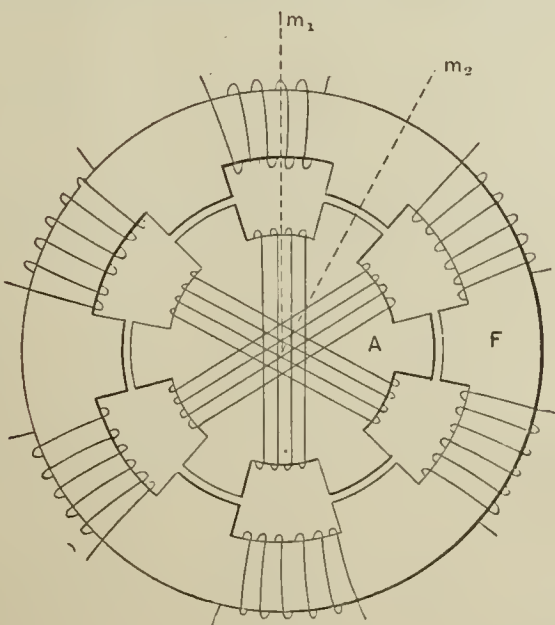


FIG. 14.

netic field in certain positions, and by an unfavorable numerical proportion of teeth.

In Fig. 14, for instance, the field and the armature are each provided with six teeth. In the given position of these pro-

jections the motor will develop almost no pull; it will behave like a one-phase motor. If we turn the armature through the arc $m_1 m_2$, so that the teeth of the armature come between the projections of the field, the armature windings will arrive at the position of minimum induction and strive to keep in this place; the armature seems to be held fast in this situation. This condition of rest is more strongly developed, the smaller the resistance of the armature windings, for the endeavor to remain in the position of minimum induction grows and the scattering of the lines of force increases with decreasing armature resistance. If the armature be given an initial velocity, it will soon attain full speed, and the periodic fields now generate a torque, as in a one-phase non-synchronous motor. If, however, the number of projections and coils of the armature and field, as well as the armature resistance, be suitably chosen, the motor will start with a torque in all positions.

J. Sahulka has shown an arrangement which makes it possible to avoid the springing up of these secondary fields. In place of a ring with four pole pieces, two separate magnets are used, with only one alternating current flowing around each. That such a motor will develop little or no torque at starting follows from the statements already made. B. Kennedy, in *The Electrical World*, Dec. 10, 1892, page 372, published an account of an induction motor with a similar arrangement, and the results reached by it can therefore not be favorable.

The assumption that the lines of force which do not form a rotary field have a harmful influence is not well founded. If the motor be so built that the greatest possible number of armature windings are acted upon inductively by neighboring fields of different phase, and if the extended outspreading of the periodic fields be promoted, the greatest attractive power can be obtained.

Under the supposition that no rotary field is present, but

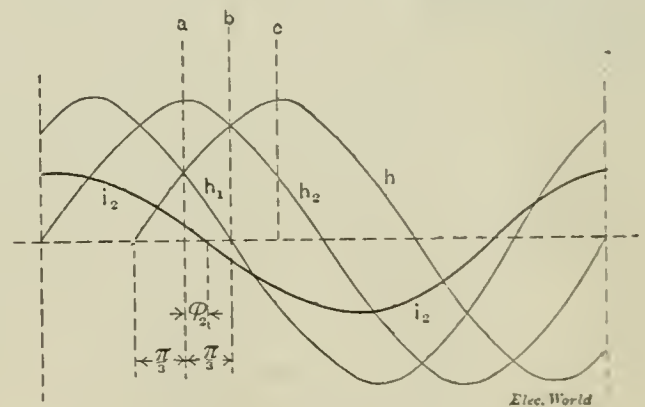


FIG. 15.

only periodic, or local fields, the amount of the torque generated is easily ascertained from Fig. 15. The sine curves, h_1 , h_2 , h_3 , with a difference of phase of 60 degrees, are to represent the course of the periodic fields of the primary phases, I., II. and III. The E. M. F. induced in the secondary windings is a maximum when the intensity of the field considered passes through zero, and equal to zero when the field has reached its maximum intensity. The current, i_2 , induced in the armature windings by the field, h_2 , is consequently in a phase differing from h_2 by $90^\circ + \Phi_2$. The course of the current i_2 is shown in Fig. 15. A torque will be created by the alternating actions between the neighboring fields, h_1 , h_3 and the current i_2 . This torque is proportional to the product of the maximum values of h_1 , h_3 and i_2 , and the cosine of the angle representing the difference of phase between h_1 and i_2 , and h_3 and i_2 , respectively.

Therefore, letting

I_2 represent the maximum value of i_2 .

H_1 represent the maximum value of h_1 .

H_3 represent the maximum value of h_3 ,

we obtain the torques

$$\frac{1}{2} I_2 H_1 f_2 \cos \left(\frac{\pi}{3} - \phi_2 \right)$$

and

$$\frac{1}{2} I_2 H_1 f_2 \cos \left(\frac{\pi}{3} + \phi_2 \right),$$

and as $H_1 = H_2$, the sum of both is equal to

$$\frac{1}{2} 1.73 f_2 H_1 I_2 \cos \phi_2.$$

Now, $E_2 = 1.73 p_1 f_2 H_1$.

Therefore, when s_2 is the number of the secondary phases,

$$D = \frac{s_2}{2 p_1} E_2 I_2 \cos \phi_2. \quad (66)$$

As before, the torque is consequently equal to the energy induced in the armature divided by the angular velocity, p_1 .

If highly prominent poles are avoided in a multiphase motor, and if the creation of a rotary field is favored in every other way, the periodic fields will not be strongly developed.

Under this supposition, the equations for the torque with rotating armature and the equation for the performance of the motor are to be derived.

(To be continued.)

The Theory and Design of the Closed-Coil, Constant-Current Dynamo.—III.

BY HENRY S. CARHART.



SIMILAR series of experiments, made on an old Gramme machine of 3,000 or 4,000 watts capacity, built at the University of Michigan in 1876-1877, gave a different result. The measurements were made by simply connecting a third brush to the upper brush holder and measuring the potential difference between it and the main brush in different parts of the field. The actual induction to which the armature wire is subjected in different parts of the field and at the same distance of two commutator bars from the main brush is thus measured.

The following table contains one series of observations:

No. of observation.	Current in amperes.	P. D. between main brushes.	P. D. between main and third brush.
1	9.5	191	4.9
2	9.5	170	5.4
3	9.5	145	5.5
4	9.5	127	6.2
5	9.5	111	6.5
6	9.5	77	7.7
7	9.5	62	7.8
8	9.5	54	7.7
9	9.5	47	7.4

In this case the induction increases throughout the larger extent of the movement of the brush. But in this machine the knee of the characteristic curve is reached at about 13 amperes, while in the other machine it is found at 7 amperes. The armature reaction in this older machine, when run at 10 amperes, is relatively less than in the other one, run with the same current. This is further evident from the fact that with the old Gramme run at 10 amperes an increase in the current, due to lessening the external resistance, is always accompanied by an increase in the P. D. between the main and the third brush; while with the 10-light Sperry machine and others, with similarly saturated field, an increase in the current when the brushes are fixed decreases the P. D. between the main and the extra brush. The reason is this: If the field is saturated, but not the armature, an increase in the current does not appreciably increase the field, but it does increase the armature reaction, and so cuts down the total P. D. between the main brushes, as well as between one

main and a third brush; while with an unsaturated field and a magnetically weaker armature, an increment of the main current produces a greater increment in the field than in the armature reaction. With the same old Gramme machine run at about 18 amperes an increment in the current produced a decrease in the P. D., both between the main brushes and the main and third brush. The armature reaction then became relatively larger than the increase in the field magnetism. But this old machine exhibits perfectly the property of governing by rocking forward the brushes on a diminishing load, with no more sparking in one position of the brushes than in another.

Hence, it is clear that for practically sparkless commutation it is not necessary that the induction near but under the brush shall be a constant. The effective means by which, with constant current, the brushes can be set in any plane round the commutator cylinder is the reactive effect of the armature. This fact is brought out quite clearly by plotting the integrated potential differences between the upper or positive brush and the third movable one as ordinates to a horizontal line. The data are the same as were employed to plot the first curve in Fig. 1. If Fig. 2 is examined a decided flattening in the curve will be found at 180 degrees, the position of the negative brush. The same flattening may be seen at 0 degrees. All curves plotted with data obtained at different loads show the same diminution or stay of the inductive process near the poles of the armature. The armature at these points paralyzes the field. As the poles of the armature move round they sweep away the lines of force of the field, and only enough remain to produce an E. M. F. competent to offset the E. M. F. of self-induction, and, in addition, cause the newly directed current to grow to its normal value as the coil passes out from under the brush.

This reactive power of the armature may be utilized to effect approximate regulation for constant current without brush shifting. But for this purpose the load cannot be a maximum. The poles of the armature must be far enough forward to produce increase of magnetic leakage. As an example of what I mean, a forty-light machine had its brushes locked in such a position that it maintained 30 lights with 10 amperes current. Ten lights were then cut off, and then ten more, with but small increase of sparking, and the ammeter showed an increase of current from 10 to 12 amperes only. A change of two amperes is within limits possible for practical lighting. The machine was then completely short circuited by placing a large bar of iron across its terminals without dangerous sparking. This means that the characteristic of the machine beyond a crown of the curve

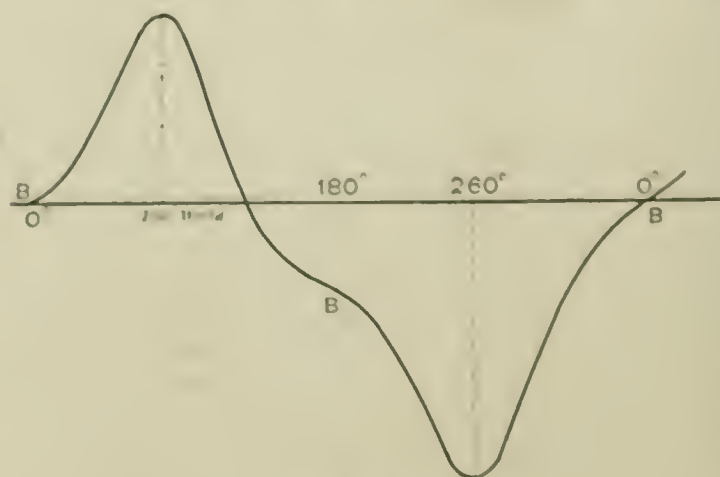


FIG. 2.

approached a vertical line, the ideal characteristic of an automatic constant-current dynamo.

The conditions requisite for sparkless commutation of a constant-current machine are therefore quite clearly defined. The self-induction of the short-circuited coils must nearly balance the field in all positions of the brushes. Both Mr. Esson, in a paper before the British Institute of Electrical

Engineers,* and Prof. Ryan, in a paper before the American Institute of Electrical Engineers,** lay down the condition that the brushes must be kept under the pole faces in order not to enter the weakened field between the pole corners. And yet I have seen constant-current machines working with the brushes beyond the extreme tips of the poles with no increase of sparking. I do not regard this condition as absolutely essential, since at maximum E. M. F. the brushes may be moved through a considerable angle without appreciable change in sparking.

Prof. Ryan states in his paper above referred to that "the magnetizing force impressed by the field ampere turns must be uniform at all points between the pole faces." This condition is favorable to sparkless commutation, but not essential. It has to do with the area of the sparkless position of the brushes for any given load. If the field is fairly uniform this area will be about the same in different parts of the polar faces; if the field is far from uniform, sparkless commutation may yet be secured, but a smaller variation in the current will produce more sparking than when the field is uniform; for the sparkless area on either side of the brush with a given external resistance is then much reduced. The region controlled by the armature poles is much more limited in extent than when the field is uniform.

It follows that the single magnet type of field is not suitable for a constant-current machine. This fact was remarked upon by Mr. Esson. For a two-pole machine the double magnet type of field is to be preferred. If then the iron is reduced at the back opposite the middle of the polar surfaces, and the poles are thickened and rounded off rather blunt at the ends to prevent saturation, the field induction will be sufficiently uniform without the necessity of resorting to the chopping away process applied to an English single magnet machine, described in Slingo & Brooker's "Electrical Engineering."

Quoting from Prof. Ryan, "The air gap is made of such a depth that the ampere turns required to set up the magnetization through the armature, without current, and for the production of the highest E. M. F. that the machine will be called on to give, shall be a little more than the armature ampere turns when it furnishes its normal current. Then as long as the brushes are kept under the pole faces the non-sparking point will be wherever the brushes are placed. This will be the case whether the armature is or is not saturated." Again, "The impressed field ampere turns are in excess of the armature ampere turns by that amount which is just sufficient to produce a weak positive field that will reverse the current in the coil when its terminal bars at the commutator pass under the brush." This latter statement appears to be borne out by the data given, but the machine experimented on was one giving a maximum of only 35 volts and 22 amperes, and its performance can scarcely be considered a sufficient guide for the design of machine required to furnish several thousand volts and a current of from 9.5 to 10 amperes. Again, I have known a 40-light machine converted into a 50-light without any change in the field whatever. The armature either contained more iron or was wound with a larger number of turns of wire. Both methods have been followed without effect on the sparking. The first method leaves the armature ampere turns the same; the second increases them 25 per cent. If the relation pointed out by Prof. Ryan holds in the first armature, it cannot also hold in the second, with such a material increase in the armature turns.

Further, if this relation does hold, there still remains unanswered the question of relative cross-section of iron in armature and field. Shall the core of the armature be saturated or not? Mr. Esson says that 17,000 lines per square

centimetre is the best practice in England for constant potential machines.

I know of one constant-current machine in which the armature core is forced well up toward the highest saturation obtainable with a dynamo machine. It is able to produce very high E. M. F., but it does not govern sparklessly by means of a single pair of brushes. Two other types of machines of which I have data work with 11,000 lines per square centimetre in the armature. In both of these recent changes are along the line of increasing iron and decreasing copper in the armature. I have explicitly advised the use of more iron in the armature for two years. One manufacturer recently told me that he is now following my advice with most gratifying results. With the same number of turns on the armature the output is greatly increased. To what extent the iron in the armature can be increased is an open question. It has now been carried beyond a cross-section equal to 75 per cent. of the wrought iron in the field cores. If increased cross-section of the core introduces sparking, this can be avoided by increasing the number of bars on the commutator, so as to decrease the self-induction in the section under the short circuit by the brush. Indeed, if the output is kept the same, increase of iron decreases turns of wire, and to that extent decreases self-induction. In a machine with two pairs of brushes the effect is to diminish the angular embrace of each pair.

It is interesting to compare two machines of almost exactly the same capacity, but differing widely in relative core section and armature turns. Let the two machines be represented by A and B. The data of the two are given in the following table:

Machine	Total volts.	Revs. per min.	Segments in commutator.	Turns per segment.	Total turns.	Cross-section of iron. Sq. in.	Lines per sq. in.
A.....	2,900	1,000	132	36	4,752	26.5	70,800
B.....	2,800	875	120	72	8,640	14.0	79,600

The maximum number of lines of force running through the armature of the A machine is 3,650,000; of the B machine, 2,213,000. The two machines are designed for the same current of a little under 10 amperes. The ratio of the ampere turns on the armatures of the two is nearly inversely as the cross-section of their iron cores. The ampere turns on the B armature are 82 per cent. greater than on the A armature. It is not probable that the field ampere turns on B are 82 per cent. in excess of those on A. Unfortunately, those particular data are lacking, but the magnetic circuit of A is quite as good as that of B. It does not appear at all probable, therefore, that Prof. Ryan's rule applies to both machines. It is gratifying to our national pride that American designers have successfully carried the Gramme ring constant-current dynamo to an output far beyond what some foreign electricians, with more theory and less practice in this direction, still declare to be impracticable. The writer of a series of articles now running in the London "Electrical Review"* says: "Beyond about 1,000 volts it is found, in general, to be impracticable to work a closed-coil armature: for either there will be a wasteful lead, or there will be vicious sparking under the brushes, or the current will flash from strip to strip, and will destroy the commutator." * * * "It seems more than probable that machines of this kind will not stand any serious alteration of load if worked at higher voltages, owing to the great range of lead which would be required, and the consequent sparking and flashing over." Again he says: "There is of necessity a large armature reaction in certain forms of arc light machines; and when this is the case the brushes would require to be shifted right into the centre of the pole arc before sparking would cease, if there were very many turns on each section. The wastefulness of this practice consists in the large number of back turns and cross turns which it involves." But in the face of such declarations as these a large number of American ma-

* London "Electrician," March 21, 1890.

** Proceedings, Vol. VIII., p. 465.

* "Electrical Review," Aug. 25, 1893.

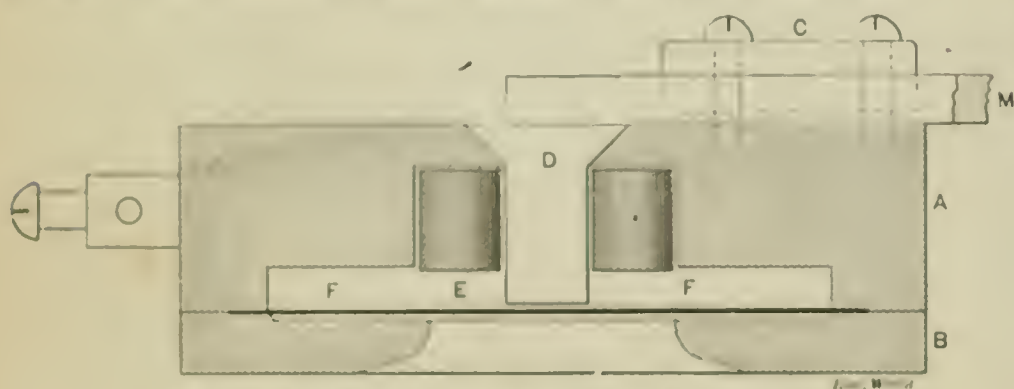
chines are now running at an output of 9.6 amperes and from 5,000 to 10,000 volts. A very considerable number of closed-coil Gramme rings giving 5,000 volts are in actual use without breakdown and without any of the fatal drawbacks predicted by the writer quoted.

The design of closed-coil Gramme rings for high potential arc lighting has thus far been limited to the two-pole type of field magnet. This involves the maintenance of higher speed than engineers find desirable. The conditions of present practice and the requirements for the immediate future demand a new departure in this class of dynamo design. All indications point toward a multipolar machine of about 50 kilowatts capacity and slow speed. The armature will contain a liberal amount of iron, much larger than would be found desirable for constant potential machines. Such a dynamo is already in demand, and it will find an immediate field for the lighting of large cities.

How to Make a Telephone.

The telephone of which we give detail sketches is simple to make, and will give excellent results on lines up to 5 or 10 miles in length, when used both as a receiver and transmitter. If used in connection with a transmitter, it will answer for any length of line. If the line is to be constructed in close proximity to electric railway or light wires, it should be made a metallic circuit, but elsewhere a grounded circuit will answer just as well.

The materials required for a set consisting of two telephones, one for each end of the line, are as follows: One-ounce No. 36 silk covered magnet wire; two horseshoe magnets, 4-inch; two flat-head stove bolts, 1-4 inch diam. and 1 1-2 to 2 inches long; a piece of photographer's tintype large enough to cut from it two round diaphragms 2 1-2 inches in diameter; four small wood screw binding posts; twelve flat-head brass screws 3-4 inch long. Use well-seasoned mahogany, or any hard wood, about 7-8 to 1 inch thick for the main case and for the cover that 1-4 or 3-8 inch in thickness is best. The pieces of wood should be larger than the di-



SECTION OF TELEPHONE, FULL SIZE.

mensions given, and if marked and bored before sawing to the size desired, there will be less likelihood of splitting.

Fig. 1 is drawn full size, from which the dimensions for the holes in the wood can be obtained. The 2 1/4 inch space under the diaphragm, *F*, can be bored with an extension bit or marked out with a compass and cut out with a chisel. The inch hole should be bored with a bit which has no lip in order to leave strength sufficient for countersinking the head of the stove bolts. The depression in the lid need not be as deep as shown, but merely enough to clear the diaphragm. The stove bolt should be cut to a length a little longer than necessary and then carefully filed and fitted by trial so that when in place it will just clear the diaphragm.

For the wire a spool should be made of cardboard to fit the bolt and central hole neatly; the spool with wire, *E*, is wrongly shaded in the cut.

The magnet is held in place, with one pole over the bolt head, by a piece of wood, as shown in Fig. 2 (half-size), the part between the legs of the magnet just clearing the bottom

when the screws are home. The ends of the wire are brought to the binding posts through two small holes bored in the wood.

Magneto bells are the best and, in the end, the cheapest for use as call bells.

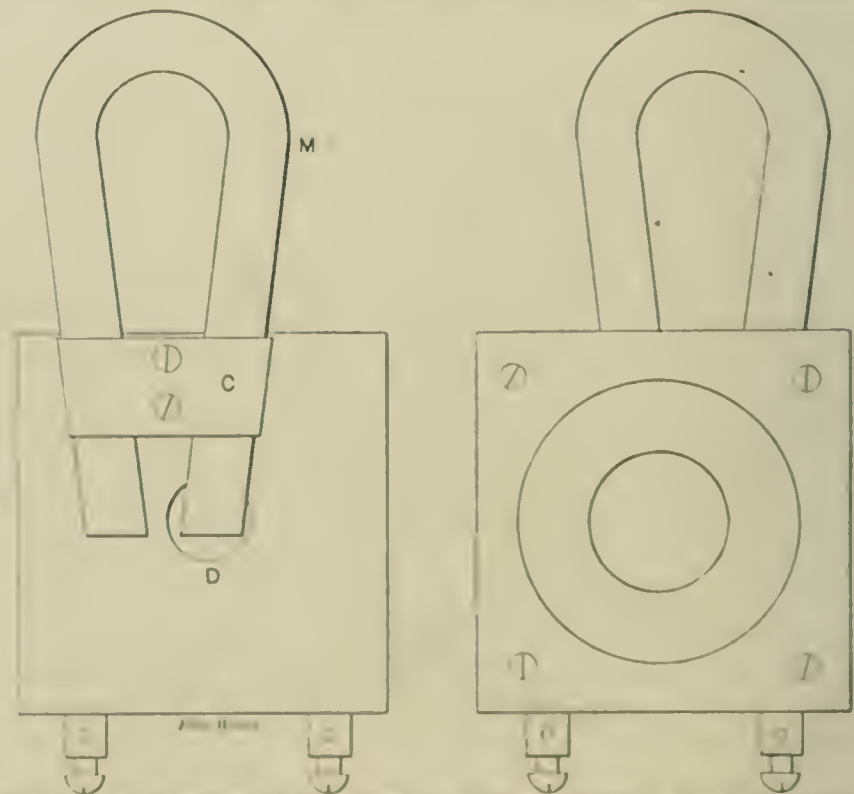
Pennock's Misrepresentations.

To the Editor of *The Electrical World*:

Sir—My attention has been called to a circular issued by George B. Pennock, in which my name is unwarrantably used, and which, to say the least, is misleading. To a casual observer this circular would appear to be a report of an exhaustive test of the Pennock system of multiplying power by a "volt distributor," and assumes that I would be responsible for the statements and figures contained therein.

A more careful perusal of the subject, however, would reveal to the experienced engineer the real object of the author (to mislead), so there is little need of warning for those posted in such matters; but, for the benefit of laymen and would-be investors in electrical enterprises, allow me to say, through the columns of your paper, that I have never made a detailed report of the Pennock system for any one.

At the solicitation of a client I called at Mr. Pennock's laboratory to investigate the workings of the machine. After listening to Mr. Pennock's explanation of and claims for his crude apparatus, and taking several readings of the current output of his battery while doing various kinds of work, I was unable to report a multiplication, or saving of power, to



REAR AND FRONT VIEWS OF TELEPHONE, HALF SIZE.

any extent whatever by the use of the "volt distributor," much less to verify Mr. Pennock's large claims to economy.

Before seeing Mr. Pennock's apparatus, I suggested to my client that the electricians of the country condemned it as a fraud, though I visited the exhibit in Boston with a fixed determination to give due credit to any point of merit I might be able to discover.

My search for merit was fruitless, but a careful survey of the exhibit and of the methods employed by Mr. Pennock and his satellites confirmed the report I had heard of this system in other localities.

A hungrier set of parasites is seldom seen, seeking as their prey any one with money. The bunco steerer's vocation seems mild when compared with this.

In the circular referred to Mr. Pennock has arbitrarily assumed conditions and figures to suit his own convenience, but the facts in the case do not warrant a single conclusion in this truly wonderful document.

New York, Feb. 3, 1894.

C. S. VAN NUIS

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE
PRINCIPAL FOREIGN
ELECTRICAL JOURNALS.
BY CARL HERING.

(Note.—Owing to a delay in the transatlantic mails, most of the foreign journals were not received in time to be abstracted for this issue.—C. H.)

ELECTRO-PHYSICS.

Dimensions of the Absolute Temperature.—In an article in "La Lum. Elec.," Jan. 13, Mr. Abraham states that the quantity of electricity is proportional to and has the same dimensions as the ratio of the pressure of a gas multiplied by its volume and divided by the absolute temperature; by equating these and finding the value of the absolute temperature he concludes that the latter has the same dimensions as an electrical potential. He quotes from an adverse criticism of Mr. Ostwald, who claims that this result is absurd, on the ground that two magnitudes which are proportional do not necessarily have the same dimensions; to this criticism Mr. Abraham replies at some length. (In the Digest, July 22, Aug. 19 and Dec. 2, references and abstracts of other articles on this subject will be found.)

Electrostatic Charge at a Distance.—"La Lum. Elec." and "L'Elec.," Jan. 13, reprint in abstract a Physical Society paper by Mr. Hurmuzescu. If the knobs of an electrostatic machine be separated to a distance greater than the greatest sparking distance, and if one of them is replaced by a point, a gold leaf electroscope placed at one or two metres distant will show electrification; if the machine is then stopped and short circuited, the electrification of the electroscope will continue to show a charge, which will have the same sign as that of the point; if the point is negative this action will be greater; the transference, he says, is due to the convection by the molecules of air; if the knob of the electroscope is enclosed by an insulator and the rest of the apparatus enclosed in a metallic cage, this transference will no longer take place.

A Fundamental Error in Maxwell's Treatise.—The "Elek. Anz.," Jan. 14, publishes a paper by Mr. Schwartz, who has for some time been a contributor of mathematical articles in this journal; he claims to show that there is an error in Maxwell's treatise, which forms the foundation of many of his deductions; Laplace's formula, which, he says, is intended to express the relation between magnetism and electricity, is entirely incorrect; at present, he says, electricity is no longer considered as being matter, but is a form of energy; Maxwell's error, he states, lies in the fact that he places as equivalent the unit of the so-called dynamic magnetism quantity (magnetismusmenge) and the "so-called static electric quantity of the motive or electromotive force"; besides this, he claims that Maxwell overlooks entirely that magnetism is only the action of surfaces; in his opinion an isolated magnet pole is "scientific nonsense."

Atmospheric Electricity on the Eiffel Tower.—"L'Ind. Elec.," Jan. 10, reprints an Academy paper describing briefly observations made on the Eiffel tower; the mean was about 3,000 volts, while frequently it was above 10,000; a diagram is given of the diurnal variation for a certain day observed on the tower and in the observatory in Paris; it shows that the variations become simpler the greater the height; the minimum in the morning occurred at exactly the same hour, while the maximum in the evening was reached about

one hour sooner on the tower. In order to be able to use a quadrant electrometer for measuring these high potentials without sacrificing sensitiveness, a number of small condensers, well insulated, are connected in cascade; by varying their number the potential at the electrometer may be made any desired fraction of the whole.

Atmospheric Electricity.—"La Lum. Elec.," Jan. 13, refers briefly to Mr. Lechner's observations regarding the St. Elmo fires, the object of which was to observe the sign of the electricity; it was found variable, especially during storms, but in general it is more often negative in winter than in summer; when the snow is in large flakes it is positive, while when in small flakes it is negative.

Dielectric Constants of Biaxial Crystals.—The article by Mr. Borel is continued in "La Lum. Elec.," Jan. 13; he discusses the measurements of the constants by Boltzmann's method of attraction.

MAGNETISM.

Forces Acting on Bodies in Magnetic Fields.—"La Lum. Elec.," Jan. 13, reprints a mathematical paper by Mr. Vaschy on the calculation of the forces to which bodies are subjected in the electromagnetic or magnetic fields.

DYNAMOS AND MOTORS.

Experiments with Brown Non-Synchronous Motors.—The same article which was abstracted in the Digest Jan. 20 is published also in "La Lum. Elec.," Jan. 13, in which is given in addition a diagram showing the complete connections of the motor and the starting devices.

Irregularities in the Action of Dynamos.—The article in "L'Elec." is continued in the issue of Jan. 13.

ARC AND INCANDESCENT LIGHTS.

Alternating Arc With and Without Reflector.—In "L'Ind. Elec.," Jan. 10, a set of curves is given for an alternating arc lamp, with and without a reflector; the reflector is horizontal and placed immediately above the arc; the maxima were 550 c. p. without and 912 with reflector; the mean spherical illumination was 275 c. p. without reflector, while the mean hemispherical illumination was 498 c. p. with reflector.

Fredeureau Diffusers.—The article in "L'Elec." by Mr. Haubtmann is continued in the issue of Jan. 13, and is devoted entirely to a discussion of the optical principles.

Electric Lighting in 1803.—The "Zeit fuer Elek.," Jan. 15, quotes from a German newspaper dated Jan. 3, 1803, mentioning that a locksmith named Probst had generated electric light sufficient to illuminate a whole room; the description is vague, but the light appears to have been generated by sparks, or some form of high-tension electric discharge.

ELECTRIC RAILWAYS.

Locomotion in London.—Mr. Graff Baker in London "Lightning," Jan. 11, advocates the construction of overhead electric railways on single columns, running through the vacant spaces at the backs of buildings, between two parallel streets on which the buildings face; he advocates single lines, preferably in the form of a loop, entering the city by one route and leaving by another; the arches where

the line crosses the street could be made quite ornamental, as these will be the only places where the line will be visible; the cost of such railways, he claims, would be far lower than that for any other means of locomotion; as an alternative, he suggests a system of light railways running below the surface of the ground in an open cut, 10 feet wide and 16 feet deep, running like the other between the backs of buildings.

A New System of Electric Traction.—According to the "Zeit. fuer Elek.," Jan. 15, certain firms are about to introduce a new system, in which the cars are hung on the tracks which convey the current; the first road to be constructed is one from Barmen to Elberfeld across a river.

Cost of Traction.—"La Lum. Elec.," Jan. 13, gives a few figures regarding the cost of traction; for horse traction in Paris and Frankfort, about 19 cents per car mile; several other horse lines in Paris, about 16 cents; for locomotives without boilers, 14.5 cents; for horse lines in Rouen, 13 cents; for compressed air at Nantes, 11 cents; and for electric traction at Frankfort, 9.6 cents.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Alternators in Parallel Driven by Gas Engines.—Mr. Roux in "L'Ind. Elec.," Jan. 10, discusses the question of driving dynamos by means of gas engines, stating that when alternators in parallel are used it would not be satisfactory if they are run independently; in such cases they should be coupled with each other rigidly, and in case an additional machine is added to the station at a future time, one should be careful to see that it is a machine of the same type.

Gas Engines in Electric Lighting Stations.—"La Lum. Elec.," Jan. 13, publishes the first part of an article by Mr. Bourquin, in which he discusses at some length the subject of gas engines, incandescent lights, the combination of the two, and gas lights; it appears to be based on papers already mentioned in the Digest, Oct. 14 (Hoest) and 28. The costs under various conditions are worked out, based apparently on prices in Paris.

Gas Engine Test.—"La Lum. Elec.," Jan. 13, publishes a test by Mr. Witz of a Crossley gas engine in an electric lighting installation.

Cologne and Amsterdam.—"L'Ind. Elec.," Jan. 10, gives an illustrated description of these two stations.

WIRES, WIRING AND CONDUITS.

Increasing the Safety of High-Tension Alternating Currents.—The "Bul. de la Soc. Int." for December publishes in full a paper by Mr. Claude, read before that society, on his method, which consists essentially in connecting a self-induction between the cable and the ground; the method was described in the Digest Dec. 16 and 23; in the present paper it is described more fully than in the previous publications. In the discussion which followed Mr. Arnoux said that it was not certain that this would reduce the current sufficiently to make it safe, and that nothing less than a practical test would determine this; with the usual alternating currents, he believes that danger ceases when the current through the body is below about 0.01 ampere; in his reply Mr. Claude claims that even though it has not been proved by an actual test that this device is sufficient, yet there is no need to prove that the danger is at least lessened thereby.

Impedance of Aerial Lines.—"L'Ind. Elec.," Jan. 13, contains an article on this subject by E. H., based on the paper by Mr. Kennelly on "Impedance" (transactions of A. I. E. E., April, 1893, reprinted in abstract in The Electrical World May 6), in which the impedance factors are given; that is, the factors by which the resistances must be multiplied to give the impedances or apparent resistances; in the present article the factors for a frequency of 100 are reproduced, and the following rule is given for deducing from these the factors for any other frequency: Square the im-

pedance factor, subtract one, multiply by the square of the new frequency, divide by 10,000, add one, extract the square root; the result will then be the new impedance factor.

Fireproof Insulation.—In the "Zeit. fuer Elek.," Jan. 15, the following flexible cement, invented by Mr. Snedekor, is given; it is used for painting wires and is said to be a fireproof insulator; the proportions by weight are about as follows: Forty magnesia, 28 tallow, 15 pulverized asbestos, 30 liquid glue, 15 glycerine and 1-4 chromate of soda or potassium; to this may be added an additional 1-4 of lamp-black if it is desired to make it black.

Conduits.—"La Lum. Elec.," Jan. 13, describes and illustrates the molds for the manufacture of the Crumpton and Chambers multitubular conduits.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Accumulators in Telegraphy.—According to an abstract from "Ann. Teleg." in the "Bul. de la Soc. Int.," the French Telegraph Department has decided, after a long series of experiments, to adopt accumulators almost exclusively for the central station at Paris; the auxiliary apparatus is described very briefly.

ELECTRO-CHEMISTRY.

Purification of Sewage.—"Cosmos," Jan. 20, publishes part of a report of a commission appointed to examine the Hermite process at Havre; the report is unfavorable; it is claimed that the action is not sufficiently rapid for completely sterilizing the materials before they are discharged into the river, and therefore does not furnish sufficient guarantee for prompt disinfection; it shares with other chemicals the property of deodorizing the material, in which respect it has a certain utility.

Copper Baths.—Dr. Langbein in the "Zeit. fuer Elek.," Jan. 15, states that in dissolving the copper sulphate in cyanide of potassium, if sulphates and ammonium, potassium or sodium hydrate be added, it will prevent the cyanogen from escaping; he has found that in that case not a trace of cyanogen escapes; such baths give very dense, strong and hard deposits.

Combination of Phenol and Iodine.—According to the "Zeit. fuer Elek.," Jan. 15, a German chemical firm produces the combination by electrolyzing an alkaline solution of phenol mixed with iodide of potassium; in this way the drug aristol may be produced at the positive electrode.

Libbey Battery.—From a short illustrated description in "La Lum. Elec.," Jan. 13, this consists of a disc of zinc and one of copper, separated by a sponge in the form of a disc, the whole being held together by means of a bolt and an envelope of porcelain, having a hole for the introduction of the liquid.

Theryc & Oblasser Accumulator.—A short illustrated description is given in "La Lum. Elec.," Jan. 13. It consists essentially of the usual plate enclosed in a perforated envelope of celluloid.

MISCELLANEOUS.

Electric Welding in 1851.—In an article by Mr. Andreoli in "La Lum. Elec.," Jan. 13, after a brief reference to galvanoplastic soldering in 1850, he quotes at some length from a French patent of Derode, No. 13,716, dated 1851, which describes a method of welding in which electricity is applied in addition to the heat of a furnace; Derode shows the advantages of using electricity and ascribes its action to its heating effect, its chemical effect and to its magnetic effect; regarding the latter effect, he believes that the magnetic attraction separates the iron from the carbon, thus increasing the ease of union of the iron; the current is applied in the form of "shocks" in rapid succession; to show its effect, he heated some pieces of cast iron in a furnace and found that by applying an electric current they were immediately lique-

fied; he also found that there was less oxidation; he claims to have welded pieces of cast iron, which, on being afterward fractured, did not break at the joint; he also welded steel to iron for tools like picks; he also covered cast iron with lead. In applying the process to soldering, he finds that the solder is more easily melted and combines with the metals better when a current is used. Mr. Andreoli claims that Derode should, therefore, be given the credit of the origination of electric welding. He also describes experiments of Napier, made in 1844, in which the electric current was applied to electro-metallurgical processes, showing that the action may be hastened by the aid of a current.

Lightning and Trees.—“L'Elec.,” Jan. 13, publishes from another paper the results of experiments made by Mr. Dimitrie, in which he subjected different pieces of wood to the sparks from a Holtz machine and found that they conducted quite differently; oak was easily pierced, while beech was quite resisting; the richness in water did not seem to have any influence, while the amount of oil contained was of great importance; woods containing starch and but little oil, like the oak and poplar, have much less resistance than those containing oil, like the beech; pine contains oil in the winter, but is very poor in oil in the summer, when it resists only as much as the oak; by extracting the oil with ether, the woods are as easily pierced as those containing starch; those containing starch are less easily pierced when living than when dead; the bark and the foliage in all the trees are poor conductors. The conclusions are in accordance with observations, as in a certain case 159 oaks were struck by lightning as against 21 beech and 59 pine trees; the danger of being struck as compared with beech is 5 for Norway pine, 33 for pine and 48 for oak.

Ozone.—According to abstracts in “La Lum. Elec.,” Jan. 6, of articles from “Rev. Scien.” and “Ann. de L'Int. Pasteur,” Nov. 25, antiseptic action of ozone ceases when the volume of ozone falls below 0.1 per 100 of air; in a vessel containing 0.5 mgr. per litre, which mixture has a strong odor and can be breathed only with difficulty, cultures of microbes were not affected, while milk and fruits putrefied as easily as in the air; it is stated that it loses its disinfecting property if the proportions are less than 0.05 per 100 in volume, which prevents it from being used in dwellings, as the air cannot be breathed if the proportion is greater.

Lessons from the World's Fair.—In an editorial on this subject the Lond. “Elec. Rev.,” Jan. 12, refers to the Fair, using the words “big” and “biggest” very freely, and stating that “only in one thing it was not big, and that was as an exhibition of the science and art of electricity and electrical engineering, from a European point of view”; but this, it says, does not refer to Americans, for whom “this show has, for the first time, brought the advanced state of electric lighting and electric power before the notice of thousands, who, prior to their visit, had only dim notions of the various developments” (!); “from the European point of view, the electrical exhibits were of little or no interest, and therefore as an exhibition we consider it was a failure.”

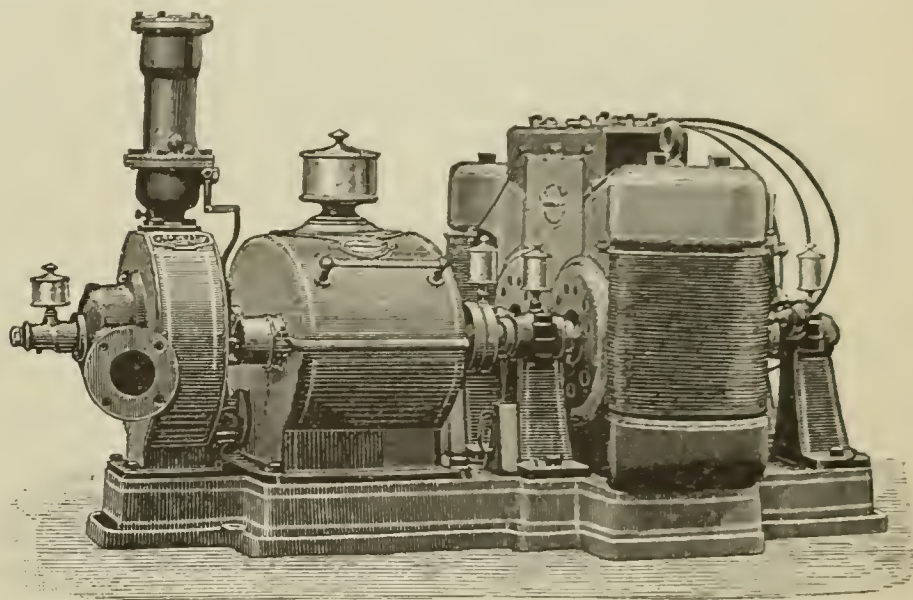
Graphics.—In “Lightning,” Jan. 11, Mr. Harrison gives the first part of an article intended to assist those who are discouraged by imaginary difficulties from reading very simple papers on electrical engineering; the idea is not to teach graphics but to teach one how to read graphics.

Electric Language.—“L'Ind. Elec.,” Jan. 10, contains an article by Mr. Picou under this heading, in which he points out the importance of using correct expressions regarding electrical subjects, in legal and other like documents.

National Laboratories.—Mr. Guilbert in “L'Ind. Elec.,” Jan. 10, discusses the subject of national laboratories for researches.

The De Laval Steam Turbine.

The steam turbine we illustrate, of which Wiley & Phelps, 1,422 Monadnock Building, Chicago, are agents, is in principle similar to the well-known axial jet turbine for water, being so arranged that the steam has acquired the same pressure as the surrounding atmosphere before reaching the turbine wheel. The steam then passes between the blades of the turbine at a constant relative velocity and in a clear jet, without any disposition to further change its pressure or specific gravity. Consequently the movement of steam in the turbine is according to the same laws as for water, and the blades of the turbine can therefore be constructed in the same manner as if designed for water. The expansion of steam takes place in the nozzle, and is caused simply by mak-



COMBINED STEAM TURBINE AND DYNAMO.

ing its sides diverging. As the steam passes through this channel its specific volume is increased in a greater proportion than the cross-section of the channel, and for this cause its velocity is increased, and also its momentum, till the end of the expansion at the last sectional area of the nozzle. A pressure of seventy-five pounds and expansion to an absolute pressure of one atmosphere give a final velocity of about 2,625 feet per second. The momentum being as the square of the velocity, it is evident that although the density of the steam is small, the impact will be considerable at the enormous velocities which are obtained.

Since expansion is complete, it is evident that all necessity of tightening against steam pressure ceases at the end of the nozzle. And since live steam does not come in contact with any of the working parts of the turbine, the machine operates equally as well with superheated as with saturated steam, thus furnishing an opportunity for economizing heat which is impossible in ordinary steam engines on account of the sensitiveness of the packing boxes to temperature.

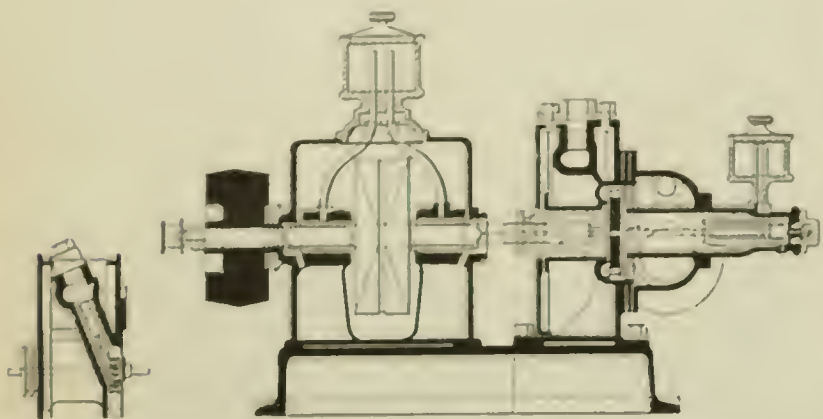
The most characteristic feature of the De Laval steam turbine is perhaps its great speed, the velocity of periphery in the 5 h. p. being 574 feet per second. De Laval has succeeded in solving the problem introduced by this high speed by providing the turbine with a flexible shaft. This yielding shaft allows the turbine at the high rate of speed to adjust itself and revolve around its true centre of gravity.

With such high speeds great power can be obtained from small apparatus. The 20-h. p. turbine is only 6 1-2 inches in diameter, 5-8 inch thick and mounted on a shaft which is less than 1-2 inch in diameter. The shaft is long and the bearings on each side of the wheel are far apart, besides which the shaft is reduced in diameter between the wheel and the bearings to give flexibility. In the gearing box the speed is reduced from 30,000 revolutions to 3,000 by means of a driver on the turbine shafts, which sets in motion a cog

wheel of ten times its own diameter. These gearings are provided with spiral cogs, carefully cut and placed at an angle of about 45 degrees. On account of the high velocity, all tensions caused by the transmission of power are very slight. Consequently the cogs can be quite small, which is one of the conditions for even running of the gearing. The governor is attached to the inner end of the shaft of the large cog wheel, and is of new and original construction. The frame is provided with a slightly conical pin, by means of

power house is 93 feet in width and 120 feet in length; the engine room, which we illustrate, is 47 feet in width, the boiler house, which is alongside, being 73 feet wide. The whole floor space of the engine room is controlled by a traveling crane which allows all the machinery to be easily placed or moved from one part of the building to another, or, in case of repairs, allows the parts to be handled quickly and economically.

The frame work of the building is entirely of steel, the



NOZZLE AND VERTICAL SECTION OF DE LAVAL TURBINE.



INTERIOR OF MODERN POWER HOUSE.

which the governor is held in a corresponding hole in the shaft. The segment weights or wings are movable on edges, thus with the least possible friction. When the governor revolves the weights diverge, their inner ends push a pin forward, and this pin in turn causing the cut-off of the valve. A spiral spring is enclosed in the governor and keeps the weights in a state of equilibrium at the desired speed. The governor is enclosed in a metal box to protect it from dust. By means of a lever the movement of the governor pin is transmitted to the governor valve.

Oil for lubrication is furnished from the two oil cups shown. In the lower part of the gearing box waste oil from the four bushings collects, as also oil from the cog wheels. It is drawn off by means of a small cock.

The turbine is manufactured from the best quality of steel, the blades are cut in one piece with the body of the turbine by means of a milling machine. A steel ring is then shrunk on outside of the blades. This ring prevents the steam from passing over the ends of the blades, and removes the tendency of the turbine to act as a fan.

The practical advantages which characterize the steam turbine as against the oscillating engine are: Simplicity of construction, very small passive resistance, small space, small weight, and a very regular speed. This last property is a consequence of the continuous admission of steam to the turbine wheel, and the equalizing effect of the rapidly revolving parts of the engine. Furthermore the governor is here in readiness for instant effect on a variation of the load, and does not, as is the case with piston engines, have to wait until the slide valve admits steam to the cylinder next time.

The economy of this steam turbine is proved by numerous tests, of which one lately made, it is claimed, by the best engineering experts, with a 50-h. p. turbine dynamo showed that an effect of 63.7 h. p. was obtained with a consumption of steam of 8.05 kg. (= 19.73 pounds) and a consumption of coal of 1.12 kg. (= 2.67 pounds) per horse power per hour.

A Modern Power House.

We illustrate an interior view of the power house of the Worcester Traction Company, Worcester, Mass., which, including the traveling cranes, was designed and built by the Berlin Iron Bridge Company, of East Berlin, Conn. The

side walls being of brick placed between the steel columns. A power house constructed in this way is absolutely fire-proof, and there is no reason, it is claimed, why any company with such a building should carry insurance, as the risk of fire is reduced to an absolute minimum. The manner in which the traveling crane facilitates the handling of machinery will be in particular appreciated by superintendents of power stations. This modern style of structure is rapidly finding its way into popular favor and fast replacing the inferior wooden buildings for light and power stations.

Cutter's New Pole Pulley.

Encouraged by the success of his swivel pole pulleys, George Cutter, The Rookery, Chicago, has now brought out a new form, which promises to become even more popular than the old one. To secure an ordinary pulley to a pole in such a way that the rope will not chafe against the edge of the casing is not so simple a problem as it would seem at



IMPROVED POLE PULLEY

first thought. For this reason Mr. Cutter came out a few years ago with a pulley which was swiveled on a special pole screw and which would always swing into line with the hoisting rope. This form has been used extensively throughout the country, and with excellent results, the saving in the wear of the rope being quite noticeable.

As the cut shows, the new type has the same style of sheave with weather-proof casing, the change being in the support, which is in the shape of a malleable iron wall plate. This plate can be readily secured to the pole by means of two lag screws, making an extra strong and rigid support.

The Shawhan-Thresher Dynamo and Motor.

One of the latest and most interesting claimants for attention in the electrical field is the Shawhan-Thresher dynamo and motor, manufactured by the Shawhan-Thresher Electric Company at Dayton, Ohio. We give herewith a good view of this machine, from which it will be seen that it is of the ironclad type. The parts are so proportioned as to afford absolute protection to the field coils and give perfect ventilation, while the magnetic material is so placed as to correspond with the theoretical blow of magnetic induction, thus forming one of the best designs for a field and giving a high efficiency.

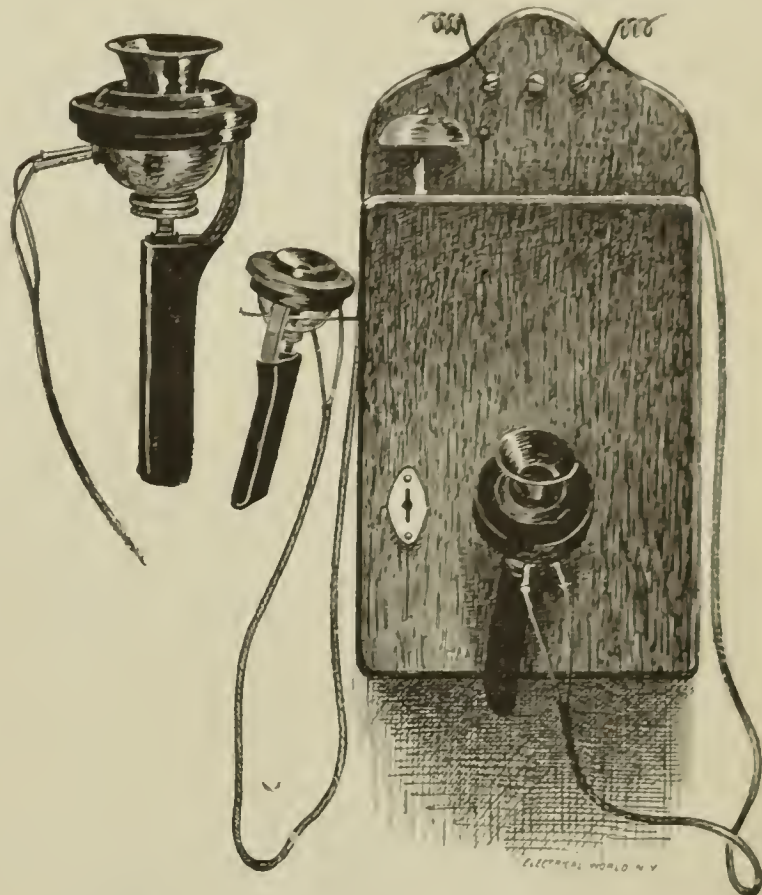
Two castings are employed, the journal boxes being cast solid to the lower one. This gives unusual strength and rigidity, and brings the centre of gravity very low, insuring great steadiness in operation. The bearings are self-oiling and self-centring, universally supported. The armature is of the drum type, exactly balanced and so wound that the coils of highest potential are farthest apart. This feature lessens the liability of burn-outs.

The machine is strong, compact and all parts are easily accessible, and is made in all sizes from 1-2 h. p. upward. The same company is also making a power generator of the multipolar type.

The Brown Magnetophone.

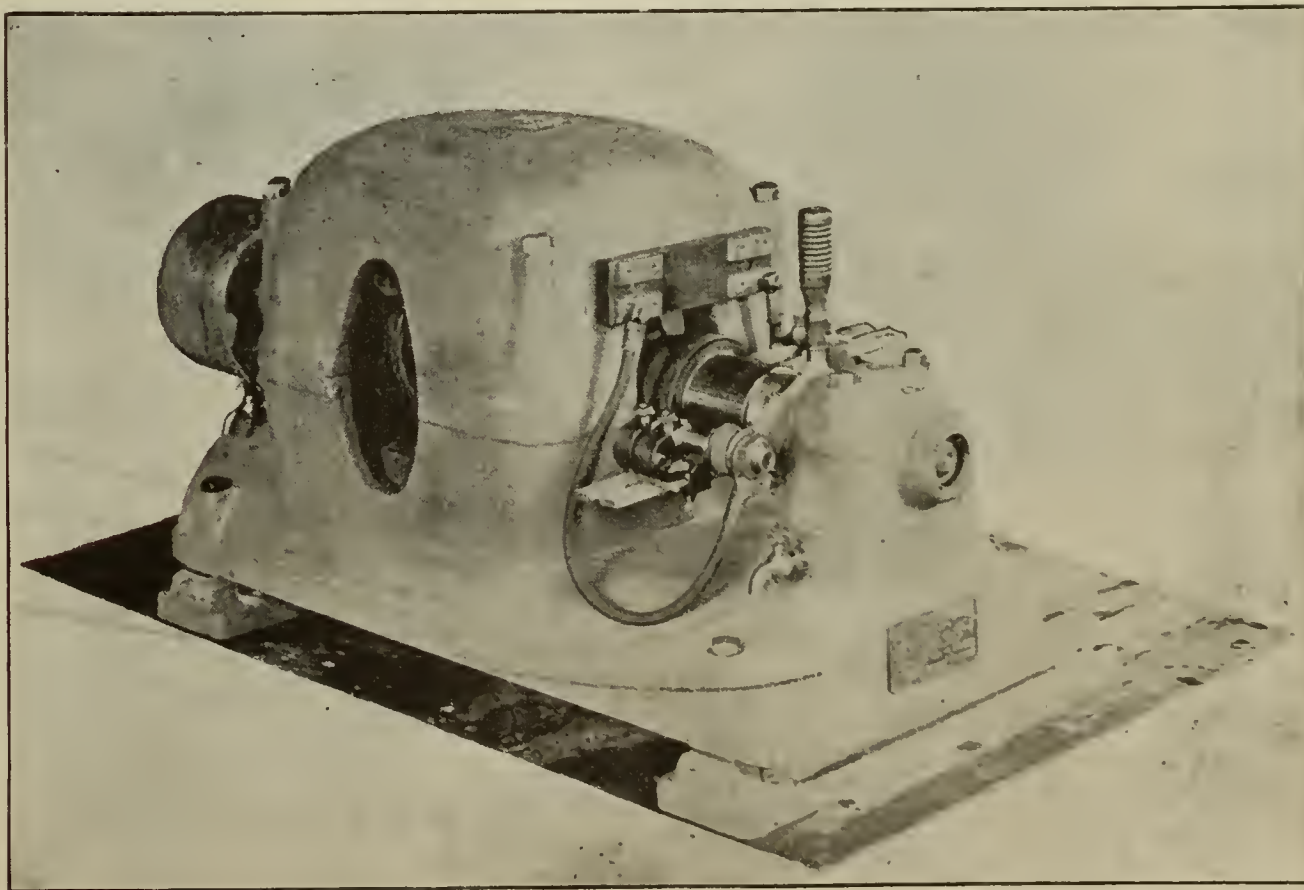
The efficiency of the Brown magnetophone, manufactured by the Brown Telephone and Telegraph Company, Chicago, appears to depend upon a C-shaped magnet and the manner in which it operates upon the diaphragm. It is claimed to differ in function in one very important particular from the bar magnet, so generally employed in the telephonic art. As is well known, the bar magnet is placed with one pole opposite the

of its vibrations in the electrical field, created by the magnet, it follows that its efficiency is decreased in exact ratio to the strength of the inward pull which opposes these vibrations. It is this obstructive action on the diaphragm which rendered



THE IMPROVED BROWN MAGNETOPHONE.

the transmitter and receiver covered by the letters patent granted to Alexander Graham Bell Jan. 30, 1877, and now just expired, of no practical commercial utility until the invention of Berliner, with its carbon patents and battery cur-



THE SHAWHAN-THRESHER DYNAMO AND MOTOR.

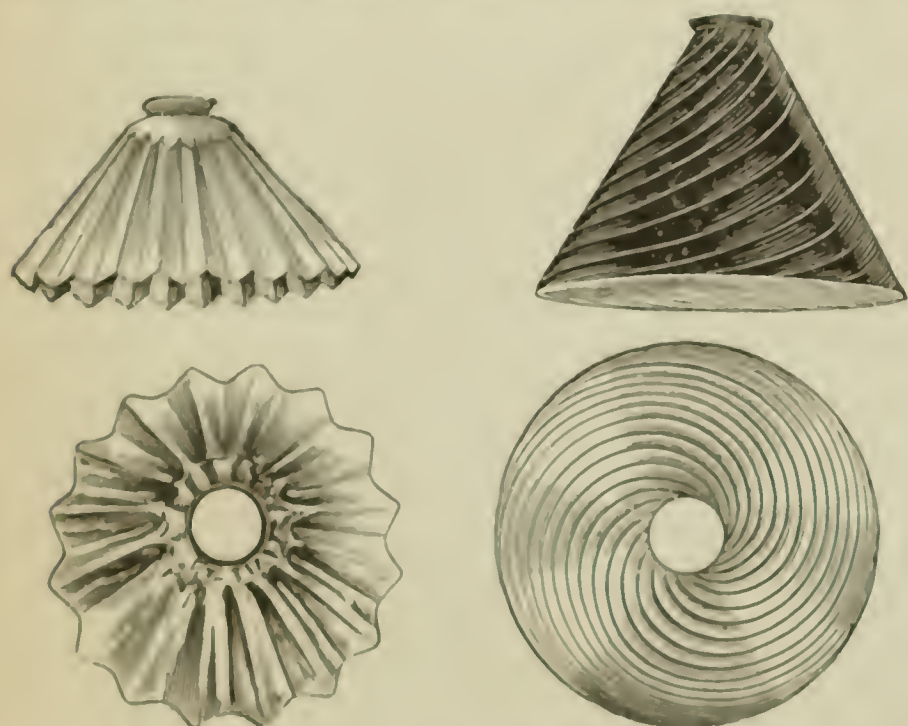
centre of the diaphragm, upon which it exerts a strong attractive pull inward toward the pole of the magnet. As this pull is constant, it operates to lessen the freedom of the vibration of the diaphragm much the same as would a weight suspended by a string from its centre. Now, as the efficiency of the diaphragm depends upon the freedom and amplitude

rements, was engrafted upon them, and which give to the Bell system its present efficiency. Berliner, however, does not by this method remove the inward pull of the magnet on the diaphragm, but employs means to largely overcome its injurious effects. Brown, however has proceeded upon a distinctly different theory than that of Berliner. His object has

been to so employ the lines of magnetic force as to neutralize the inward pull, so obstructive and hurtful in the bar magnet. Referring now to the Brown magnet, we find that the end presented to the diaphragm is divided into two arms, creating poles of the same polarity, one of which is placed in actual contact with the diaphragm at a point on its periphery and the other near and opposite its centre. As the lines of magnetic force emanating from these poles under the laws of electricity must repulse each other, the pull upon the centre of the diaphragm is now not all one way, for the attractive force of the centre arm of the magnet is in part neutralized by the lines of force emanating from the side arm. Such is the theory, and the facts show that the diaphragm is so relieved of the inward pull at the centre as to be free to respond to the slightest vibrations of the voice in speaking; it being practicable, so it is claimed, to communicate, with its use, in whispers. Brown's method, as above imperfectly presented, will, it is believed, prove of some interest to electricians. The economic results claimed for it are also important. It obviates the use of the battery and gives to the magneto type of telephone long-distance carrying power. Being apparently free from infringement of the Berliner patent, it is also of interest to the public in its promise of wholesome competition.

Silvered Glass Reflectors.

The E. P. Gleason Manufacturing Company, Houston and Mercer streets, New York, which is constantly adding to



SILVERED GLASS REFLECTORS.

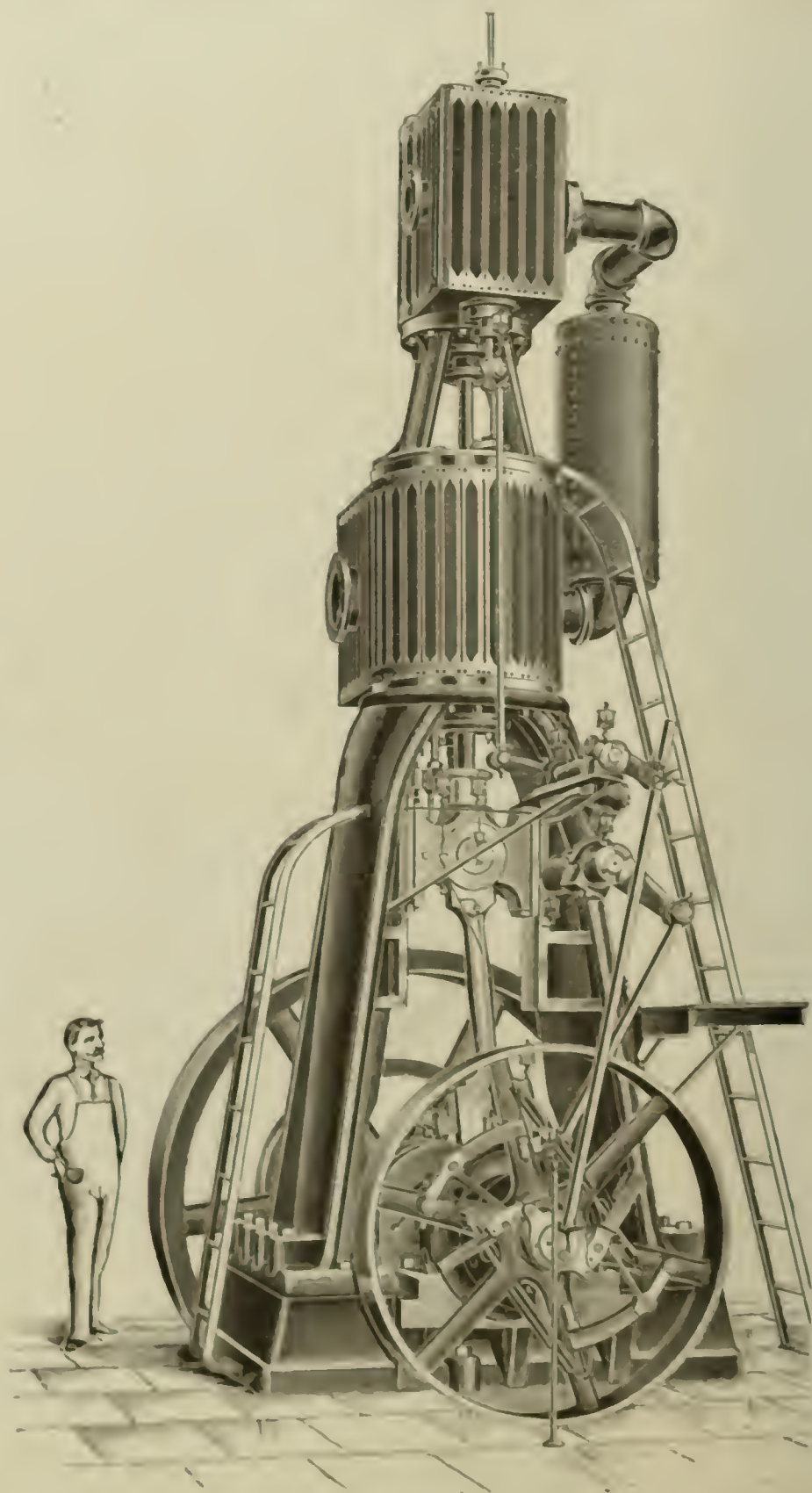
its already large line of appliances for electric lighting, is now in the market with a number of new styles of silvered reflectors, as shown in the accompanying cuts. They are made in shape of the staple electric shades, radial fluted and spiral corrugated, richly silvered inside, enameled green outside, greatly increasing the candle power of electric lamps. The reflectors are always bright, cannot tarnish and are easily cleaned, and another advantage is that they can be made cheaply.

A Vertical Compound Engine.

The engine illustrated herewith is one of a pair which was built expressly by the Fitchburg Steam Engine Company, Fitchburg, Mass., for electric light and power use in Oakland, Cal. It has a high-pressure cylinder 16 inches in diameter, a low-pressure cylinder of 27 1/2 inches, with a 20-inch stroke, and making 210 revolutions per minute. These engines are run under 130 to 140 pounds pressure, and

will develop easily 350 to 400 h. p. The valves used are the special patented expansible valves used in all the engines built by this company, which are balanced and adjustable to take up all wear during the life of the engine. The valve of the high-pressure cylinder is operated directly from the automatic governor, controlling the cut-off from zero to five-eighths. The valve of the low-pressure cylinder is operated from an adjustable eccentric fastened to the back of the automatic governor case, so that any point of cut-off can be obtained from 1-5 to 2-3 stroke.

The crank shaft is of the best forged steel, 12 inches in diameter, with bearings 24 inches long, the offset crank being carefully counterbalanced so that the weight of the reciprocating parts and the centrifugal weight of the connecting rod are balanced as nearly as possible. The exhaust from the



VERTICAL COMPOUND ENGINE FOR ELECTRIC LIGHT AND POWER USE.

high-pressure cylinder is carried through a steam jacketed receiver, which has also an outside jacket to prevent radiation, giving perfectly dry steam slightly superheated for the low-pressure cylinder.

The heavy flywheel has a clutch ring firmly bolted to it connecting with the other half of the clutch upon the main line shaft, which is thus driven direct from the engine, upon

which are friction pulleys belting to the dynamos and motors. The steam cylinders are carefully covered with non-conducting material, and then with iron lagging, polished upon its raised surfaces.

The workmanship of these engines is the very best possible, the valve motion is very simple, and the closest economical results are being obtained.

Trolley Overhead Fittings.

The Mansfield strain insulator illustrated in Fig. 1, made by the Ohio Brass Company, Mansfield, Ohio, consists of two steel staples moulded into a special insulating compound. The medium size is 7 inches in length over all and weighs less than three-quarters of a pound and has a breaking strain of 10,000 pounds.

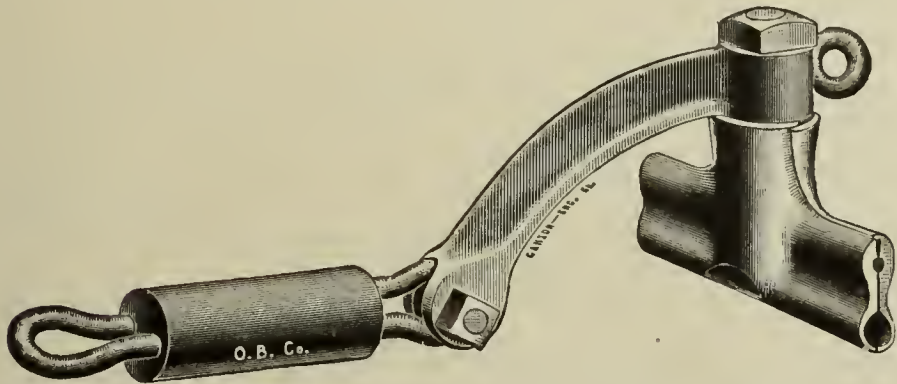


FIG. 1.—STRAIN INSULATOR, PULL-OVER AND TROLLEY CLAMP.

Fig. 1 also shows a single curve pull-over, fitted with a "type W" trolley clamp. The yoke and adjustable cone are made in one malleable casting and insulated from the span wire by a small Mansfield strain insulator. This pull-over was designed to meet the demand for a curve insulator of minimum weight for use on the smaller sized trolley wires.

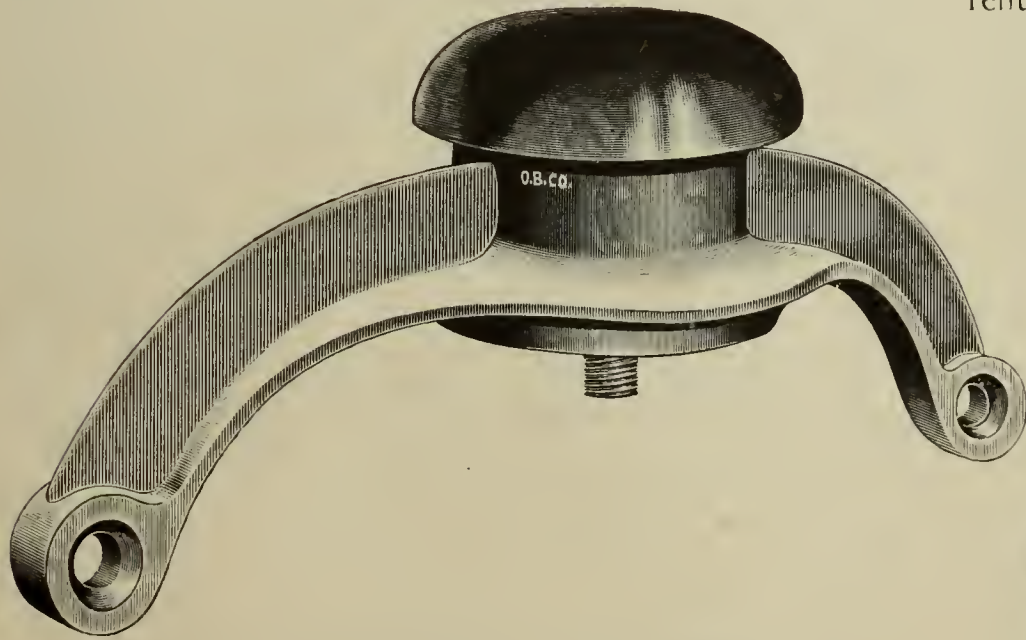


FIG. 3.—DOUBLE CURVE PULL-OVER.

It is strong enough to support No. 0 B. & S. trolley.

The double curve pull-over, Fig. 3, is similar in design and detail to the single curve pull-over, but has a double yoke and double insulation. The double and single curve hanger bodies are made from the best malleable castings, giving strength with lightness. The insulating pieces are moulded from a special compound selected after the most exhaustive tests. The top and bottom pieces are dovetailed together and also into the hanger body, thus preventing any surface leakage. The iron casting, which is moulded into the insulating cap, is larger than the inside diameter of the collar, which does away with the possibility of the hanger stud pulling through and allowing the trolley wire to drop to the street.

New Book.

FOURIER'S SERIES AND SPHERICAL, CYLINDRICAL AND ELLIPSOIDAL HARMONICS, With Applications to Problems in Mathematical Physics. By William Elwood Byerly, Ph. D. Boston: Ginn & Co. 1893. 287 pages. Price, \$3.15.

This little volume treats of Fourier's Series, that is the development of a function of x in terms of sines and cosines of whole multiples of x , and of the corresponding series formed of those higher transcendental functions known as Legendre's Coefficients, or Zonal Harmonics; Laplace's Coefficients, or Spherical Harmonics; Bessel's Functions, or Cylindrical Harmonics; and Lamé's Functions, or Ellipsoidal Harmonics. This is a good deal of ground in an abstruse branch of mathematics to be covered in the allotted space, but after a careful examination of the book we are impressed with the highly creditable manner in which this has been done.

The work is called an elementary treatise. Elementary treatises on all subjects have very commonly the fault that in the author's intense desire to make them elementary he leaves out so much of fundamental principle that they are really more difficult to understand than more advanced works. The work under consideration is particularly free from this fault; the introductory chapter is a very satisfactory foundation for the succeeding chapters, and we would call especial attention to the remarks on differential equations, beginning with Article 2. We do not remember to have seen a more clear and concise statement of the principal properties of the kind of differential equations here treated. It may be as well to remark for the benefit of the uninitiated that the branch of mathematics treated in this book has a wide application in all departments of physics. Not only are many problems in the theory of electric and magnetic potential flow of currents, etc., soluble by these methods, but what has a more direct bearing on practical engineering, Fourier's series are the key to the theory of alternating currents, and the improvement of the design of alternating current machinery.

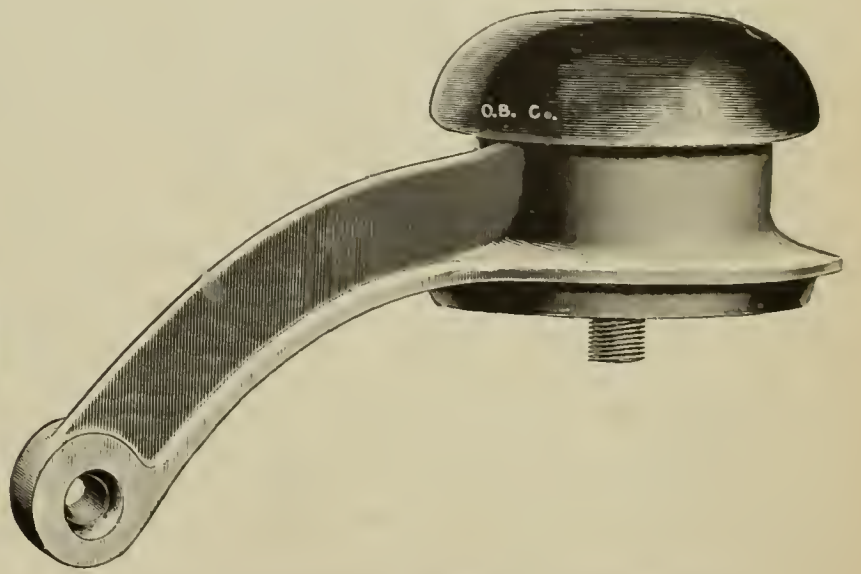


FIG. 2.—SINGLE CURVE PULL-OVER.

The intrinsic difficulty of the subject and not its lack of utility is the reason for its not being more generally known, and the work before us seems to present it in as simple a manner as its nature will admit. There are tables in the back of the book of numerical values of some of the functions employed. They are somewhat incomplete, which is a pity, as complete tables of all and any transcendental functions, excepting logarithms and trigonometrical functions, are scarce in the English language.

Chapter IX. is an interesting historical summary of the subject. The mechanical get up is good and the work as a whole is a creditable production, and to be recommended to students and the higher class of electricians generally.

THE SAFETY INSULATED WIRE AND CABLE COMPANY recently supplied to the Metropolitan Telephone and Telegraph Company, of New York, one of the largest cables ever laid in this country. It is nearly a mile long, is $2\frac{3}{4}$ inches in diameter and weighs $21\frac{1}{2}$ tons.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Feb. 3, 1894.

THE CITY OF CAMBRIDGE, MASS., is petitioning the legislature for authority to build a conduit for the purpose of burying electric wires, and renting the same.

THE BROCKTON (MASS.) STREET RAILWAY COMPANY will begin as soon as the frost is out of the ground to construct three roads—one to Bridgewater by way of West Bridgewater; another to Elmwood through East Bridgewater, and another to Stoughton.

LYNN, MASS.—The General Electric Company has received an order for 400 railway motors. These, together with the car equipments, are to be made at Lynn, while the generators for the same are to come from Schenectady. It is understood that the order is to be got out by April 1. The General Electric shops in this city were right in the path of the \$76,000 fire of this week, and were only saved by the efficient fire shutters.

NOTWITHSTANDING THE SEVERE STORMS which have prevailed for several days, the West End Railway Company has been comparatively free from difficulty in running its regular trips. In fact, the public has not been materially discommoded at all. In Providence, R. I., and some other points in New England there has been some little trouble experienced in operating lines owing to the excessive severity of the storm, but it was quickly removed.

THE UNION RAILROAD COMPANY, of Providence, is to maintain wagons equipped to do service on the wires at all the fires where the trolley is near enough to be dangerous. These wagons are to be provided with every appliance for rapid work in cutting or unstringing wires, and will be manned by a regular force of men, who will sleep at the several stations for the wagons and be just as ready to act as the regular firemen. Horses will be kept on hand for service and everything will be arranged with a view to reaching fires as quickly as possible.

EX-GOVERNOR RUSSELL appeared this week before the Committee on Manufactures of the Massachusetts Legislature in opposition to the bill before that body to enable cities and towns to manufacture gas and electricity for municipal purposes. The Governor drew out from the committee the admission that the bill would hurt the companies, and that it proposed a principle which was not applied to any water company or to any railroad company in the State, and which might cripple seriously any company to which it was applied. The ex-Governor said he was not opposed at all to the principle of municipal ownership, but he objected to the principle of allowing municipalities to come in and destroy the profits of the companies, thus destroying their property.

THE MASSACHUSETTS ELECTRICAL ENGINEERS AND MECHANICS' ASSOCIATION, of Boston, gave its fourth annual ball at Copley Hall, in that city, on the evening of Jan. 29, before a crowded gathering notwithstanding the stormy weather. The electrical decorations and display surpassed all its previous efforts. Current for the incandescent lamps was furnished by the Edison Illuminating Company and for the arc lights by the Boston Electric Light Company. The Telephone Employees' Mutual Benefit Association, of Boston, gave its annual ball on the evening of Jan. 27. It was the most successful in the history of the organization.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
956 Monadnock Building, CHICAGO, Feb. 3, 1894.

THE STAR ELECTRIC LAMP COMPANY, with Mr. A. S. Terry at the helm, is again in the field in earnest. Its new "vapor" lamp has created an unusual amount of interest everywhere, and sales have been very large.

GEORGE C. CARTER & CO. is another firm that finds itself fortunate in the matter of a good business for this season. It is particularly busy in its carbon department, sales of American carbons being far above anything expected.

THE CAMPBELL AND ZELL COMPANY has closed in the past ten days the following contracts for the Zell improved water tube safety boilers: Keiffer Brothers, New Orleans, La., 50 h. p.; William Henderson, second order within six months, 317 h. p.; Valentine Blatz Brewing Company, Milwaukee, Wis., 1,164 h. p.; Citizens' Street Railway Company, Indianapolis, Ind., 1,500 h. p.

THE METROPOLITAN ELECTRIC COMPANY is now nicely located in its handsome new headquarters, 188 Fifth avenue. Some remaining touches have to be added to make this place one of the most attractive stores in Chicago. It finds business as brisk

as it would like, and with others predicts a bright outlook for the trade. Mr. W. H. McKinlock has just returned from a most successful trip East.

THE BROWN TELEPHONE AND TELEGRAPH COMPANY, of Manhattan Building, is flooded nowadays with inquiries for its perfected magneto telephone, which promises to be one of the most prominent of the candidates for new telephone honors, now that the Bell patents have expired. Its offices in the Manhattan Building are crowded every day with people anxious to secure telephones and advice on their installation.

MR. F. S. TERRY is now giving his attention entirely to the affairs of the Sunbeam Lamp Manufacturing Company, having accepted the office of secretary. He has entirely severed his connection with the Ansonia Electric Company, with which company, or as it was formerly called, the Electrical Supply Company, he had been continuously connected since its organization in 1880, having gone with that company first as its bookkeeper and later on, in the winter of 1884-5, opened the branch in Chicago.

THE ELECTRIC APPLIANCE COMPANY has been keeping a large extra force busy for the past few weeks taking care of the large shipments which are being received and placed in stock in preparation for spring business. The Appliance company is materially increasing its storage and shipping facilities, and when the alterations are completed its arrangements for promptly handling large orders will be perfect. Several carloads of wire, cross arms and insulators have been taken care of during the past week and considerably more is still in transit.

CENTRAL ELECTRIC COMPANY.—This company is receiving many inquiries and orders for its "metal-sheathed bushings," a new and valuable product made especially to conform to the requirements of the underwriters' rules. This bushing has many points of superiority over any other kind permitted by the rules, filling every requirement of porcelain tubes, and being much cheaper. The company is very busy on all lines and reports business as exceedingly brisk, considering the season and the general trade depression.

THE GREAT WESTERN MANUFACTURING COMPANY.—This company is among those who have nothing to complain of from hard times. During the past thirty days they have sold many important plants, among them being the following: Of 600-light alternating dynamos, with all appurtenances, it has sold one to each name given: Ladd, Illinois; Manselona, Michigan; Reed City, Mich.; Fond du Lac Light and Power Company, Fond du Lac, Wis.; Freeport Electric Light and Power Company, Cripple Creek, Col. Of direct connected dynamos it has sold the following: One 80-kw. compound wound to A. L. Ide & Son, Springfield, Ill. Of direct current constant potential dynamos, one 320-light compound, with plant, to Duncan Brewer & Co., Duluth, Minn.; one 320-light compound, with plant complete, C. P. Brisk & Co., Chicago; one 500-light compound, with plant, Harter Electric Company, Chicago; one 6-kw. direct current motor, Harter Electric Company; one 12-kw. direct current motor, same firm. Also one 50-light arc dynamo and 50 arc lamps, to the Waco Street Railway, Waco, Tex.; one 12-light arc dynamo, with lamps, Cudahy Packing Company, Cudahy, Wis.; one 12-light arc dynamo, with lamps, Iron Mountain, Minn. In addition to this list, it has disposed of an enormous amount of "Clark" wires and cables and general supplies.

English Notes.

(From Our Own Correspondent.)

LONDON, Jan. 17, 1894.

SUGGESTED DEVICES FOR ALTERNATE CURRENT HIGH-PRESSURE CIRCUITS.—At a recent meeting of the Societe Internationale des Electriciens, M. Claude described a device suggested by him for diminishing the danger of touching a wire belonging to a high-pressure alternate-current circuit; a danger which cannot be got rid of by merely adding to the insulation, since the danger is mostly due to the capacity of the wires with regard to earth. M. Claude's remedy is to actually connect each lead to earth through a low ohmic resistance choking coil, the mains then behaving as if they had next to no capacity. The device is of considerable scientific interest, but it seems likely that these choking coils will prove expensive, and as they are only efficacious so long as the mains are not connected to earth through a leak having a little self-induction, the insulation would in addition have to be very good, so that there would be no corresponding saving in this direction. In this connection, I may mention that the inquest on the unfortunate man who was killed in September last in one of the transformer sub-stations belonging to the London Electric Supply Corporation was concluded yesterday, the inquest having been adjourned to enable the man who was injured at the same time to attend and give evidence. The accident occurred through an employe being sent by inadvertence to clean a "live" switch gear, the man who was sent being merely injured, whilst the man who sent him and came to his rescue was killed. The verdict of the jury was as follows: "We are of opinion that had the man been provided with gloves, the danger might have been averted. We also think that the rules and regulations of the station should have been printed, and that the second man should have been more competent before undertaking the work."

THE DOUGLAS-SAXEY ELECTRIC TRAMWAY.—An electric tramway seven miles long, part of which came into operation last summer, is in course of completion between Douglas and Saxey in the Isle of Man. The line runs along a very pretty coast, and has necessitated the construction of a large number of bridges, embankments and sea walls. The only feature of electrical interest is that this line is yet another example of the preference felt in this country for taking the current off an overhead wire by means of a pair of under-running metal bars.

News of the Week.

Electric Light and Power.

SOUTHERN PINES, N. C.—The new Piney Woods Hotel is to have an electric light plant.

LOCKPORT, N. Y.—The Council is discussing the matter of a municipal electric lighting plant.

ADRIAN, MICH.—Adrian residents are agitating for the establishment of an electric lighting plant.

NEWVILLE, PA.—The incoming Council will likely consider the matter of an electric lighting plant for the borough.

BRUNSWICK, MO.—The city has voted for the issuance of \$10,000 in bonds for the purpose of a municipal electric light plant.

GLENCOE, MINN.—Residents of Glencoe will soon vote at a special meeting in the matter of electric lights and waterworks.

DAWSON, GA.—A company with a capital stock of \$10,000 is being organized with the purpose of erecting an electric light plant.

Brooklyn, and the matter has been referred to the Committee on Lamps and Gas. Mirabehn L. Towne is president of the company.

ONTONAGON, MICH.—The matter of electric lighting for the streets of Ontonagon will be discussed at the next meeting of the Council.

WILMINGTON, WINDHAM COUNTY, VT.—Joseph Courtemanche offers to put in a dynamo, provided 125 subscribers can be secured.

SEARCY, ARK.—W. G. Brown and J. T. Pullen, of Little Rock, have been granted a franchise for the erection of an electric lighting plant.

WYNNE, ARK.—An electric lighting plant is to be erected. The Kennedy & Morlock Slave Company can be addressed for information.

LINDENHURST, SUFFOLK COUNTY, L. I., N. Y.—Residents of Lindenhurst are contemplating the establishment of an electric lighting plant.

YORK, PA.—The matter of the proposed electric lighting plant for York was again brought up at a meeting of the Council, but no definite action was taken.

MINNEAPOLIS, MINN.—City Engineer P. W. Cappelien will present to Council at the first regular meeting in February plans for a municipal lighting plant.

GRAND RAPIDS, MICH.—The Council contemplates an election to vote in the matter of a bond issue of \$100,000 to purchase or build an electric lighting plant.

GRAFTON, WIS.—An electric light plant is to be established at one of the water powers at Grafton to light the village, Cedarburg and other villages in the vicinity.

CHICAGO, ILL.—The West Side Improvement Club is seeking to secure electric lights for Douglas Park. A committee has been appointed to wait on the Park Board.

HENWOOD, W. VA.—Henwood business men are soliciting subscriptions toward the \$25,000 capital needed for the establishment of the proposed electric lighting plant.

BATTLE CREEK, MICH.—The Battle Creek Electric Company, of which W. A. Foote is manager, has decided to put in a machine to furnish electric power to factories, etc.

SPARTA, WIS.—The city is contemplating the purchase of the plant of the Thayer Electric Light Company and using it for city purposes as well as for household lighting.

SPRINGVILLE, ERIE COUNTY, N. Y.—The trustees of Springville have given the water company there the privilege of putting up poles and stringing wires for electric lights.

ROCHESTER, N. H.—A resolution was adopted authorizing the committee on electric lights to ascertain if the city could save money by purchasing an electric lighting plant.

BRISTOL, PA.—Residents are discussing the matter of any lights and a committee has been appointed to confer with the electric light company relative to the price per light.

KANSAS CITY, KAN.—The Consolidated Electric Light Company will soon commence extensive improvements on its electric lighting plant. Benjamin Erickson is the president.

CEDAR RAPIDS, IOWA.—Proposals are called for to Feb. 22 for lighting the streets by electricity, gas or kerosene, as per details to be had of J. L. Hardwick, chairman of the Board of Public Works.

WHITEHALL, N. Y.—McLachlin & Son, owners of the Whitehall

electric light plant, recently burned, state that they have put men to work rebuilding and will again furnish light as soon as possible.

INDIANAPOLIS, IND.—The County Commissioners met and formally rejected all bids for lighting in the court house and county jail. Others will likely be called for under new specifications.

NEW ORLEANS, LA.—Bids will be received by J. B. Fischer, chairman of the Young Men's Gymnasium Club, for the erection of an electric light plant and installation of electric lights and fans in the building.

BALTIMORE, MD.—Edward D. Preston, of Clay street, has received the contract for rebuilding the works of the Brush Electric Light Company, recently burned. The figure is about \$40,000. Henry Brauns is architect.

MEMPHIS, TENN.—The New Lyceum Theatre Company wants plans for a fireproof steel building for a theatre. A steam-heating plant, dynamo and furniture are to be included in the cost, which is \$100,000. S. D. Kyle is secretary.

LAWRENCE, MASS.—The Board of Aldermen have instructed Mayor Rutter to support the bill now pending in the legislature authorizing cities and towns to construct and maintain conduits for telephone and electric light wires.

EASTON, MD.—It is proposed to introduce a bill into the present Legislature authorizing a bond issue of \$50,000 for the purchase of the present waterworks and electric lighting plant or for the creation of new plants, if same cannot be bought at a fair price.

EASTON, PA.—Sealed proposals will be received to 5 p. m. Feb. 15th by L. M. Fine, City Clerk, for about 6 miles of hard-drawn insulated wire, to be used for Gamewell Fire Alarm System, as per samples furnished, on application to Thos. P. Ricker, chief of the fire department.

BATAVIA, N. Y.—The bid of the Fort Wayne Electric Company for the proposed electric light plant of Batavia has been accepted at \$12,776.99. The system is similar to that operated in Batavia at present, and which gave satisfaction when operated by the Consolidated company.

EVERETT, MASS.—An order was introduced at the meeting of the Board of Aldermen that the Mayor file a petition with the legislature for permission to hold a special election to see if the citizens will accept the authority granted by the statutes to erect and maintain an electric light and gas plant.

GREAT BARRINGTON, MASS.—The new cotton company expects to have its own electric lighting plant for lighting its mills at Riverdale, near here. It is also reported that the Great Barrington Electric Light Company wishes to have the Riverdale corporation furnish power to light the streets all night.

PALMYRA, N. Y.—The Canandaigua Electric Light and Railroad Company has built an electric light plant at Littleville, which cost \$50,000, and they state that as soon as the plant is completed they will light Palmyra, Manchester, Shortsville and Canandaigua. It is now believed that Palmyra will have electric lights in the spring.

HAMILTON, OHIO.—The special committee appointed by the Council to superintend the construction of the new electric lighting plant consists of Messrs. Helvey, Miller, Wirtz and Rice. They have met Engineer Charles Cornell and looked over plans and specifications. The engineer has been instructed to have those in shape for the next meeting of the Council.

MOLINE, ILL.—The city has owned and run its own electric light plant for a number of years, but found that it was a very poor investment and that their lights were costing them much more per year than they would if they made a contract with the local company. The electric light plant has therefore been sold to the Rock Island People's Power Company and a two years' contract made with them for light.

ANNAPOLIS, MD.—Proposals will be received until noon of the 15th of February for lighting the streets of Annapolis with gas or electricity for three or five years. Proposals will also be received for the construction of an electric lighting plant with sufficient capacity to light the city and for the necessary construction of lines, lamps, etc. Bids will be received together or separately. At present the city is using 41 arc lights of 2,000 c. p. and 85 incandescents of 16, 25 and 50 c. p. Thomas Hinkelheber is clerk.

LE ROY, N. Y.—Charles F. Prentiss, president of the Le Roy Salt Company, has for the past year been engaged in the construction of an electric transmission plant to utilize the power of Okauch River, one mile north of the village. A stone power house 4x50 has been built of material blasted out of the wheel pit. One 24-inch McCormick cylinder gate turbine has already been set. It has a 4-foot feed pipe and develops 1.6 h. p. with a 25-foot head. Another turbine of 22 h. p. will be added, with an electrical equipment, consisting of a power generator of 150 h. p. and 70-light incandescents machines. A steam plant will supplement this and possibly a trailer road for the use of the stone quarry.

ROCK ISLAND, ILL.—The People's Power Company, which purchased from E. M. Russell, former manager of the Brush Electric Company, Cleveland, Ohio, the gas and electric companies held in his name, and the Moline, Ill., company, is erecting a large new electric light station on the water power located between Moline and Rock Island. The electric light stations in Rock Island and Moline will be abandoned and all their good apparatus removed to

the new station. A large amount of new electric lighting apparatus has been recently purchased from the Brush company, and plans have also been laid for the distribution of the power the two cities will need. The new People's Power Company has a capital stock of \$300,000. C. H. Deere is president, S. S. Davis, secretary; C. O. Nason, treasurer.

The Electric Railway.

GREENSBORO, N. C.—The City Council has granted a franchise for a street railway. C. H. Harman is manager.

MEDFORD, MASS.—The West End Railway Company will soon begin work on its proposed stable and car house in Medford, off Salem street.

MEMPHIS, TENN.—It is reported that the East End street railway will change its motive power to electricity. W. M. Smeed is president.

CAPE CHARLES, VA.—The Baltimore "News" is authority for a statement that an electric line is contemplated between Cape Charles and Parsonville.

LITITZ, PA.—John R. Bricker, of Lititz, is receiving subscriptions for bonds of the proposed electric railway between Lititz, Lancaster and Manheim.

FITCHBURG, MASS.—The selectmen have decided to grant the franchise for the West street line to the Fitchburg and Leominster Railway Company.

CALAIS, ME.—Mr. A. F. Gerald, of Fairfield, has been in Calais for the past few days in the interest of the electric railway which he proposes to build there.

McKEESPORT, PA.—The McKeesport and Wilmerding Railway Company is considering the erection of a light station and the placing of arc lights along its route.

LYNN, MASS.—It is stated that the Boston, Revere Beach and Lynn Railroad will start the work of equipping its line electrically next spring, but the method is not yet decided.

MYERSVILLE, MD.—The following are the directors of the proposed electric road from Myersville to Middletown: G. W. Wathtel, D. V. Harp, C. F. Flook and E. J. Smith.

HAYDENVILLE, MASS.—The electric road here is a certainty, and it is stated that the matter of an electric lighting plant, to be run in connection therewith, is also under consideration.

NORTHAMPTON, MASS.—The Northampton Street Railway Company will likely be granted permission to extend to Williamsburg and Easthampton. President Olmstead will give details.

NEWBURGH, N. Y.—The Newburgh Street Railway will be sold at public auction on Feb. 6 by James H. Moran as assignee in the suit of the Farmers' Loan and Trust Company against the railway company.

BALTIMORE, MD.—The Baltimore County Commissioners have granted a franchise to the Pikesville, Reisterstown and Emory Grove Railway Company, and the work of construction will begin within six months.

BRADDOCK, PA.—The incorporators of the proposed Braddock and Homestead Electric Street Railway Company, to build one and a half miles of road, are C. Jutte, F. K. Morse, C. M. Buchanan and George W. Theiss.

ELIZABETH, N. J.—A franchise will likely be granted by the council on Feb. 1 to the Suburban Electric Railway Company to run cars through Orchard street to connect with the Morris avenue and Cranford, Westfield and Plainfield lines.

DETROIT, MICH.—The Detroit and Howell Plank Road Company will build an electric railway to extend ten miles northwest of Detroit. M. M. Willmarth, C. E., 310 Hammond Building, and Frank D. Clark, 408 Trumbull avenue, Detroit, Mich., are interested.

READING, PA.—A special to the Philadelphia "Public Ledger" states that the engineering corps has laid out a route for the extension of the lines of the Reading and Southern Electric road from Mohntonville to Adamstown, in Lancaster county. About \$25,000 of the \$50,000 needed has been subscribed, and work will be begun in the spring.

WILMINGTON, DEL.—The Wilmington "Star" is authority for the statement that the Gordon Heights Railway will be built and finished to the river front in the spring or early summer. It will connect with the Wilmington Steamboat Company's line at their wharf at Gordon Heights station.

ELMIRA, N. Y.—The petition of the West Side Railway Company for leave to increase its capital stock from \$100,000 to \$300,000 has been granted by the State Railroad Board. President Tompkins of the company states that the step was necessary because of intended extensions of the road in the spring to Horseheads.

SPRINGFIELD, MASS.—The Wyman-Lea Electric Railway Company has organized to build in the spring a railway to connect Springfield and Holyoke. This is intended to be the first move toward building a competing line with the Boston and Albany Railway to connect Boston with the Connecticut Valley. The capital is \$300,000.

WASHINGTON, D. C.—The Washington and Georgetown Ter-

minal Railway Company is before the Commissioners with a petition to build and operate a belt line, and such permission will likely be granted. Amongst those interested are E. Kurtz Johnston, William A. Wimsatt, J. B. Rank, E. Southard Parker and Andrew B. Duvall.

BRADDOCK, PA.—The Braddock Electric Street Railway Company will likely rebuild its old line. A. L. Taylor is president and C. F. Ellis is secretary. The officials have held a meeting with the Supervisors and filed a bond of \$5,000 that they will have the road built and in operation by July 1 next. It will be remembered that the road was abandoned some two years ago and the tracks covered up. The supposition is that it will connect with the Duquesne Traction Company.

NEWPORT, R. I.—Now that a charter has been granted for the proposed electric railway to run a line of cars from One Mile Corner to Stone Bridge, the only remaining requirement is the permission of the authorities of Middletown and Portsmouth to lay tracks. Senator E. A. Brown, of Middletown; E. F. Dyer, of Portsmouth; A. C. Titus, of Newport, president of the Newport Street Railway Company, and Lorenzo Tallman, of Newport, are interested. It is expected that work will be begun in the early spring.

ANDOVER, MASS.—The hearing before the Selectmen of the town of the South Side Street Railway Company for permission for location on its route from Lawrence to Lowell was held and no objection was made. Two locations were asked for, one on the river road, and the other on the Tewksbury road and private lands. The hearing in Tewksbury is to be held Feb. 21. The major part of the route lies in the two towns; the terminals only being in the cities. The company desires that two years be given in which to complete the line.

BATAVIA, N. Y.—Capt. Lina Beecher is the projector of an electric road connecting Batavia with Oak Orchard, on Lake Ontario, and preliminary work is well under way. It is proposed to use the Beecher single rail, elevated 12 feet above the surface of the highway on steel supports. The motive power will be storage batteries, and both freight and passengers will be handled. The estimated cost of construction is \$10,000 per mile and the Oak-Orchard-on-the-Lake company has taken \$25,000 worth of stock. The road will probably take in Albion and Waterford, where unlimited water power is available.

Personal Notes.

MR. JOHN WARING, the inventor of the Novak lamp, is a type



of the modern inventor who, equipped with a thorough scientific knowledge, applies scientific methods to invention. Mr. Waring was born at Darlington, Wis., in 1862, and graduated from Cornell University as a mechanical engineer in 1884, although a portion of his senior year was devoted to electrical work in the physical laboratory under Prof. Anthony. In 1886 he became connected with the Mather Electric Company and had charge of their laboratory. His duties were connected with testing and special work, and among other work he perfected resistance boxes for fine measurements and designed a copper coil for the same purpose to be used for directly reading temperatures, which has

been supplied to a number of the best boxes in this country. He also worked on ammeters, voltmeters and galvanometers, developing the present type of magnetic vane instruments from a French model. In 1890 Mr. Waring became the electrician of the Perkins Electric Lamp Company, with whom he remained until its factory closed on Dec. 1, 1893. Mr. Waring's recent connection with the Novak lamp is too familiar to require comment.

Miscellaneous Notes.

A COMMON CARRIER.—The Federal Court of Appeals at Kansas City, Mo., through Judge Smith, has decided that a telegraph company is as much a common carrier as a railroad company, and, therefore, when it does business in more than one State comes under the interstate commerce laws.

THE CHICAGO ELECTRICAL ASSOCIATION at its last meeting listened to a lecture by Mr. W. Clyde Jones on "A History of the Telephone." On Feb. 13 Mr. A. M. Walter will read a paper on "The Student Course at Lynn," the discussion of which will be opened by Mr. F. S. Hickok, of the Western Electric Company.

SANTA FE, N. M.—A 20-year franchise has been granted to I. Sparks, the manager and secretary of the Santa Fe Electric Company, for the operation and erection of a local telephone exchange in the city of Santa Fe. The poles and lines are now erected, and

the exchange will be put into operation as soon as practicable. A \$2 rate will prevail. Sixty-five subscribers have entered into contracts for one year from date of the opening of the central office.

THE NATIONAL ELECTRIC LIGHT ASSOCIATION has extended an invitation to electric railways to be represented at the seventeenth convention of this Association, to be held in Washington, D. C., Feb. 27, 28 and March 1, 1894. They are informed that some of the topics for discussion will be of particular interest to electric railway companies, such, for instance, as "Storage Batteries," and that the electrolytical effects of return currents will be treated of in a paper entitled "The Importance of Complete Metallic Circuits for Electric Railways," which will merit wide attention from railway interests, and will be thoroughly discussed.

CITIZENS BARRIED THE RAILS. At Auburn, Me., there has been a bitter fight between citizens and the local street railway company, which culminated recently by the citizens seizing a snowplow in operation and immediately selling it at auction. They then covered up the tracks with snow and ordering out the city fire engine turned the hose on the banked snow, which soon became frozen into a compact mass. The city officials were forced to assist in these measures by an indignation meeting. In the neighboring city of Lewiston the tracks were also covered and policemen ordered to guard against their being cleared, notwithstanding that an injunction had been issued against any interference with the street railway company's property.

PENNOCK IN NEW PASTURES. The Atlanta "Constitution" of Jan. 14 contains an advertisement of the Pennock Battery Electric Light and Improvement Company, soliciting subscriptions to the stock of that concern. We warn the Southern public against placing reliance in the absurd claims for this system, and advise any intending investor to write to Peoria, Ill., and Bridgeport, Conn., for information in regard to Pennock himself. It would be interesting to know the professional standing of the following sponsors of the system, whose recommendations are used to bolster up its claims: William R. Beebe, M.D., Bridgeport, Conn.; F. G. Hatch, "electrician," Boston; Charles R. Thomas, "Edison Elec. Ill. Co.," Boston; John H. Wesler, "electrical expert," Bridgeport, Conn., and R. H. Gribben, "electrician," Boston.

THE NETHERLAND SOCIETY FOR THE PROMOTION OF INDUSTRY asks for papers containing an indication of the means to obtain energy through windmills, to accumulate this energy electrically, to transmit it or to make it transportable; and desires more particularly an answer to the following questions: 1. What is the average energy a common windmill is able to produce, per day of 24 hours, in combination with an electric accumulator, what would be the installation most suitable to this effect and what would be the cost of one-horse power hour? 2. Is it possible from an economical point of view to apply the new aerial motors on an extensive scale for the accumulation and the utilization of this energy? If so, what mechanical appliances would be required for this purpose? The project of a supposed application of the system, by which a factory is provided with light and power, is wanted as an illustration. The drawings belonging to the answers must be made on white paper (no blue prints) on a scale of $\frac{1}{4}$. The prize offered is the gold medal of the society and a reward of 100 (\$140). Answers must be sent before July 1, 1894, with the author's name in a closed envelope, to the general secretary of the society, F. W. Van Eeden, at Haarlem, Holland.

Trade and Industrial Notes

THE ELLIOTT LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, is running its factory overtime in order to fill its orders.

THE MILLER CONSTRUCTION COMPANY, of Pittsburg, reports business first-class, having sufficient orders ahead to keep it busy for some time.

PURITY OIL FILTER COMPANY, 601 Water street, Pittsburg, reports business excellent; orders for January were largely in excess of any month last year.

J. L. HAYS & CO., 300 Liberty street, Pittsburg, report business for this year thus far has been very good. The company is running full time and has all it can do.

THE AUTOMATIC SWITCH COMPANY, of Baltimore, reports business improving very nicely. Collections, however, are yet a little slow, but improvement is also noticeable in this direction.

WILLIAM J. TROTT has resigned his position as electrical engineer of Furniture City Electric Company to accept the management of the Wolverine Electric Light Company, of Holland, Mich.

WALLACE & SONS, Augusta, Conn., have made a proposition to their creditors to pay them 60 per cent. of the face value of their claims, or the firm will place the whole business in the hands of three trustees to be run for the benefit of the creditors.

THE WENSTRÖM ELECTRIC COMPANY, of Baltimore, is about to place on the market a new arc lighting apparatus which is said to be an improvement on those at present in use. Mr. J. P. Smith, of this company, reports business prospects very encouraging.

FRANK W. STEWART, 1,208 Green street, Philadelphia, now

has the agency for the Novak lamp for the territory formerly covered by Messrs. O. D. Pierce & Co. He was employed by Messrs. Pierce & Co. for nearly two years as salesman and is well acquainted with the trade.

JENKINS BROTHERS, 71 John street, New York, have issued a new catalogue and price list of their celebrated valves and packing. All of the various valves, packing and steam fittings manufactured or handled by this firm are illustrated and directions given how to use their standard packing.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has issued a second edition of its instructive pamphlet on graphite as a lubricant. Many opinions of men competent in various lines are given as to value of graphite as a lubricant, including an elaborate test by Prof. Thurston.

THE WASHINGTON CARBON COMPANY, of Pittsburg, reports business very much improved and the prospects for a good year as very promising. This company shortly will place on the market a new special carbon for arc lamps, which, it is claimed, will be different and superior to anything yet introduced.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., has designed and built the new iron coal sheds of the Grosvenor-Dale Company, Grosvenor-Dale, Conn., which are so arranged that the coal can be unloaded direct from the cars into the pockets without handling. The Grosvenor-Dale Company expect to save a large amount of money each year by lessening the expense of handling their coal the second time.

THE RUSSELL ELECTRIC MANUFACTURING COMPANY, 212 Eddy street, Providence, R. I., has published a number of photographic reproductions showing the operation and giving views of their well-known mast arms of which, we learn, there are now in daily use more than 100,000 lineal feet. The views are printed on heavy cardboard and the different sheets held together by a single eyelet fastener, which is quite a convenient innovation.

THE SPERRY SINGLE-MOTOR SYSTEM and Sperry electric brake have been selected by the People's Traction Company to go on its system in Philadelphia, Pa. It made this selection after the most thorough investigation, the electric brake especially being a pleasing feature to them. The electric brake simply stops the car with the same kind of power which is used to start it, and the adoption of such a device is claimed as a great step in advance.

CHARLES A. SCHIEREN & CO., 45 Ferry street, New York, have their Dixie Tannery, Bristol, Tenn., about ready for business and are beginning the operation of tanning there. The best quality of bark is obtained there, and they intend to manufacture the best quality of leather suitable for leather belting purposes, only tanning leather for the best belting for their own use. They report encouragement in the volume of business for the month of January, and think the outlook brighter.

THE VIADUCT MANUFACTURING COMPANY, of Baltimore, reports that a great improvement has taken place in its business during the past three weeks, and it has booked orders for thousands of telephones, magnets, call bells, switchboards and other apparatus pertaining thereto. The experience of this company in this particular line has been very extensive, and the quality of goods turned out by it is well known, and anything that is not satisfactory will be made so.

THE METROPOLITAN ELECTRIC COMPANY, Chicago, Ill., has just taken the general sales agency for the P. & B. specialties, which include paint, armature varnish, electrical compounds, tape and Chatterton's compound. A large stock will be carried at its store and warehouses, 186-188 Fifth avenue, and prices will be made the same as from the factory. This is an important arrangement, and the Metropolitan Electric Company is to be congratulated upon securing this agency.

C. C. PECK, Rochester, N. Y., has received the contract for the boilers to supply the Detroit city electric light plant, the well-known Peck boiler having been selected after strong competition. The order is for seven 300-h. p. boilers to carry 165 pounds of steam, working pressure. Each boiler is required to evaporate 2,000 pounds per hour of feed water at 100 degrees Fahr. into steam at 165 pounds gauge pressure, and to evaporate 10 pounds of water from and at 212 degrees per pound of combustible in Hocking Valley coal. The duty is that of supplying triple expansion vertical marine engines used in running dynamos.

WILEY & PHELPS, Menadnock Building, Chicago, have received favorable reports from Europe in regard to the Laval steam turbine, where recently 505 have been sold in competition with other motors for electric lighting. Great success has been met with in their introduction on account of the small weight and space occupied and the admirable steadiness of light, which results from the high speed and ingenious governor used. Up to date no wear has been detected in any of the machines in use. At the recent exhibition in Batavia the Laval steam turbine received an "honorable reward," the highest distinction granted.

THE NEWTON ELECTRIC COMPANY, of 39 and 41 Cortlandt street, New York City, is now ready to introduce very extensively its lighting appliances. It manufactures a line of sockets, cut-outs, fixture and arm switches, etc., which are all simple, mechanical and sold at reasonable prices. Thirty thousand of its sockets have already been sold and are working very satisfactorily. Its factory is on 17th street and has a capacity of 300,000 sockets.

per annum, beside a proportionate number of their other special appliances. They are the only manufacturers of the standard socket in this city. W. J. Newton is the manager.

PARTRICK & CARTER CO., 125 South 2d street and 131 Gothic street, Philadelphia, Pa., has issued the 1894 edition of its well-known catalogue of house goods and general electrical supplies—a book that is found almost indispensable to dealers in electrical goods. The 1894 edition is bound in cardboard covers and contains 136 $7\frac{3}{4} \times 10\frac{1}{2}$ inch pages, with some hundreds of illustrations. Eleven pages are devoted to a list of hotels using the Partrick & Carter patent needle annunciator, a glance at which shows that a prospective purchaser in any part of the United States or Canada will have but few miles to travel in order to inspect the working of this system. A commendable feature of this catalogue is the concise explanatory notes that accompany most of the illustrations, which contain many hints as to the selection of apparatus and material for particular duty or service and point out special features.

THE CARPENTER ENAMEL RHEOSTAT COMPANY, Bridgeport, Conn., will immediately put upon the market a full line of electrically heated appliances, such as soldering irons, flat irons and glue pots, various kinds of electrically heated tools, as well as electric cooking utensils, such as chafing dishes, coffee pots, ovens, broilers, etc. The rheostats of this company are now in almost universal use by manufacturers of electrical generators and motors, and by electric contractors. Their theatre dimmers and field rheostats have such marked advantages as regards space and safety from fire as to have really no competition, and the progressive policy of this company in continuing to make reductions in price, notwithstanding this is in marked contrast with usual methods of charging high prices because of the protection of fundamental patents. The following agencies of the company have recently been established: Walker & Kepler, Philadelphia; Sargent & Lundy, Chicago; Owen Ford, St. Louis; William Oswald, New Orleans.

THE INTERIOR CONDUIT AND INSULATION COMPANY has issued its annual report and statement, which are highly satisfactory in view of the business depression during eight months of the period covered. The report states that the license agreements referred to in last year's report as likely to be shortly consummated, and to yield substantial royalties to the company from the manufacture and sale of new generators and railway motors, have not been consummated, mainly on account of the financial panic of the past summer. The Board of Directors states its determina-

tion that the company's interests would be best conserved by awaiting a more opportune time wherein to conclude such transactions, particularly in view of the fact that in so far from suffering any deterioration by the lapse of time, the inventions involved are being improved upon and supplemented by others of great value, all going to make up a highly organized system of railway equipment, with which the directors feel they can deal to much greater advantage than with the segregated parts hitherto constituting the subject matter of their license negotiations.

THE OHIO BRASS COMPANY, Mansfield, Ohio.—The officers of this company are Mr. E. T. Cooke, president, and Mr. F. B. Black, secretary and manager, both well known as active business men of Mansfield, with an extensive experience in the manufacturing business. Mr. C. K. King, who was lately connected with the Ansonia Electric Company, of Chicago, and is well known among Western street railway men, has been engaged to look after the interests of the electrical department and act in the capacity of special salesman. This company is not a novice in the manufacture of street railway supplies, as it has been engaged in this line of work for several years past, a large Western supply house having taken its entire output. Its manufacturing plant consists of a machine shop and foundry equipped with machines of the most improved design, and a complete laboratory for testing purposes, fitted with a Riehle Brothers testing machine, Queen & Co. testing sets and the electrical meters necessary to make exhaustive measurements on the different articles which this company puts out to the trade. The company intends to send out a comprehensive and reliable record of tests made on the various articles manufactured by it, which will include the breaking strains and insulator resistances of each article, so that the engineer in charge of the construction of a road will have reliable data to figure on. An illustrated catalogue of a complete line of material necessary for the construction and maintenance of electric street railways will be ready for distribution about Feb. 15, which every street railroad man will find of interest to him.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED JAN. 23, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

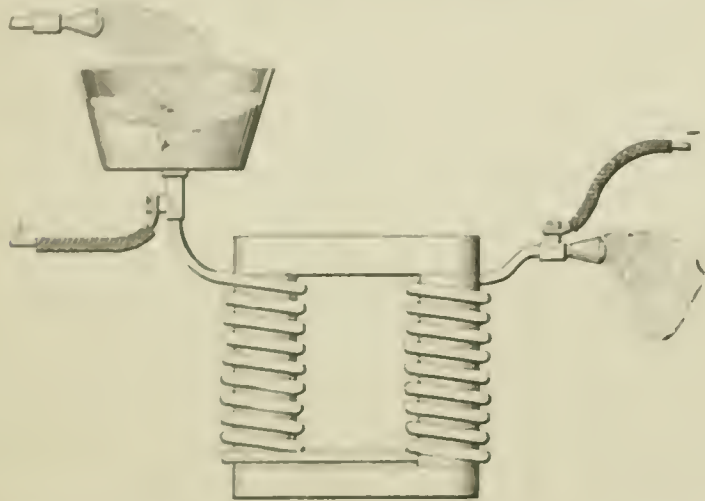
- 513,097. PHONOGRAPH; T. A. Edison, Llewellyn Park, N. J. Application filed Dec. 3, 1890. This comprises a centrifugal governor connected with a motor operating a phonograph, a spring contact in the motor circuit normally resting on the movable part of the governor, a stop in the path of the contact, and another connection with the governor completing the motor circuit.
- 513,109. ELECTRIC RADIATOR; W. D. Hough and E. Z. Burns, Niagara Falls, N. Y. Application filed Jan. 9, 1893. This comprises two sections, the metallic parts of which are insulated from one another, pipes in connection with but insulated from the sections, and electrical connections from the sections.
- 513,111. ELECTRIC ARC LAMP; W. Jandus, Cleveland, Ohio. Application filed Oct. 22, 1892. In an arc lamp, a carbon-holding tube formed with a contracted socket portion having longitudinal slits closed at both ends.
- 513,112. GAS AND ELECTRIC COUPLING; W. J. Kelly, Boston, Mass. Application filed Sept. 19, 1893. This comprises two hollow members, one having arms secured to the outside thereof, a collar carried by and movable on the outside of the other member and engaging the arms of the other member, and means to lock the collar and arms together.
- 513,113. ELECTRIC LIGHT FIXTURE FOR MUSIC STANDS; W. J. Kelly, Boston, Mass. Application filed Sept. 19, 1893. A fixture for a music stand consisting of a hollow body containing an incandescent lamp and provided with a longitudinal slit to emit the light.
- 513,122. ELECTRIC SAFETY DEVICE FOR ELEVATORS; R. W. Magrane, Brooklyn, N. Y. Application filed March 17, 1892. A device adapted to engage a stop on the valve rope when the door is open, an electric circuit and a make and break contact for the circuit controlled by the opening and closing of the door.
- 513,126. RHEOSTAT; W. Meredith, Aurora, Ill. Application filed April 20, 1892. The combination with a series of perforated plates of a bolt passing through the perforations and insulated from the plates, and terminals whereby the solid mass of plates is brought into circuit and the free ends are left exposed to reduce the heat of the mass.
- 513,134. ELECTRIC ELEVATOR; N. P. Otis, Yonkers, N. Y. Application filed June 25, 1890. The combination with the elevating engine of a current controller consisting of a switch and a disc, two springs connected on opposite sides with the centre of the disc and tending to restore it to a mid-position, and means for operating the switch.
- 513,181. MICROPHONE; A. Groper, Dusseldorf, Germany. Appli-

cation filed Jan. 14, 1893. A transmitter having a mica diaphragm and a carbon diaphragm arranged with an air space between them, the mica diaphragm adapted to receive and transmit sound waves to the carbon diaphragm, and a number of carbon balls in contact with the carbon diaphragm and subjected to varying pressures, and an electric current passing through them.

- 513,213. ELECTRIC MOTOR-CONTROLLING DEVICE; J. E. Stanton, Boston, Mass. Application filed June 19, 1893. The combination of fixed plates connecting strips insulated from each other, a movable guide piece of non-conducting material provided with spring contact pieces adapted to engage with the plates and connections to form part of a circuit through a motor and generator.
- 513,219. ELECTRIC BELL; C. Turnbull, Jr., North Shields, England. Application filed July 24, 1893. An electric bell having an extension upon its vibrating arm, and a make and break connection between the extension and the hammer arm.
- 513,220. ELECTRIC BELL; C. Turnbull, Jr., North Shields, England. Application filed Nov. 11, 1893. An electric bell having a fixed extension upon its vibrating armature, the outer point of which extension is pivoted to an intermediate point on the hammer bar, and a make and break point of circuit between the inner end of the extension and a point to which the circuit wire is connected.
- 513,245. SECONDARY BATTERY; E. and L. Paget, New York, N. Y. Application filed Feb. 9, 1893. In a secondary battery, treating the electrodes in a solution of nitrate of magnesium.
- 513,250. ELECTRIC LIGHT CUT-OFF; J. B. Stewart, Haverstraw, N. Y. Application filed June 21, 1893. This comprises a single magnet and armature, a rocking arm mounted on the magnet, the arm being provided with a conducting and a non-conducting bar and having electric light terminals, and a single projection on the arm engaging the armature lever by which it is operated.
- 513,251. ELECTRO-MECHANICAL GONG; N. H. Suen, New York, N. Y. Application filed Oct. 11, 1893. The combination with a striking arm of two springs for alternately moving it in opposite directions, the springs being joined so as to be wound simultaneously.
- 513,264. ELECTRIC METERS; J. C. Henry, New York, N. Y. Application filed Dec. 24, 1891. This comprises an irregularly shaped member moved by a controlling mechanism adapted to correct irregularities therein and to transmit regular movements in opposite directions to connected registers or indicators.
- 513,294. ELECTRICAL APPARATUS FOR FIRING SUBMA-

INE MINES; G. Bertolini, Venice, Italy. Application filed April 6, 1892. The combination of discs supported on a stand and having electrical conductors with contact points, a shaft rotating on the stand, a vertical contact piece carried by the shaft, a telescope trunnioned on the shaft, contacts affixed to the telescope, and a device adapted to be inserted between the contacts.

513,399. ELECTRIC GAS LIGHTER; W. L. Brown, San Francisco, Cal. Application filed June 22, 1893. This comprises a movable electrode, a rotatable cam having eccentric and concentric passages communicating at their ends and adapted to en-



No. 513,422.—MEANS FOR COOLING ELECTRIC CONDUCTORS.

gage the movable electrode to move it when the cam is turned in one direction, and to allow it to remain stationary when it is turned in the other direction.

513,395. TELEPHONE TRANSMITTER; F. R. Colvin, New York, N. Y. Application filed Oct. 10, 1893. A transmitter provided with a diaphragm carrying a cell containing a granular conductor and fixed electrodes relatively non-vibratory in contact with the granular conductor.

513,345. ELECTRIC CALL BELL FOR PNEUMATIC TUBES; L. Strouse, Baltimore, Md. Application filed April 6, 1893. This comprehends the use of an electromagnetic call bell, which is operated when a call is to be made by a puff of air through a tube.

513,347. MAGNETO-ELECTRIC MACHINE; H. H. Taylor, Los Angeles, Cal. Application filed March 15, 1893. An electromagnetic machine provided with movable auxiliary pole pieces arranged respectively at each side of the permanent pole pieces of the machine and adapted and arranged to be moved toward and away from, and to fit close to the periphery of the armature.

513,349. MEANS FOR NEUTRALIZING SELF-INDUCTION IN ALTERNATING CIRCUITS; E. Thomson and E. W. Rice, Jr., Swampscott, Mass. Application filed Sept. 1, 1893. The combination of a transformer and a condenser in circuit with a separate winding on the same core with the primary and secondary windings of the transformer and adapted to neutralize the lag of the current in the circuits to which the transformer is connected.

513,359. AUTOMATIC RHEOSTAT; B. C. Van Emon, San Francisco, Cal. Application filed April 4, 1893. A rheostat whose lever is controlled by a reciprocating piston, the cylinder of which is supplied with pressure by the motor.

513,352. ANNUNCIATOR SYSTEM; A. L. Vogt, Delaware, Ohio. Application filed March 8, 1893. An annunciator cabinet having push buttons which make contact with the proper circuits, terminating in an inner wall.

513,360. APPARATUS FOR REGISTERING TELEPHONE CALLS; L. Kahn, Hamburg, Germany. Application filed March 2, 1893. An apparatus for registering telephone calls, consisting of a transmitter for producing currents of alternate polarity to operate a printing telegraph at a distant station from the call station.

513,370. METHOD OF AND APPARATUS FOR PREVENTING PHASE DISPLACEMENT IN ALTERNATING CURRENTS; C. P. Steinmetz, Lynn, Mass. Application filed Sept. 9, 1893. The combination in an alternate circuit of a condenser connected inductively to the circuit through conductors carrying currents respectively proportional to the potential and current strength in the main circuit.

513,376. RAILWAY SIGNALLING APPARATUS; E. A. Winterhalter, Kappel, Germany. Application filed Dec. 3, 1892. In a block signalling apparatus, two symmetrically arranged electrically operated mechanisms driving two endless chains intermittently for the purpose of exhibiting colored discs, and a mechanical device operated by the train to remove the discs out of sight.

513,387. ELECTRIC BELT; W. C. Fuller, Salina, Kan. Application filed Oct. 11, 1893. In a belt, the combination of battery cells open at one end, a renewable inner element and surrounding absorbent packing adapted to be included within a casing.

513,391. ELECTRIC METER; C. Guldell, Independence, Mo. Application filed June 21, 1892. This comprises a solenoid having a movable core, a number of cumulative weights connected to a flexible attachment which is also connected to the movable core, an indicating train, and a wheel mounted in the train and engaged by the flexible attachment.

513,401. ELECTRIC MOTOR FOR STREET CARS; B. G. Lamme, Pittsburg, Pa. Application filed March 27, 1893. This comprises an armature mounted upon the axle of the car, and two field magnets independently sleeved upon the axle and suspended at their rear ends from the car body.

513,420. METHOD OF COOLING THE IRON OF TRANSFORMERS; H. A. Rowland, Baltimore, Md. Application filed Feb. 8, 1893. The combination with laminated iron sheets subjected to varying magnetic influences, of vessels containing fluid in juxtaposition to the sheets and parallel to the motion of the lines of force.

513,421. METHOD OF COOLING TRANSFORMERS; H. A. Rowland, Baltimore, Md. Application filed Feb. 8, 1893. The combination of a closed vessel, a volatile liquid partly filling the vessel, and a transformer immersed in the volatile liquid.

513,422. MEANS FOR COOLING ELECTRIC CONDUCTORS; H. A. Rowland, Baltimore, Md. Application filed Feb. 14, 1893. This consists in cooling hollow conductors carrying electric currents by passing a conducting fluid through the conductors and in breaking the electrical continuity of the fluid before it reaches and after it leaves the conductors.

513,425. SELF-INDUCTION COIL; C. F. Scott, Pittsburg, Pa. Application filed Nov. 25, 1892. A laminated core for induction coils composed of plates having complete and incomplete iron circuits alternately.

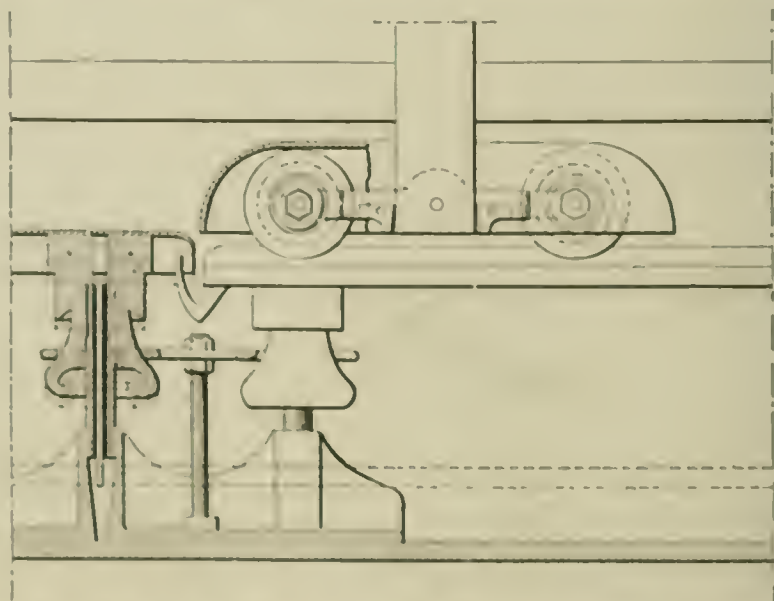
513,426. SPAN WIRE FOR OVERHEAD ELECTRIC RAILWAYS; S. H. Short, Cleveland, Ohio. Application filed April 1, 1890. The combination of parallel overhead line conductors, with span wires divided at one or more points between the conductors into two or more sections insulated from each other and from the ground.

513,440. SUPPLY SYSTEM FOR ELECTRIC RAILWAYS; H. S. Pruyn, Hoosic Falls, N. Y. Application filed Sept. 16, 1893. This comprises a main continuous conductor, a working sectional conductor, branch conductors from the main to the sectional conductor, spring mounted insulators supporting the sectional conductor, the insulators containing oil chambers.

513,457. RESISTANCE COIL; H. P. Davis, Pittsburg, Pa. Application filed April 22, 1893. In a resistance coil, a spiral strip of resisting material, and mica strips interposed between the convolutions thereof.

513,459. DYNAMO-ELECTRIC MACHINE; G. F. Dieckmann, Chicago, Ill. Application filed Dec. 23, 1892. The combination with the field magnet and its armature helix of a supplemental coil mounted separately from but located parallel to the helix and inductively influenced thereby.

513,460. COMMUTATOR FOR DYNAMO-ELECTRIC MACHINES; H. L. Fee, New Orleans, La. Application filed July 26, 1893. The combination with the radial arms of a commutator of detachable



No. 513,440.—SUPPLY SYSTEM FOR ELECTRIC RAILWAYS.

insulating thimbles which are applied to the free ends of the arms and surround the same.

513,466. ELECTRICAL MEANS FOR PROPELLING CANAL-BOATS; J. Sachs, New York, N. Y. Application filed Feb. 15, 1893. The combination of a carriage movable along a support near the waterway, a motor on the carriage, means for connecting the carriage and boat, and a controlling device of the boat for the motor on the carriage.

513,469. ELECTRIC CLOCK SYSTEM; J. H. Gregory and Frederick Schmidt, Brooklyn, N. Y. Application filed May 16, 1893. The combination with a clock of an electric motor and train of gears, a controlling disc and armature lever, the disc having springs.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, New York.

The Electrical World.

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The first issue of 1894 contained 320 different Advertisements.

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STEEL FOR ELECTRIC MACHINERY.

While homogeneous iron under the name of cast steel has come much in use among larger manufacturers of electrical machinery, yet little has been written on the subject, and the definite information given in another column will be found of timely value. Perhaps one reason why its use has not become more general is on account of the misleading name applied to the material. The property of temper is so bound up with the name of steel that it seemed paradoxical that it could be used for a purpose demanding, above everything else, the absence of that property. The name is actually a misnomer, as the material possesses only one property of cast steel—that of being homogeneous—and it should be called homogeneous iron. Cast iron, were it not for the significance already attached to the term, would be still better, but by the addition of "homogeneous," ambiguity would be avoided and a source of much misconception removed. An attempt in other branches of manufacture has been made to apply the correct name, and thus put an end to a wrong practice, which, in the early days of the use of the material for shipbuilding and structural work, was probably deliberately adopted to take advantage of the popular estimation in which the qualities of real steel were held.

MR. PREECE ON CIVIL SERVICE REFORM.

Those who advocate the government ownership of telegraphs in the United States will do well to carefully read the remarks of Mr. Preece in another column upon this subject. It is not too much to say that he is the one most competent in the world to speak on the question, and but little comfort can be drawn from his remarks, notwithstanding the intrinsic advantage which he shows may accompany government ownership—under proper civil service rules. The lesson conveyed may be a useful one if the advocates of government ownership will follow the inference that the first stage is the reformation of our civil service. By first devoting their energies to this, any considerable success they meet may have a general beneficial effect even greater than that anticipated from the accomplishment of their ultimate object. While we do not think our readers will entirely agree with Mr. Preece in his comparisons between the English and our own telegraphic service, yet those who believe in civil service reform will feel under obligations for the weight of his argument in its favor, which has also an indirect application to the subject of municipal ownership of lighting plants.

SUSTAINING THE EDISON LAMP PATENT.

The decisions favorable to the Edison lamp patents rendered last week in the Davis and Novak cases would seem to imply that as far as the New York and New England Federal Court Circuits are concerned, there is little chance of any other action on their part. The decision in the Novak case was rendered on Judge Shipman's opinion, and in the absence of an opinion from the full bench we are left in darkness as to the reasons of the court for not giving any weight to Judge Rick's recent opinion, which formed part of the Novak argument, as well as to their opinion in regard to the contention of the complainant's counsel that the carbon filament is Edison's invention, and that the removal of occluded gases is not a necessary part of the Edison patent. There are two important issues yet re-

maintaining for final decision in this celebrated series of cases—the Goebel and Buckeye suits—which will probably end the most sensational patent litigation on record, unless the New York Federal Court of Appeals in March reverses the decisions of the lower courts in the Bate refrigerator case. Should this be done, which seems to be not at all probable, the new lease of life given to the Edison patent would undoubtedly also renew the energy of its opponents.

LONG-DISTANCE TELEPHONY.

The article by Mr. Kennelly in another column will be found a most important contribution to telephony, not only on account of the practical deductions made, but also as showing how, by the choice of proper methods, a subject may be simplified which has heretofore been thought to be almost beyond the reach of ordinary mathematical processes. A comparison of the manner in which the same subject is treated by Heaviside will at once show the beauty and relative simplicity of the graphical method developed by Mr. Kennelly as applied to involved problems of this character, and which places within the reach of the practical man subjects heretofore only dealt with for the benefit of the chosen few who could understand the special mathematical processes employed. One result of the deduction is to again show the empirical character of the so-called KR law, which assumed that the amplitude of the received current varied inversely as the square of the length of the line, whereas it is shown that for lines of the length treated it varies inversely as the hyperbolic sine of a fraction of the length, and that beyond a certain point the values given by the alleged KR law are absurd. While it is true that actual telephonic currents are quite different from the simple harmonic form here treated, yet by the selection of proper mean values by experiment and the exercise of good judgment there is no reason why the same method should not be applied in dealing with the problems encountered in practical telephony. A most promising field is thus opened up, which, as pointed out in the concluding paragraph of the article, includes other branches than that of telephony.

THE SUPREME COURT AND PATENTS.

A recent decision handed down by the United States Supreme Court will probably have a revolutionary effect on patent procedure, and may affect the validity of some important patents. The gist of the decision is that when an inventor has a patent the subject matter whereof is disclosed in an earlier patent, and such earlier patent also has claims pertaining to the same subject matter, even though the two sets of claims may differ in breadth, the later patent is void. In order that the later patent may be valid the two sets of claims must apply to things that are physically different, such as separable and independent parts of the same machine. The decision, in other words, is a reaffirmation of the established doctrine that two patents cannot be issued for the same invention, but in terms so strict as to greatly affect previous practice. It does not seem that the decision has any bearing in regard to inventions by independent inventors, but refers only to separate applications of, or two or more patents already issued to, the same inventor. The effect of the decision will be good as far as it relates to basing separate patents upon hair-splitting distinctions, and stopping what had already come to be considered irregular practice in regard to divisional applications. In these respects it will probably bear some wholesome fruit, though at the same time it may work hardship to bona fide inventors misled by a prevailing practice. Those most competent to speak on the subject are averse to giving any definite opinion in regard to actual scope of the decision, owing to an apparently unusual use of terms that have a settled signifi-

cance in patent law, and its definite significance will therefore have to await interpretation by the courts in cases which no doubt will be soon brought up.

THE EDUCATION OF ENGINEERS.

During the last year the subject of the education of engineers has been referred to frequently in our columns, and in his recent presidential address before the English Institution of Electrical Engineers Mr. Alexander Siemens, in his remarks on that subject, strongly confirms the views we have here expressed. Referring to the fashion of deprecating the study of dead languages, he feels certain that the attack is from quarters where the mental training which the study of these languages entails is not appreciated at its right value. After the mental powers have been thus prepared, he adds, it is of no great consequence whether most of the details of school-teaching are forgotten or not, as the essential point is that the student should have acquired a good method of learning, so as to assimilate to the best advantage the course of training he afterward attends. He states that while preliminary teaching should have a general character, and embrace chiefly subjects that ought to be known to all classes, at college the various professions are differentiated, and in each branch the students learn the general principles that ought to govern them in their future career. "Formerly it was possible to let the course of scientific studies embrace all that was known in any particular branch; in fact, the general principles and the interdependence of the various branches were not, and partly are not yet, properly understood. To attempt a similar course at the present time is simply impossible, and the danger that has to be avoided in our scientific colleges is the tendency to teach our profession too much in detail. Besides overwhelming the professors with work, such a course is apt to create in the students the conviction that on leaving college with a first-class certificate they know all that can possibly be known, and that anything that does not fit in with the theory of their pet professor must necessarily be condemned." Mr. Siemens concludes that it is highly desirable that the teaching at engineering colleges should be confined to general principles as far as the applications of science are concerned, and that the student should become thoroughly well acquainted with the mental tools that are used in scientific investigations, such as mathematics, the general principles of chemistry, and of the branches of natural philosophy, and be trained afterward in practical work, when he has time to select what special branch of the profession he wishes to devote his life to.

Calculating the Resistance of Wires for Alternating Currents.

Our attention has been called by Mr. Horatio A. Foster to an error in a table published on page 114 in the issue of Jan. 27; the last number in the first column, namely, 137,958,900 should read 151,009,800.

"Nothing to be Learned From Americans."

Mr. William H. Preece, of London, in a recent paper, describing his visit to the United States, refers to his former visit in 1877, stating that the results were the introduction in England "of the telephone, the practical application of quadruplex working, the adoption of sound reading in our telegraph offices, the disappearance of the Morse recorder and the more general assimilation of the methods of working in the two countries"; the chief result of his second trip, in 1884, "was the introduction of the multiplex system of working by Mr. Delany, now so much in use amongst us, and doing splendid service in many of our chief towns." Anything else? Yet, some Englishmen claim that there is "nothing to be learned from Americans"!

Multi-Frequency Machines.

BY E. ARNOLD.

In The Electrical World for Jan. 6, 1894, page 21, Lieutenant F. Jarvis Patten publishes, as his own invention, a sketch of a multi-frequency machine. This gives me occasion to state that in the "Electrotechnische Zeitschrift" of Jan. 20, 1893, I have shown exactly the same arrangement. The Electrical World took notice of this under the title "Doubling the Frequency," in the issue of Feb. 11, 1893, page 109.

In the aforementioned article I have first proven analytically that when we move a circuit, closed on itself, in a periodic magnetic field, synchronously with the pulsations of the field, a current of double the number of alternations will be induced. Furthermore, I have there said: "If we fasten two alternating-current machines with the same number of poles and windings, on a common shaft, in such a manner that the field of the second one is excited by the current of the first, the second machine will generate a current of double the number of alternations."

The multi-frequency machine shown by Lieutenant F. J. Patten is only a copy of this design. I have also had in mind the employment of this apparatus in the generation of Tesla currents, but the great losses through hysteresis and eddy currents prevent the use of the present alternating-current machines with low frequencies. In order to obtain a useful, working alternator on the principles laid down by me, the construction must be suited to the changed conditions. The solution of this problem is conceivable, and I will come back to it at an opportune occasion.

Oerlikon, Jan. 18, 1894.

Air-Core Transformers.

BY E. R. CARICHOFF.

In your issue of last week I observe a joint communication on "Air-Core Transformers" from Messrs. Frederick Bedell and Albert C. Crehore, in which those gentlemen, referring to the fact that Mr. Remington, in a paper read before the Physical Society, Oct. 27, 1893, "called attention to the case in which the primary current of a transformer falls off when the secondary is closed," point out that they noted the same phenomenon last spring, and called attention to it in The Electrical World, June 17, 1893.

I wish in turn to assure Messrs. Bedell and Crehore, as they have done Mr. Remington, that the same phenomenon was noted by me in the fall of 1892 at Johns Hopkins University, while drawing A. C. curves with the Duncan-Carichoff electro dynamometers, and I should not be surprised if some one can assure me that the phenomenon was noted even earlier than that date.

Edison Lamp Suits.

A decision in the appeal of the Davis Electrical Company, of Springfield, Mass., against the decision of Judge Colt, enjoining it from repairing Edison incandescent lamps, has been rendered by the Appellate Court in favor of the General Electric Company.

The Circuit Court of Appeals, sitting at New York, has affirmed the decision of Judge Shipman against the Waring Electric Company in the Novak lamp case. Unless by agreement of counsel on both sides the order will not be handed down until March 19.

The Universal Electric Company, of Cleveland, Ohio, on Feb. 12 submitted affidavits and an argument to Judge Ricks asking that his decision affecting the Buckeye Company be extended to it. Decision was reserved.

Chemistry of the Air.

Our contemporary, London "Lightning," Jan. 11, contains a short description of Prof. Dewar's recent Royal Institute lectures, from which we take the following: "The powerful oxidizing power of ozone was shown by its rapidly piercing a piece of india rubber. The absorption of oxygen by molten silver, which gives it off again on cooling, was next shown, and the lecture concluded by an exhibition of the absorption bands when a beam of light passed through a tube containing air at a pressure of 100 atmospheres, proving that air is colored. The separate steps to liquid air were then explained—ether, solid carbon, dioxide, liquid nitrous acid, liquid ethylene, which last is not a little dangerous, as it readily takes fire, though so cold that when thrown into water it forms cups of ice, in which it floats. The vapor of some drops so treated was set on fire in illustration." A flask of liquid oxygen was brought in boiling away at -180°C . It was a pale blue color, showed the absorption bands and was slightly cloudy with solid impurities, such as dust, carbon dioxide, water and ammonia—all solids at this temperature. He explained the critical temperature of a body which below that temperature can exist either in a liquid or a gaseous state. "He illustrated this with a tube of carbon dioxide, which he first raised above the critical temperature and then cooled until the liquid began to appear at the top of the tube. He said he had been asked the cost of liquid air; he did not dare to say, lest the treasurer of the institute might be present and the proceedings be put a stop to; but he showed views of apparatus required, described its use, and left his audience to draw their own conclusions. Other striking experiments followed in rapid succession—a snowstorm of carbon dioxide in the upper part of a tube of boiling oxygen—the formation of a mirror of solid mercury on a Torricellian vacuum tube by cooling the glass with cotton dipped in liquid oxygen—liquid air and liquid oxygen clinging like iron filings to the poles of a magnet—a demonstration that at very low temperatures oxygen would not combine with the most oxidizable substances, nor support combustion. But perhaps the most striking of all was the condensation of the air of the room on the surface of a tube of liquid oxygen cooled by evaporation to -205°C ., so that it fell from the end of the tube in drops."

The National Electric Light Association.

Mr. C. O. Baker, master of transportation, has issued the following circular:

The various passenger associations have granted a rate of a fare and one-third for the round trip from all points east of Chicago, Burlington and Peoria and the Mississippi River to Washington, D. C. Negotiations are now pending with the Western Traffic Association for members in that territory to secure this rate. Ask the ticket agent from whom you purchase your going ticket for Delegate Certificate to National Electric Light Association meeting, which, when properly filled in and certified at association headquarters in Washington, will entitle you to return for one-third the regular fare.

A special vestibuled train, composed of parlor cars, will leave via Royal Blue Line, foot of Liberty street, New York, at 1.20 P. M. Monday, 26th instant, and will leave Twenty-fourth and Chestnut streets, Philadelphia, at 3.20 P. M., arriving at Washington, D. C., 6.20 P. M. Seat checks for this train can be procured from the undersigned at \$1.25 each, and railroad tickets from New York to Washington at \$6.50 each. Railroad tickets can also be obtained at any Blue Line ticket office. Be sure you get a certificate when purchasing ticket. Please make checks payable to C. O. Baker, Jr.

Electrical Quackery.

In referring to the Harness "electric belt" advertisements, the London "Times" states that the so-called religious papers were the worst offenders in the matter of quack and fraudulent advertisements.

A Brief Review of the Faraday-Maxwell-Hertzian Epoch.—II.

BY M. I. HUPIN

To sum up briefly: The most essential features of the science of electricity and magnetism during the epoch preceding Faraday may be described concisely as follows: The fundamental concepts in the science were the forces acting between electric and magnetic bodies. The fundamental laws were the laws of action of these forces; that is, mathematical statements expressing the relation between the intensity and direction of these forces and the distances between the acting bodies, including also quantities describing the intensity of the magnetic or electric states of these bodies, the so-called quantities of electricity, of magnetism and of current. These laws were Coulomb's laws of inverse square for electrified and magnetized particles, and Ampere's law of inverse square for elementary electrical currents. The striking similarity between these laws and Newton's law of universal gravitation made the problems in electricity and magnetism mathematically almost identical with those in geodynamics and celestial mechanics, hence whatever notions had gradually become attached to the idea of force of gravitation were necessarily introduced into the science of electricity and magnetism, and among them the belief in "direct action at a distance."

The opinion that this belief retarded the progress of the electrical science at the time is hardly justifiable. On the contrary, it may be said to have done considerable good, for it prevented useless speculation, and thus saved time for the work which produced most excellent results such as Ampere's, Green's and Poisson's beautiful and exceedingly useful theorems. The time for the discussion of this belief was not ripe until the science of electricity was enriched by Faraday's immortal discoveries. They form the physical basis of our belief that electrical and magnetic actions between bodies are transmitted by the intervening medium. More than that, they were the very seed which, falling upon the virgin soil of an unprejudiced mind, sprang forth naturally in the luxuriant growth of such a belief. For who can see a current generated in a neutral conductor by the motion of a magnet, or the capacity of a condenser changed by the change of the dielectric substance, or a substance paramagnetic in air become diamagnetic when immersed in a more strongly paramagnetic iron salt solution, or the electromagnetic induction intensified a thousand fold by the introduction of iron between inductively related circuits; who can see all these revelations of Faraday's profound researches and still believe that they suggest nothing beyond direct action at a distance? Surely, not a physicist like Faraday, whose wonderful faculty of keen observation was equalled, if not even surpassed, by great powers of poetic intuition. So deeply was he convinced by these phenomena of the importance which the medium surrounding electrical and magnetic bodies plays in the mutual action of these bodies, that he proceeded to draw a map describing in detail the function which the medium performs in these actions. We thus obtained Faraday's map of the field of electric and of magnetic forces. I now quote from Maxwell: "For instance, Faraday, in his mind's eye, saw lines of force traversing space where the mathematicians saw centres of force attracting at a distance; Faraday saw a medium where they saw nothing but distance. Faraday sought the seat of phenomena in real actions going on in the medium; they were satisfied that they had found it in a power of action at a distance impressed on the electric fluids." These few words, coming from a man who was first to see clearly the bearing of Faraday's immortal work, suffice to give a faithful picture of the ideas which guided the great master of modern elec-

trical research in his profound investigations.

A few words must be added here to show briefly the relation between Faraday's work and this picture, which Maxwell gave us, of Faraday's guiding ideas.

Faraday's discoveries are known to-day, especially among electrical engineers, chiefly through the technical applications of the fundamental principles which were first established by these discoveries. The dynamo and the motor, the telegraph and the telephone, the induction coil and the modern transformer, all these great inventions; in fact, the whole science of electromagnetism and electrodynamics, both pure and applied, are only single illustrations of the wide range which is covered by these discoveries. But it is no more than just to mention here that in the region of the electrical science just mentioned, namely, in electromagnetism and electrodynamics, a very fair, if not an equal, share of the glory of original discovery belongs to our own countryman, illustrious Joseph Henry.

Faraday can well afford to share these honors with so great a physicist. For it adds to his greatness to have it recorded in the annals of science that the supreme effort in the life work of so great a physicist as Joseph Henry was the first step only in the long series of Faraday's far-reaching discoveries. A comparison of the flight of an eagle to that of a falcon suggests itself irresistibly to my mind when I compare the researches of these two great investigators. The falcon eye of Joseph Henry scanned carefully from its lofty height the enchanting view of the newly discovered regions, the regions of electromagnetic induction. Faraday's mind is carried, as it were, by the powerful wings of the royal bird to heights that are sublime. *But what is it that calls Faraday away from and far above the lofty heights of Joseph Henry?* This is the question which presents itself to every thoughtful student of Faraday's "Experimental Researches." For who does not feel that the pleasure one gets from reading Faraday's masterly story of his discovery of electromagnetic induction given in the first part of volume I. of his "Researches" ends much too soon? I even venture to suggest that many a one among these students of Faraday, especially those whose taste runs more in the direction of estimating the value of a new discovery by the immediate practical application to which it can be put, has undoubtedly bemoaned the fact that Faraday allowed himself to be drawn away so soon from his researches in electromagnetic induction to matters so abstract as electro-chemistry, electric discharges through gases, specific inductive capacity of dielectrics, magnecrystalline action, magnetic properties of flames and gases, action of magnetism on light, etc., etc., seem to be, in comparison to so eminently practical a subject as electromagnetic induction certainly is.

But a careful review of Faraday's long series of researches suggests to my mind a very intimate connection between the numerous and apparently independent parts of that long series. They are all just so many little streams which flow into the same main current of thought. It starts from the phenomena of electromagnetic induction. The tributary streams make it stronger and stronger. It grows wider and wider, and finally disappears in the dim regions, which, according to Faraday's visions, connect the phenomena of light, electricity and magnetism. The phenomena of electromagnetic induction inspired the prophetic mind of Faraday with the idea that there must be an invisible mechanism connecting material bodies, and that it is the activity of this mechanism which makes us cognizant of the existence of electric and magnetic forces. He gave expression to this inspired idea by introducing into his mode of thought and of description a new term, the term magnetic curves, or lines of magnetic forces. At first he gave us only their geometrical definition: "By magnetic curves," he added in a foot

*Treatise on Electricity and Magnetism, previous volume I, page 19.

note, volume I., page 32, "I mean the lines of magnetic force, however modified by juxtaposition of poles, which would be depicted by iron filings; or those to which a very small magnetic needle would form a tangent." But the intimate connection between the phenomena of electromagnetic induction and these curves, or lines of magnetic force, convinced him that these curves are actual physical existences and not mere geometrical space relations; of which the iron filings give us a convenient material picture. He was aware that the nature of these new physical existences could not be revealed by a study of phenomena like those of electromagnetic induction, as long as these phenomena could be observed in bodies of finite dimensions only. He saw that the road leading to the understanding of the lines of force was by way of the phenomena which can be traced with certainty to the ultimate elements of matter, to atoms and molecules. This was the voice which called Faraday away from the lofty heights of Joseph Henry and bade him rise higher and higher until he reached heights so sublime that only the wings of a genius like that of Maxwell could reach him. This is why Faraday's discoveries in electromagnetic induction led him into researches of what may be called the atomic and molecular region of the science of electricity. From this standpoint of view, the chronological order in which his researches in electro-chemistry, voltaic electricity, specific inductive capacity of dielectrics, disruptive discharges through gases, animal electricity, action of magnets on light, on metals and their compounds, on gases, on crystals, etc., etc., follow each other in rapid succession, appears natural. The numerous discoveries revealed by these profound researches encouraged the great discoverer that his work was in the right direction. With steady aim he forges ahead with giant strides. The most vigorous years of his life are consumed in gathering the vast amount of evidences with which to reveal before our eyes the physical nature of the lines of force, his first inspiration, and banish forever the old superstition of direct action at a distance. With renewed vigor he returns to this favorite subject toward the closing years of his life. His research "On the Lines of Magnetic Force; Their Definite Character; and Their Distribution Within a Magnet and Through Space" (Philosophical Transactions, 1852, page 1), given in the twenty-eighth series of his "Researches," mark the beginning of the last epoch in his great work. It prepares us to enter into the innermost thoughts of Faraday and see that inspiration and those visions which guided his steps for twenty years. The essays which now follow, "On the Lines of Magnetic Force," "On the Physical Character of the Lines of Magnetic Force," "On the Physical Lines of Magnetic Force," "Thoughts on Ray Vibrations," etc., are just like the glow of an approaching sunrise. The fairyland of Faraday's vision begins to appear clearer and clearer in this gently rising light, but, alas! the cloud of old age hides away the beauties of the sunrise itself.

A tower rising way above this cloud was needed. Faraday had collected the building material and he also prepared a rough sketch of the plan. It was reserved for Maxwell to raise the lofty edifice from which we first obtained a clearer view of the wonderland of Faraday's visions.

I cannot do better than close these few observations on the position which Faraday occupies in the epoch which closed with Hertz by quoting a beautiful passage from a lecture of this most worthy pupil of Faraday and Maxwell: "Faraday heard of the belief that electrification puts something into a body, but he saw that the changes produced were all external and none internal. Faraday was taught that forces jump through space, but he saw that these forces

were influenced in the highest degree by the substances which filled the space. Faraday read that electricities certainly existed, but that their forces were a disputed question, and yet he saw that these forces produced tangible effects, although he could not perceive anything of the electrifications themselves. Hence, in his conception, the state of these things became reversed. The electric and the magnetic forces appeared to him as existing, as real, as tangible; electricity and magnetism were things whose existence might be a disputed question. The lines of force, as he called the forces considered as independent entities, stood before his mind's eye as conditions in and of the space, as strains, as vortices, as fluxes, as something or other—he could not tell as what—but there they stood, influenced each other, they pushed the bodies and they pulled them, and they continued from point to point, conveying impulses to each other. The objection that nothing but absolute rest was possible in empty space he met with questions: Is space really empty? Does not light itself compel us to assume it as filled? Could not the ether which conveys the waves of light become the seat of those changes which we recognize as electric and magnetic forces? Is it not even possible to imagine a relation between these changes and those waves of light? Why could not these waves of light be something like the oscillations of those lines of force?

"So far did Faraday reach in his conceptions and his surmises. He could not prove them. He busily searched for evidences. The connection between light, electricity and magnetism was the favorite subject of his research. The beautiful connection which he found was not the one for which he looked. * * * Only the highest old age put an end to his efforts."

(To be continued.)

The Niagara Falls Power Plant.

In a recent communication Mr. Charles Russell, of Philadelphia, Pa., expresses doubt as to the realization of all the hopes of those connected with the scheme for the transmission of power at Niagara Falls. As to transmitting power to Buffalo, the whole question, according to his idea, resolves itself into a difference of cost between running a water-power plant at Niagara and a steam plant at Buffalo. Admitting that there is an advantage of 25 per cent. in favor of the Niagara water-power plant, the additional cost of lines from Niagara to Buffalo and their maintenance, as well as the depreciation and interest on the same, will make it evident that there cannot be a great percentage in favor of Niagara, and as the distance increases the advantage decreases. Mr. Russell states that he has given the matter considerable attention and made various estimates, and that he fails to see such a glorious future as some have claimed for the Niagara Falls Power Company. He has great faith, however, in the success of the project in so far as it does mass the business together at the Niagara plant, and believes that Niagara's profit is in utilizing its power for manufacturing purposes on adjacent grounds.

At Last They Make a Beginning.

Our English contemporaries publish as a piece of news, to which they seem to attach some importance, that the first large electric motors for driving printing presses in London have recently been installed in the office of the "Pall Mall Gazette." The Electrical World was printed from presses driven by an electric motor in 1884, just ten years ago. And yet some Englishmen claim that there is "nothing to learn from Americans."

*Hertz: Ueber die Beziehungen zwischen Licht und Electricitaet; a lecture delivered before the convention of German naturalists and physicians at Heidelberg in 1890. Published by Emil Strauss, Bonn.

A Current Without a Difference in Potential.

BY PHILIP K. STERN.

In the matter of "Current Without Difference of Potential," a subject which appeared in *The Electrical World* of Jan. 27, page 110, and reappeared in the next issue, kindly permit me, through the medium of your columns, to ask the writer of the original item whether it is to be understood that the supposed charge is to be considered as resident on the conductor, i. e., the charges of the plus and minus values respectively on the opposite faces of the concentric cylinders, or are these values to be considered as a mere difference of potential in the dielectric medium intervening? The third paragraph has, apparently, the former meaning.

In any event, if a current is set up without a difference of potential existing between any two points in the conductor, I ask permission to state that the supposed current would not flow through the conductor between such points. Though choosing a point of reference in the dielectric medium, and an electrified particle located at a point on the ring having angular velocity, a current might be considered as flowing from the right or left of the point of reference, according to the direction of rotation. In this case there would be a difference of potential. According to Maxwell: "Two electrified particles having the same potential placed side by side, starting from a state of rest and set in motion with a positive acceleration, will mutually repel until they have attained a velocity equal to that of light, when their electrostatic repulsion would exactly balance their electromagnetic attraction; after this period, though they would still be at the same potential, they would attract mutually." There must certainly be a difference of potential; where is it? Is it not in the medium through which the charges are being conveyed, and may not this be due to a transverse strain on the luminiferous ether and positive or negative (from a point taken midway between the particles), in consequence of the resultants of the forces at work, viz., the resistance offered by the medium and the force which is overcoming the same?

Here we have come face to face with resistance in the nature of a velocity, and so in the case of the two concentric cylinders we must consider the velocity of the rotating cylinder in question. With a charge located at a point on its outer surface, or at a number of points, as a resistance; and as resistance is being overcome, work must be the result. Does this not define potential? Moreover, the term employed to electrically denote that which overcomes resistance is an electromotive force.

Are these not instances of differences of potential where work is being done between the points referred to? It would appear as though we might call this, as well as the work that can be done by virtue of the position of these points (electromotive force), a difference of potential.

Considerable gain might result in these investigations by directing our attention to the dielectric medium as the true cause of the phenomena.

I should like to ask Prof. Anthony to kindly inform me as to what direction the current might be expected to flow through the ring referred to without a difference of potential, or, as stated, "electrical potential." If there should be a difference of potential, or, potential other than electrical, as soon as we consider the question of there being electrical work done or electricity moved against resistance, why can we not consider this electrical potential?

(There is, to our knowledge, no original author of the note referred to, it being merely a summary of an informal discussion which we published, as it was sent to us, thinking the subject might be of interest to some of our readers. The publication of such reports does not, of course, necessarily imply any endorsement on the part of the editors of

the opinions expressed. It seems evident from the original note that the charges are supposed to reside in the conductors and not in the dielectric. We might add here that we believe Prof. Rowland showed experimentally a number of years ago that a static charge in motion was the equivalent of a current. It has been suggested to us that a discussion of this subject may be found in J. J. Thomson's recent work.—Eds.)

Long-Distance Transmission with Alternating Currents.

BY FRANK C. PERKINS.

MOST interesting alternating-current plant has recently been installed at Schöngeising and Furstenfeld-Bruck, Germany, for the transmission of electricity for light and power.

This transmission plant was designed by Mr. Oscar von Miller, of München. The general plan of the line and distribution of power is shown in Fig. 1. The generating station is situated at Schöngeising, a distance of seven kilometres from the centre of distribution of light and power at Furstenfeld-Bruck.

The single-phase alternating current was chosen for this plant, because it was thought to be the cheapest and surest

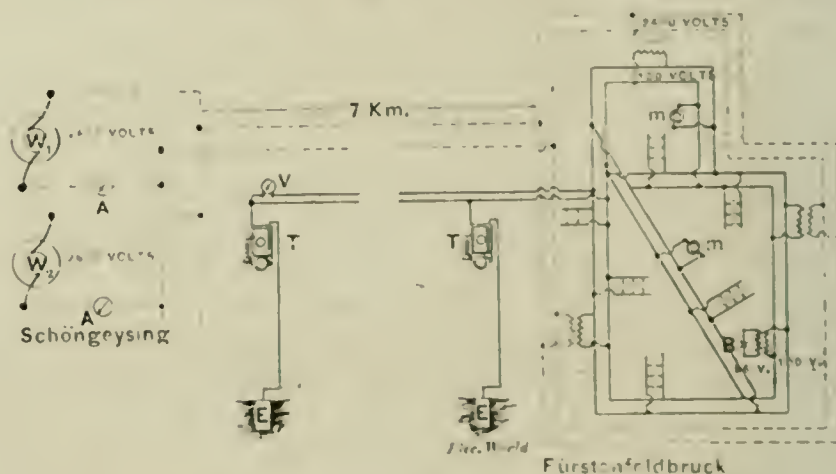


FIG. 1—GENERAL PLAN OF DISTRIBUTION.

method for the conditions presented. Two alternating-current dynamos (Fig. 2) of 2,600 volts each are connected in parallel, and the current is carried on two conductors to a closed ring distribution, the dotted lines in Fig. 1 representing the high potential circuit and the heavy lines the sec-

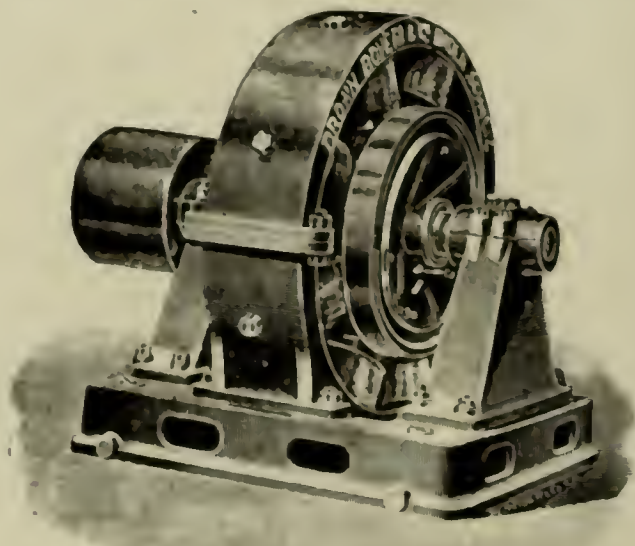


FIG. 2—SINGLE-PHASE DYNAMO.

ondary, or low potential circuit. Transformers are connected at various points, reducing the voltage from 2,400 volts to 100 volts. Each arc lamp on the secondary circuit has a small transformer in circuit, reducing the voltage from

100 to 36 volts, thus avoiding the use of resistance coils for the arc lamps.

A novel feature connected with this plant is the use of a potential indicator circuit for a telephone line. A voltmeter

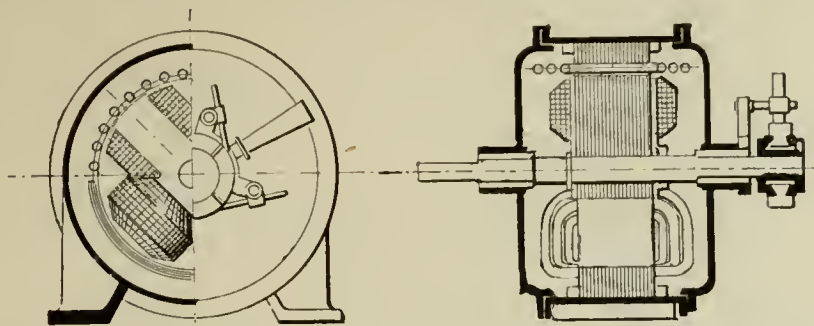


FIG. 4.—SECTIONAL VIEWS OF SINGLE-PHASED MOTOR.

in the generating station is connected by a line with the secondary lighting circuit at Furstenfeld-Bruck to show the potential at the centre of distribution. One of the conductors of this circuit is connected, through telephonic instruments, to the ground; and it is said the line gives good service.

The turbine and generator plant (see Fig. 3) utilizes

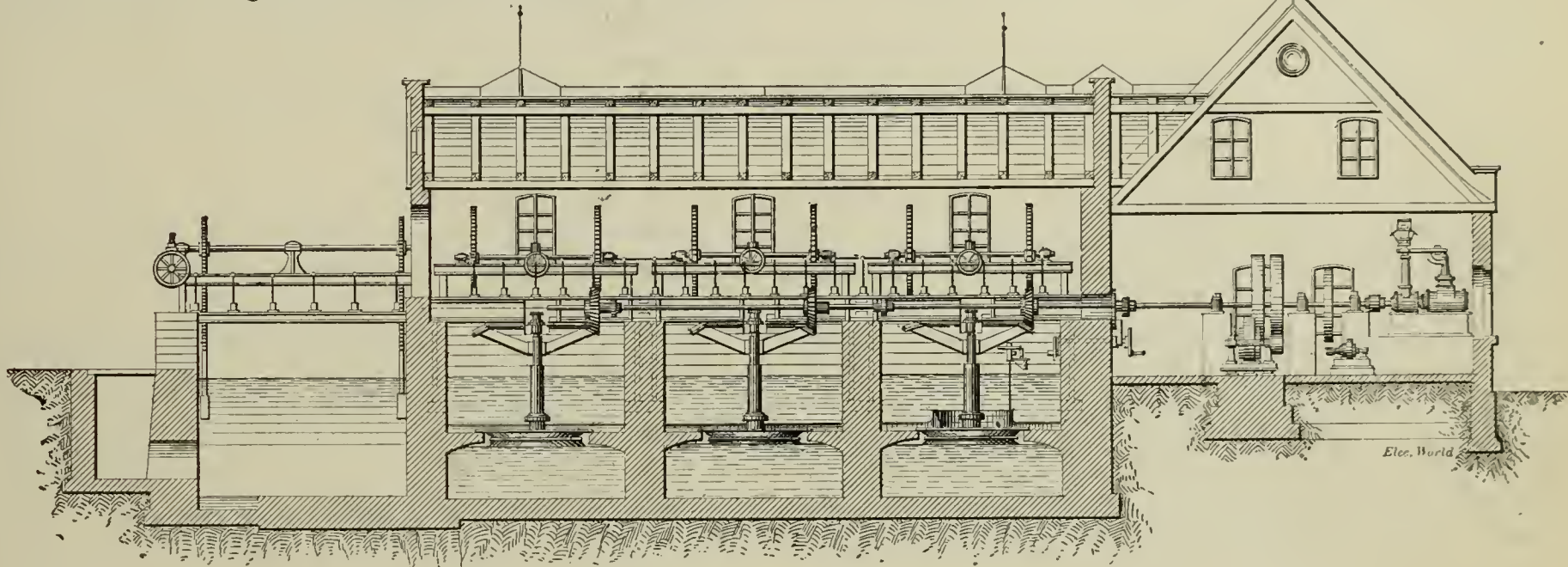


FIG. 3.—THE TURBINE AND GENERATOR PLANT.

the water of the River Amper. When the plant is completed three turbines and three dynamos are to be used. Up to the present time but two turbines have been installed, each having a capacity of 68 h. p. The turbines and regulating apparatus were furnished by Schelson & Issmayer, of Munchen,

The rate charged per lamp hour at Furstenfeld-Bruck is 8 pfennig (one-quarter cent), where 2,500 lamp hours are used annually, shutting off at 11 o'clock.

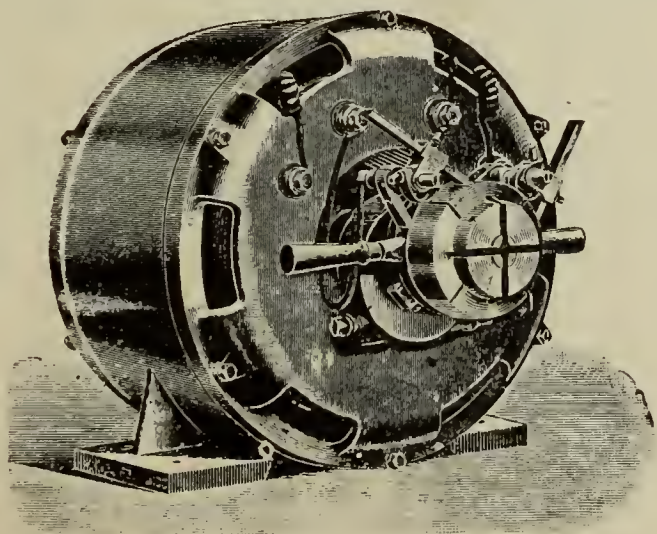


FIG. 5.—SINGLE-PHASED MOTOR.

and Briegleb, Hansen & Co., of Gotha. The turbine shafts revolve vertically and are geared to a line shaft, to which the dynamos are belted. The alternating-current generators, transformers and motors were furnished by the firm of Brown, Boveri & Co., of Baden, and they are exceedingly simple in construction. The design of the motors may be seen in Figs. 4 and 5.

The main line from Schongesung to Furstenfeld-Bruck consists of two bare wires six millimetres in diameter, mounted upon the usual porcelain insulators. The loss on the line and at the transformers amounts to 17 1-2 per cent. It was found to be necessary to use an overhead construction for the distribution instead of underground cables, as the former method averages about 20 marks per house and the latter method about 200 marks per house, or ten times as much.

In giving the total energy received at Furstenfeld-Bruck the energy necessary for a 16-candle power lamp has been used as a unit.

Energy at Schongesung—

2 machines, 120 h. p. 1,580 16-c. p. lamps

3 machines, 180 h. p. 2,370 16-c. p. lamps

Seventeen and one-half per cent. loss on line and transformers—

2 machines 280 16-c. p. lamps

3 machines 420 16-c. p. lamps

Net energy at Furstenfeld-Bruck—

2 machines 1,300 16-c. p. lamps

3 machines 1,950 16-c. p. lamps

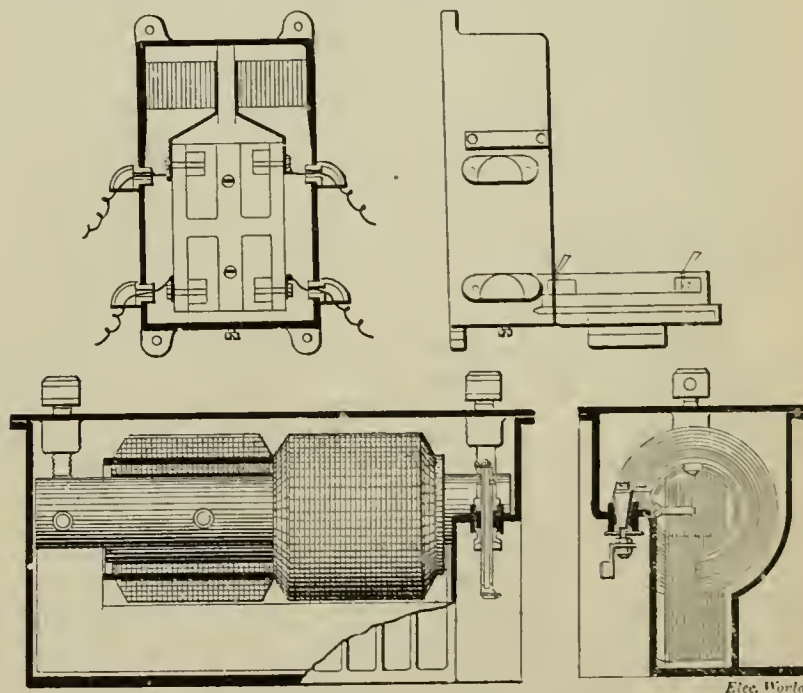


FIG. 6.—THE TRANSFORMER.

The transformers (Fig. 6) consist of an iron frame, on which the primary and secondary coils are wound. These are placed in cast-iron cases filled with oil.

A recent communication received from Mr. Oscar von Miller states that the plant is giving excellent satisfaction.

A Contribution to the Theory of Telephony.

BY A. E. KENNELLY.



HE theory of the transmission of telephonic current waves is complex to the degree that the wave character of their generated E. M. F. must be, in order to follow and even partly conserve the highly composite character of vocal vibrations in air. Nevertheless, the theory of transmitting sinusoidal current waves of any single frequency within telephonic range is simple, and with judiciously selected values of frequency and amplitude, the application of this elementary theory may, with due reservation, be of practical value.

It is the object of this article to develop the theory of simple harmonic telephony in its simplest form, and to point out a few of its consequences.

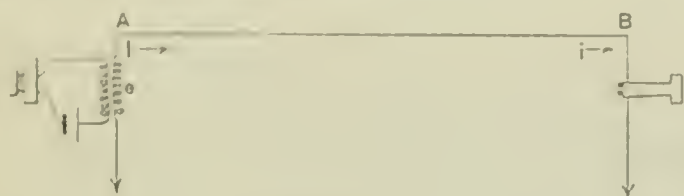


FIG. 1.

$A B$ in Fig. 1 represents a single line of copper wire L miles or kilometres in length, with an induction coil transmitter at A , a receiving telephone at B , and ground return circuit.

If we assume that a pure musical note of some standard frequency is sung steadily before the transmitter at A , producing a steady sinusoidal current in the primary circuit of the coil, a sinusoidal E. M. F. will be generated in the secondary winding. The effective E. M. F. delivered at the terminal A will, however, depend upon the load, namely, the impedance of the line and receiving instrument. The man-

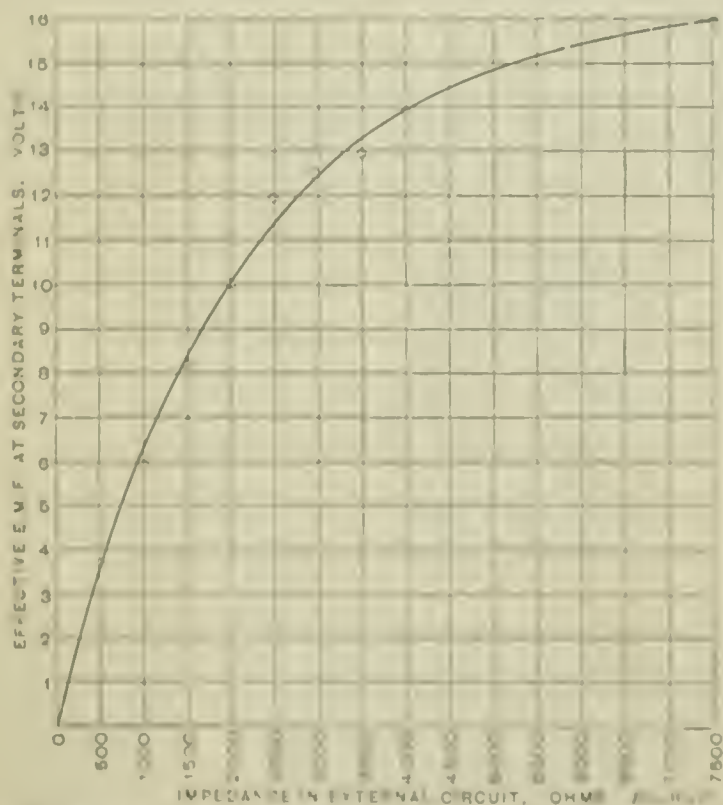


FIG. 2.—CURVE REPRESENTING THE OBSERVED RELATION OF EFFECTIVE TERMINAL E. M. F. TO LOAD IN A TELEPHONE INDUCTION COIL.

ner in which the voltage of delivery varies with the load may be observed by experimentally substituting for the line an adjustable non-inductive resistance, and measuring the E. M. F. at terminals with a delicate electrostatic voltmeter as this resistance is changed. The following table and the curve (Fig. 2) give the result of a series of observations made with a small telephone induction coil of European construction, having a primary of 1.21 O and 0.0001 H a secondary of

393 O and 1.13 H , and a mutual inductance of 0.12 H , with two storage cells in the primary circuit, and the note "middle C" of 256 $\sim$ sustained in a moderately loud voice before the transmitter. The readings were too variable to admit of a high degree of accuracy, but the curve fairly represents the terminal E. M. F. produced by the transmitting apparatus under those conditions for any external impedance up to 7,500 ohms.*

Ext. Res.	Effective Volts at Terminals.
500	3.75
1,000	6.
1,500	8.25
2,000	10.
2,500	12.
3,000	12.5
3,500	13.
4,000	14.
7,500	16.

Returning then to Fig. 1, the effective voltage at the terminal A is experimentally determinable, when the impedance of the line and receiving instrument can be assigned.

The distance at which simple harmonic sound waves will be recognizable with sufficient clearness for the purposes of intelligent communication will then depend upon the strength of the current reaching the telephone at B , the usual amount of "cross-talk," and other disturbances, being taken into consideration.

The problem may therefore be stated as follows:

For any given homogeneous line of known resistance, inductance, leakage, and capacity, grounding through apparatus of known impedance, to find the total impedance as presented at A , and thence having determined the effective pressure at A , to find the current strength that will reach B . Simple harmonic telephony will then be practicable or not, according as this current strength exceeds or falls short of some experimentally determined and limiting value, at the standard frequency adopted.

Let L be the length of the line in miles or kilometres.

r be its conductor resistance in ohms per mile or kilometre.

l be its inductance in henrys per mile or kilometre.

c be its capacity in farads per mile or kilometre.

g be its leakage conductance in mhos per mile or kilometre.

ω be $2\pi \times$ the frequency.

j be $\sqrt{-1}$.

e be the effective terminal voltage at A .

i be the effective current strength through B , in amperes.

I be the effective current strength at A in amperes.

Z be the vector impedance of the apparatus at B .

Z will usually have the form $(R_T + jL_T\omega)$, where R_T and L_T are the resistance and inductance of the apparatus, which is shown in Fig. 1 as a telephone.

Then it can be readily shown that

$$I = \frac{e}{y} \left(\frac{y \cosh Lz + Z \sinh Lz}{y \sinh Lz + Z \cosh Lz} \right) \quad (1)$$

and

$$i = \frac{e}{y \sinh Lz + Z \cosh Lz} \quad (2)$$

where

$$z = \sqrt{(r + j\omega l)(g + j\omega c)} \text{ and } y = \sqrt{\frac{r + j\omega l}{g + j\omega c}} \quad (3)$$

These equations give the magnitude and phase of the currents at the receiving and transmitting ends of the line.

*It is not, of course, justifiable to assume that because these values of E. M. F. were observed with non-inductive resistance they would be exactly reproduced with impedances of equal numerical value. The angle of lead or lag in the impedance of a telephone line seldom equals 30 degrees, however, and experiment appears to show that the discrepancy is not worth considering in consequence.

the quotient e/I in (1) being of course the impedance of the line A , which being computed gives both e and I , whence equation (2) determines the serviceability of the line.

These equations involve plane vectors, of which the rules for treatment are given in *The Electrical World* for Jan. 6, 1894, volume XXIII., No. 1, page 18. The equations may, however, be further simplified when dealing with electrically long lines; that is to say, lines approaching the limitations of transmission; for in such cases the influence of impedance in the receiving apparatus usually ceases to be dominant upon the circuit, and we may make $J=0$, while, since the vector Lz is then sure to be more than two units in length, its hyperbolic tangent in (1) will be practically unity, so that for long lines, here considered, our equations become:

$$I = \frac{e}{y \tanh Lz} = \frac{e}{y} \quad (4)$$

and

$$i = \frac{e}{y \sinh Lz} \quad (5)$$

But long distance telephony employs metallic circuits, such as is represented in Fig. 3 with an effective E. M. F. of E volts at A .

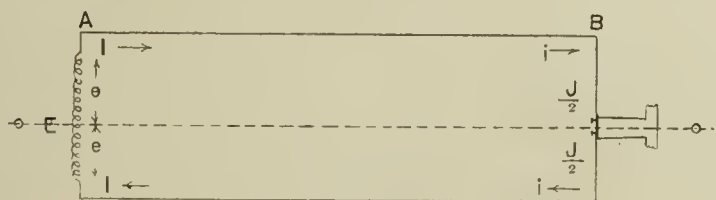


FIG. 3.

The line OO divides this circuit into two symmetrical halves, each as though employing ground return, and with half the E. M. F. at A , half the impedance in the apparatus at B , and twice the capacity allowed to each wire that is measured between them when insulated from the ground and from each other. In equation (1) we therefore insert half the vector quantity J , and the quotient e/I then gives the impedance of either half of the complete circuit. Twice this result being the impedance of the loop at A , E is obtained from the experimental data, and e or half of E inserted in (2) or (5) supplies the strength of received current i .

We may now consider some examples of these formulae. First case: Two parallel overhead wires, each 950 miles long, of hard drawn copper 0.165 inches (0.419 centimetre) in diameter, are supported on poles at an interaxial distance of 9 inches (22.9 centimetres), no other wires being in their vicinity. Then each may have per mile a resistance of 2.2 ohms, a capacity of 0.009525×10^{-6} farad, an inductance of 0.00159 henry, and a leakage conductance quite negligible.

Then if the simple harmonic standard frequency is 238.7 $\sim$, making $\omega = 1500$, we have

$$L = 950.$$

$$r = 2.2.$$

$$l = 1.59 \times 10^{-3} \therefore l\omega = 2.385.$$

$$\text{Doubled } c = 1.9 \times 10^{-8} \therefore c\omega = 2.85 \times 10^{-5}.$$

$$g = 0.$$

Therefore, as shown in Fig. 4, $z^2 = 9.248 \times 10^{-5} \angle 137^\circ 18'$, $z = 9.617 \times 10^{-3} \angle 68^\circ 39'$, $y^2 = 1.1385 \times 10^5 \angle 42^\circ 42'$, $y = 3.374 \times 10^2 \angle 21^\circ 21'$.

It is to be observed that twice the actual value of c has to be allowed, owing to considering the lines as being operated independently with ground return. Similar remarks apply to the case on page 19, vol. XXIII. The impedance y of one line is thus 337 ohms, and 674 ohms is the impedance of the loop at A . By reference to Fig. 1 it appears that the terminal pressure which the transmitter would support on this circuit would be 4.6 volts, or 2.3 volts on

each wire. Fig. 5 shows Lz , which is L times the length of the vector z , and with components a and $j b$ of 3.326 and 8.508 respectively. The hyperbolic sine may be fully



FIG. 4.

worked out as indicated on page 18, vol. XXIII., but whenever, as in this instance, the horizontal component a is greater than 2, the maximum possible error in the numerical value of $\sinh Lz$ made by ignoring the vertical component is 3.5 per cent., and when a is greater than 2.5, 1.25 per cent.; rapidly dwindling. We may, therefore, when considering long lines, write equation (5) as

$$i = \frac{e}{y \sinh a} \quad (6)$$

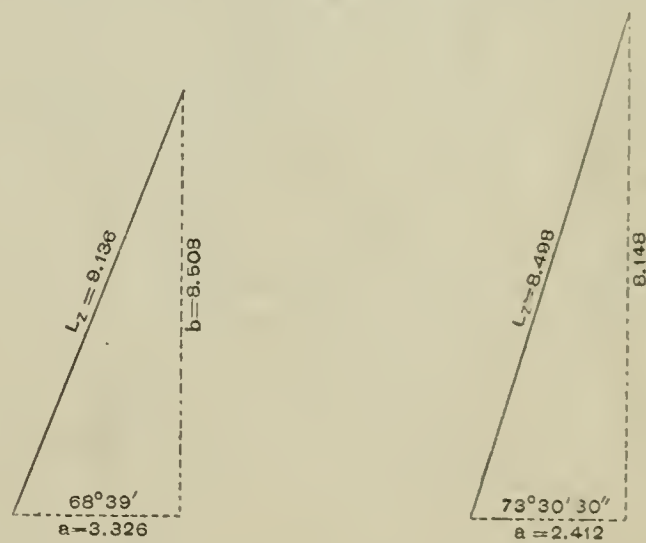
Here, see Fig. 8,

$$\sinh a = 13.9, \text{ and } i = \frac{2.3}{337 \times 13.9} = 0.0004905 \text{ ampere.}$$

This is the current strength we should expect at B .*

Second case: The same wires separated to an interaxial distance of 72" (183 centimetres), the inductance per mile of each is now 0.002259 H , and the capacity of each to each insulated 0.006604×10^{-6} farad.* Thus $l\omega = 3.389$, and doubled $c\omega = 1.981 \times 10^{-5}$.

Fig. 5 represents the corresponding steps in computation



FIGS. 5 AND 7.

$$z^2 = 8.00 \times 10^{-5} \angle 147^\circ 1', z = 8.944 \times 10^{-3} \angle 73^\circ 30' 30'',$$

$$Lz = 8.498 \angle 73^\circ 30' 30'', y^2 = 2.041 \times 10^5 \angle 32^\circ 59',$$

$$y = 4.518 \times 10^2 \angle 16^\circ 29' 30''.$$

The impedance of the loop at A or $2y$ is now 904 ohms, at which the terminal pressure is $E = 6$ volts, or 3 to each wire. Entering equation (6) with this value of e , Fig. 7 shows that the horizontal component of Lz is now 2.412, whose hyperbolic sine (see Fig. 8) is 5.53. The received current is consequently $\frac{3}{452 \times 5.53} = 0.0012$ ampere. The

* If in this first case the receiving telephone at B has a resistance of 75 ohms and an inductance of 0.1 henry, representing an impedance at $\omega = 1500$ of $167.7 \angle 26'$ ohms, it will be found by inserting this value for J in formula (2) that the received current at B is thereby reduced from $i = 0.0004905 \angle 148^\circ 45'$ to $i = 0.0004236 \angle 122^\circ 45'$. That is to say, the ignoring of the impedance of the telephone in this case produces an overestimation of the received current strength amounting to 25.8 per cent.

separation of the wires has here more than doubled the received current strength.

By watching the geometrical development of the computation, the utility of inductance in telephonic conductors is symbolically apparent in two ways. First, by making the length $(r + j l \omega)$ greater, it adds to the length of y , and thus augments the impedance at A and the effective voltage delivered to the line. Secondly, it increases the angle of z and $L z$, thus reducing the horizontal component a , upon which the value of $\sinh a$ so sensitively depends. On the

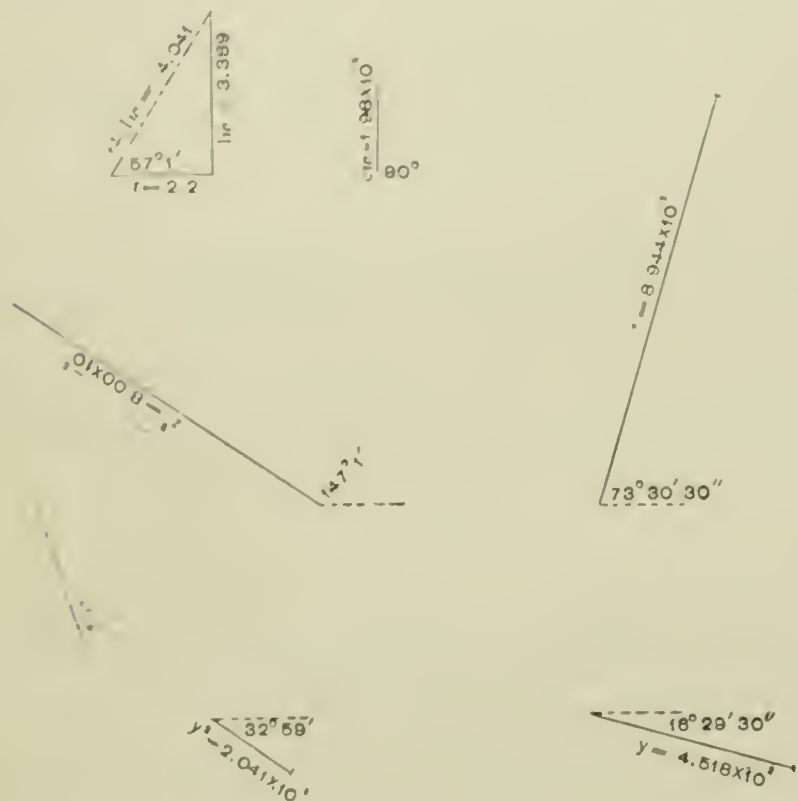


FIG. 6.

other hand, it will be evident that beyond a certain value the beneficial influence of inductance will cease.

Equations (1) and (4) indicate that when the circuit is sufficiently long to make the horizontal component of $L z$ more than 2, the factor $\tanh L z$ is practically unity, and the impedance of the circuit as apparent at the transmitter becomes practically constant, no matter how far the line be then extended. The effective voltage of delivery therefore remains constant, and the received current, as the length of line increases, depends entirely upon the reciprocal of $\sinh a$. In other words, with a moderately long line of fixed and uniform electrical constants, the strength of the received current varies inversely as the hyperbolic sine of a fraction of its length, and not inversely as the square of its length. Fig. 8 gives the curve of hyperbolic sines, which may be employed when a table of these functions is not available. The dotted line represents a particular curve of squares. The agreement between the two curves is very fair until the variable exceeds 3.5, and, to a first approximation therefore, the law that assigns the amplitude of received current to the inverse square of the length is correct. This does not, of course, contravene Lord Kelvin's law of signal transmission, which asserts that the interval of time required to bring the amplitude of current strength received at the distant end of a cable (having small inductance in relation to its capacity) to a given fraction of the ultimate full maximum varies as the square of the cable's length. In the case of harmonic telephony before us we consider only the amplitude of harmonic current waves that have already practically reached their full development, and the progress of that development toward maturity, at the start, and in the initial stages of transmission, is removed from present consideration.

Third case: Two No. 10 A. W. G. copper wires, 0.1019 inch (0.2588 centimetre) in diameter, are suspended parallel and alone upon poles at an interaxial distance of one foot (30.48 centimetres). Assuming that their capacity, when insulated from each other and from ground, is 0.007 microfarad per mile, their separate inductances 2,138 millihenrys per mile, their resistance each 5.28 ohms, and their insulation to ground each 250,000 ohms per mile, required the distance at which harmonic telephony will be possible with the special transmitter above referred to, when the limiting current strength at $\omega = 1,500$ is 0.00025 ampere.

Here $r = 5.28$, $l = 2.138 \times 10^{-3}$, doubled $c = 1.4 \times 10^{-6}$, $g = 4 \times 10^{-6}$, $l \omega = 3.207$, $c \omega = 2.1 \times 10^{-5}$.

Constructing triangles as before, we find $(r + j l \omega) = 6.178 / 31^\circ 16' 30''$, and $(g + j c \omega) = 2.138 \times 10^{-5} / 79^\circ 1'$, whence $z = 0.01149 / 55^\circ 8' 45''$, and $y = 537.6$ with neglected phase. The loop impedance at A is 1075 ohms, to which the transmitter will respond with a terminal E. M. F. of 6.7 volts by Fig. 1, or 3.35 volts to each wire. We have then the relation $(e/y \sinh a) = 0.00025$, or $\sinh a = 24.93$, so that (see Fig. 8) $a = 3.91$.

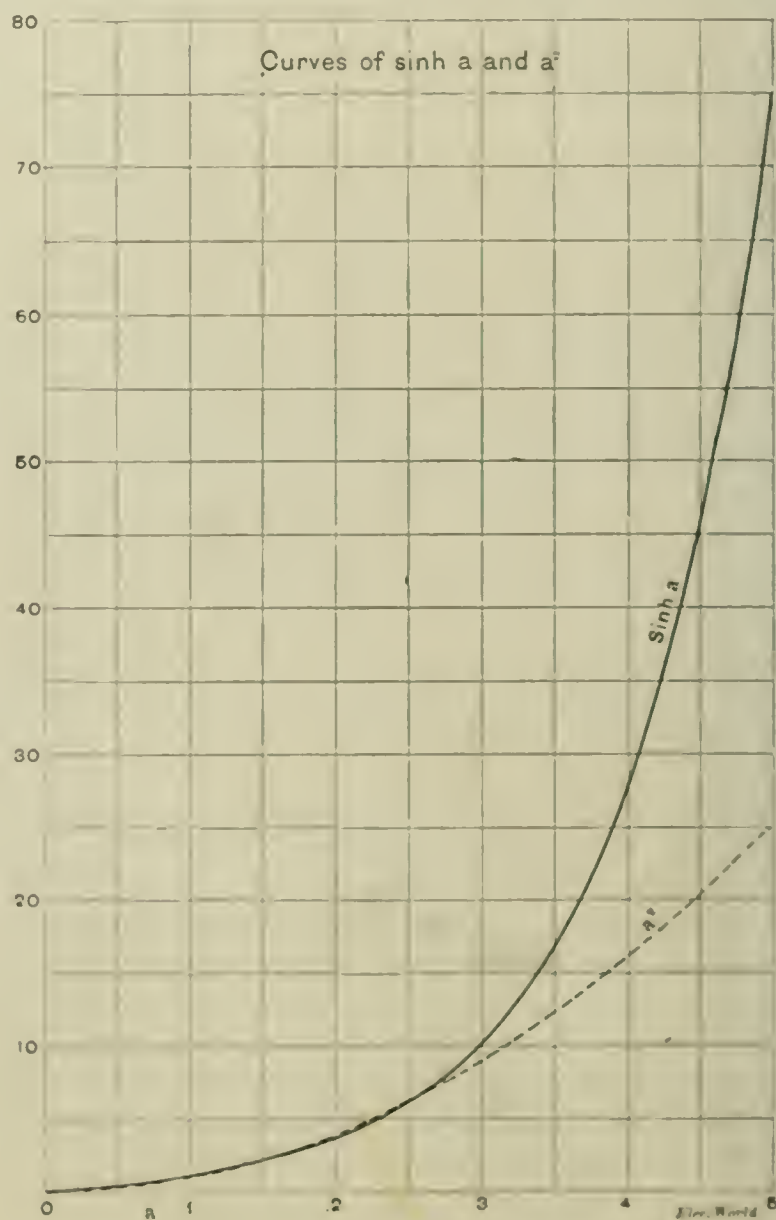


FIG. 8.

$L z$ is $3.91 / (\cos 55^\circ 8' 45'')$, or 6.842, and $L = 6.842 / 0.01149 = 595$ miles. The harmonic sound reproduction would have the limiting amplitude at about 600 miles.

In conclusion, it may be pointed out that all the preceding formulae apply immediately to continuous current *leaky* circuits, by suppressing the influence of their inductance and capacity; that is, by equating l and c to zero. The consequent values of y and z are no longer complex quantities, and the equations degrade into ordinary scalar or algebraic formulae for determining the influence of uniform leakage upon the outgoing and received continuous currents.

Some Unique and Useful Methods of Measurement.—II.

BY GEO. T. HANCHETT.



IN the case of the dynamo, especially if it be a compound wound machine, there are a number of resistances which are troublesome to measure, and if there is but one machine the matter is made worse, since the electrical expert is deprived of all means of getting an independent current, and the useful and well-known fall of potential method becomes an impossibility. It is true that if we insert an

ammeter in the shunt field while the machine is running and take the potential at the terminals of the shunt we may thus calculate its resistance. This is usually a good method, but sometimes when the ammeter is of large scale the current cannot be read accurately, and thus the calculated value of the resistance is doubtful. Similarly we can insert an ammeter in the main circuit and take the potential around the terminals of the series field, and thus determine its re-

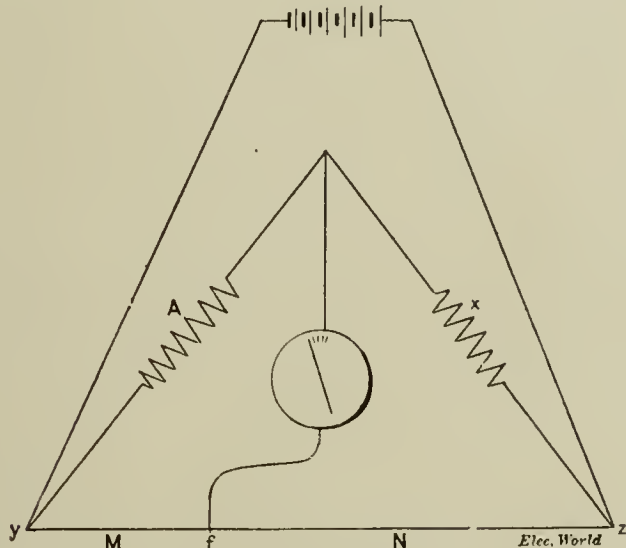


FIG. 7.

sistance, but here again the small difference of potential involved will be inaccurately measured by the voltmeter, which is very apt to have a scale reading of 150 volts and perhaps 500. Moreover, if the so-called series and long shunt connection is employed, the ammeter reading errs by the amount of current necessary for the shunt field.

It is not always easy to cut in an ammeter between the brush and the series field, and at best a check measurement of these resistances would be desirable, if not necessary. For the purpose secure a resistance which can be measured by the fall of potential method, and at the same time give a good deflection on the scales, so as to insure an accurate measurement.

Having secured a resistance the value of which is either known or easily determined, the next thing to provide is a smooth, straight piece of wire, either iron or copper, about four feet long, and of as uniform cross-section as possible. Then connect this wire with the known and unknown resistances, as shown in Fig. 6. Upon a small block of wood, of suitable shape, wind a quantity of fine insulated copper wire. Over this coil place a pocket compass, or, if the latter is not at hand, suspend, by a fine silk fibre, a needle, magnetized on the fields of the dynamo. Connect as shown in Fig. 6 and with one or two cells of battery the equipment is complete.

Adjust the movable contact *f* along the wire and with a foot rule measure the lengths *M* and *N*. Then apply the time-honored formula:

$$M; A :: N; X; \text{ whence } X = \frac{A N}{M}$$

Here *y z* represents the wire, *A* the known and *X* the unknown resistance.

If a battery is not available, one can be made by using a pail of salt water and two lead plates. Charging while the machine is running, it will be found that an E. M. F. of two volts is at hand upon shutting down. It will not last long, it is true, but if the test is made at once there will be no difficulty.

The resistance chosen should be governed by the resistance desired to be measured. If this is low, the resistance chosen should be low, and vice versa. The known resistance is somewhat governed by the scales of the voltmeter and ammeter, as it is necessary to have a good deflection on each when measuring it by the fall of potential method. On no account should it be subjected to such a current as would heat it and thus change its value, as it is cold when used to measure the desired resistance. It will be very curious if a suitable resistance is not available. The writer would suggest the following:

Low resistances to use in measuring armature resistance or the resistance of series coils: (1) The known resistance of the ammeter. (2) A spool of wire from the engineer's supply. This resistance can be verified by computing from length, gauge number and table of ohms per foot. (3) The rheostats of the switchboards in parallel. They can be measured singly and their resistance in parallel computed if it is more accurate to do so. (4) One of the building circuits short circuited at its further end, all lamps cut out. (5) Several resistances, such as are used in connection with incandescent arc lamps, in parallel. (See Fig. 3.)

High resistances used in measuring shunt coils: (1) The known resistance of the voltmeter. (2) The rheostats of the switchboard connected in series. (3) Incandescent arc lamp resistances in series. A little ingenuity will suggest many more.

The galvanometer is likely to be the most difficult problem. A small detector is invaluable in this case. An operator is inclined to lose patience with a needle suspended by a fibre, but yet, with care, it will yield better results than a detector, being more delicately poised.

The writer, with a bit of looking glass, a quantity of an-



FIG. 6.

nunciator wire, a short piece of stout wire for a support for the fibre, a little mucilage, a few bits of watch spring and a silk thread from his necktie, has constructed, on the spot, in half an hour's time, a galvanometer such as is shown in Fig.

7. The data obtained by it amply pay for the trouble of construction. The cost is nothing.

The insulation resistance of the dynamo is a desirable thing

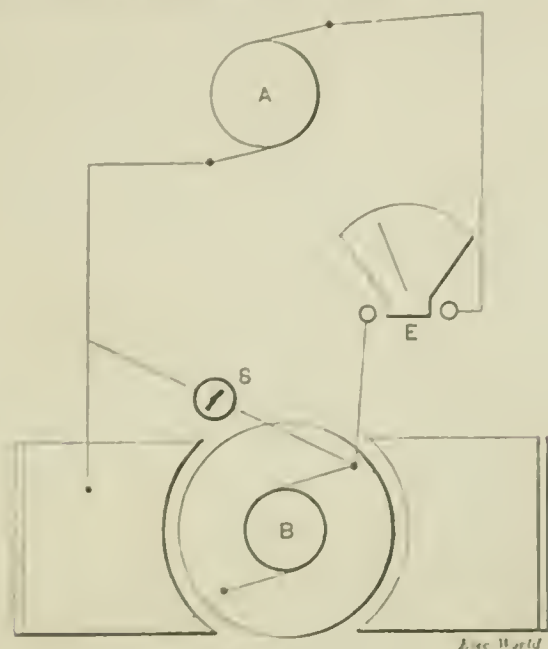


FIG. 8.

to know, and although the method to be given here is not a new one, it is not as generally known as it should be. Connect as shown in Fig. 8. Let E be a voltmeter and S a snap switch. Throw off all circuits and by means of the shunt rheostat crowd the voltage of the machine A up to a maximum. B must be at rest. Then with the snap switch open take a voltmeter reading. Call this V' . Immediately close the snap switch and take a new reading, V . Then the insulation resistance of the machine will be

$$R = \frac{(V - V') R'}{V'}$$

where R is the voltmeter resistance and R' the insulation resistance. The proof of this is as follows:

With the snap switch open we have the insulation resistance and the voltmeter in series. Let C be the current flowing.

$$C = \frac{V'}{R'} = \frac{V}{R + R'}; \text{ whence } R = \frac{(V - V') R'}{V'}$$

This, of course, requires another dynamo with which to test. The insulation resistance can be found by using the

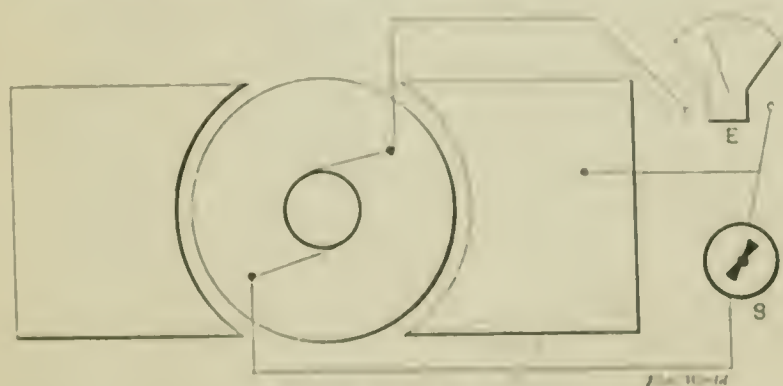


FIG. 9.

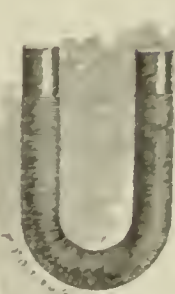
electromotive force of the machine itself in the following manner: Connect, as shown in Fig. 9, and in precisely the same way as before measure and compute. Then connect with voltmeter and snap switch interchanged and repeat. If the results check fairly well, they represent the insulation resistance of the machine.

This method has an element of danger from the fact that on throwing the snap switch a good ground is established between the wires and the frame. Another ground at a great potential difference from this one will work mischief, and unfortunately the voltmeter, while it will give warning on the side near the snap switch by a large deflection, will give less and less warning in this way as the ground is nearer the other side, and therefore dangerous.

This danger may be avoided by taking preliminary deflections on either side of the machine.

On the Design of Electromagnets for Specific Duty.—II.

BY E. R. CARICHOFF.



ELECTROMAGNETS may be designed, as was shown in a previous article, with a certain length of air gap which if multiplied by the pull between the armature and the poles separated by this air gap gives a maximum. The length of this air gap is different for different values of the magnetic induction, and may readily be determined.

For example: Suppose the magnet to be made of cast steel, the B H curve of which is furnished by the Syracuse Steel Foundry Co., and plotted in Fig. 1 as curve 1.

Draw a tangent to any point of curve 1 and parallel to it draw a line through the origin, then the point where this parallel cuts the horizontal line drawn through the point of tangency is one point of curve 2, the abscissae of which represent the magneto-motive forces for different values of the induction in the variable air gap above defined divided by the length of the magnetic circuit in the steel.

The abscissae of curve 3 represent the length of these variable air gaps in ten-thousandths of a centimetre, corresponding to different values of the induction B ; also for each centimetre length of the magnetic circuit in the steel. The successive points of this curve are determined from those of curve 2 by dividing each abscissa by its corresponding ordinate.

Curve 4 is plotted from a table that is given in S. P. Thompson's book on magnets and was calculated from Maxwell's formula.

$$P = \frac{B^2 A}{8 \pi}$$

using such units that the abscissae are pounds per square inch of polar area instead of dynes per square centimetre.

Denote the abscissae of curve 4 by P in pounds, those of curve 3 by L in .0001 centimetres, the length of the magnetic circuit in the steel by l in centimetres, and the polar area by A in square inches.

Then work, being defined in this case as initial pull times travel, is expressed by

$$W = P \times L \times l \times A.$$

Assume W to be ten centimetre pounds, then

$$A l = \frac{10}{P L}$$

and the values of $\frac{10}{P L}$, corresponding to the successive or-

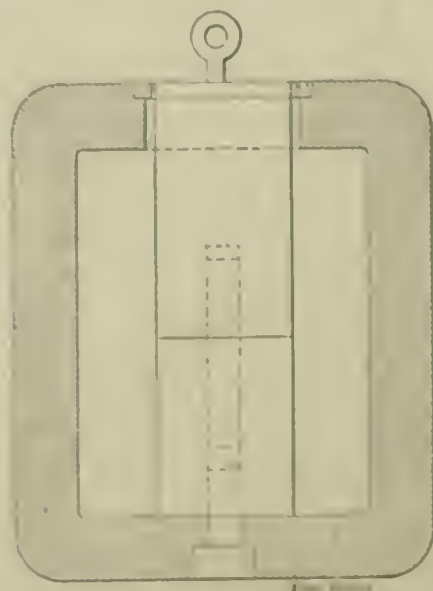


FIG. 2.

ordinates B , give the abscissae of curve 5. $A l$ is a volume in which l is in centimetres and A in square inches, and

this is seen to be proportional to the work, as above defined, which the magnet is capable of doing.

To illustrate the use of curve 5, suppose it is required to move a lever arm a distance of one centimetre against a pull of 100 pounds, $W = 100$ centimetre pounds.

Assume $\mathfrak{B} = 13,500$. We see that for this value of $\mathfrak{B}$ and for $W = 10$ centimetre pounds $Al = 18.5$; for $W = 100$ centimetre pounds $Al = 185$. Of course we may give to l or A any value we please, but as the magneto-motive force $\mathfrak{F}$ varies directly with l , there is economy in making A large and l small—just long enough, in fact, to permit the necessary winding.

As an example, try l at 20 centimetre and A at 9.14 square inches. The total magneto-motive force becomes

$$\mathfrak{F} = 20 (18.3 + 70) = 1,766,$$

and the ampere turns are about eight-tenths of this or 1,420. If these dimensions do not afford sufficient space for proper winding it will be necessary to increase l .

neck of the magnet may be made very short and of large area. The upper cylinder is guided by the brass ring at the neck and by the brass rod sliding in the lower cylinder.

$\mathfrak{B}$.	P .	L .	$P \times L$.	$\frac{10}{P \times L}$	$\mathfrak{F}$ for 1 cm. of steel plus Values of $\mathfrak{F}$ for air gap l for $\mathfrak{F}$ defined. $= 1,000$.	
					$\mathfrak{F}$ for air gap	l for $\mathfrak{F}$
8,000	37.	.00097	.0258	279.	12.8	78.2
8,500	41.5	.00112	.0465	215.	14.8	67.7
9,000	46.7	.0013	.0607	164.	17.4	57.6
9,500	51.9	.00152	.079	127.	21.	47.7
10,000	57.7	.00176	.1015	98.5	25.	40.
10,500	63.5	.00205	.13	76.5	30.0	33.2
11,000	69.8	.0024	.1675	60.	35.7	28.0
11,500	76.2	.00278	.212	47.	42.5	23.5
12,000	83.1	.00324	.269	37.3	50.4	19.8
12,500	90.	.00374	.337	29.8	60.4	16.6
13,000	97.5	.00437	.426	23.6	72.2	13.9
13,500	105.	.00518	.545	18.3	88.4	11.3
14,000	113.1	.00625	.707	14.1	108.7	9.2
14,500	121.4	.00778	.946	10.6	137.	7.3
15,000	129.7	.01015	1.315	7.73	184.	5.45
15,500	138.8	.0146	2.02	4.93	260.	3.78

The accompanying table has been arranged partly from

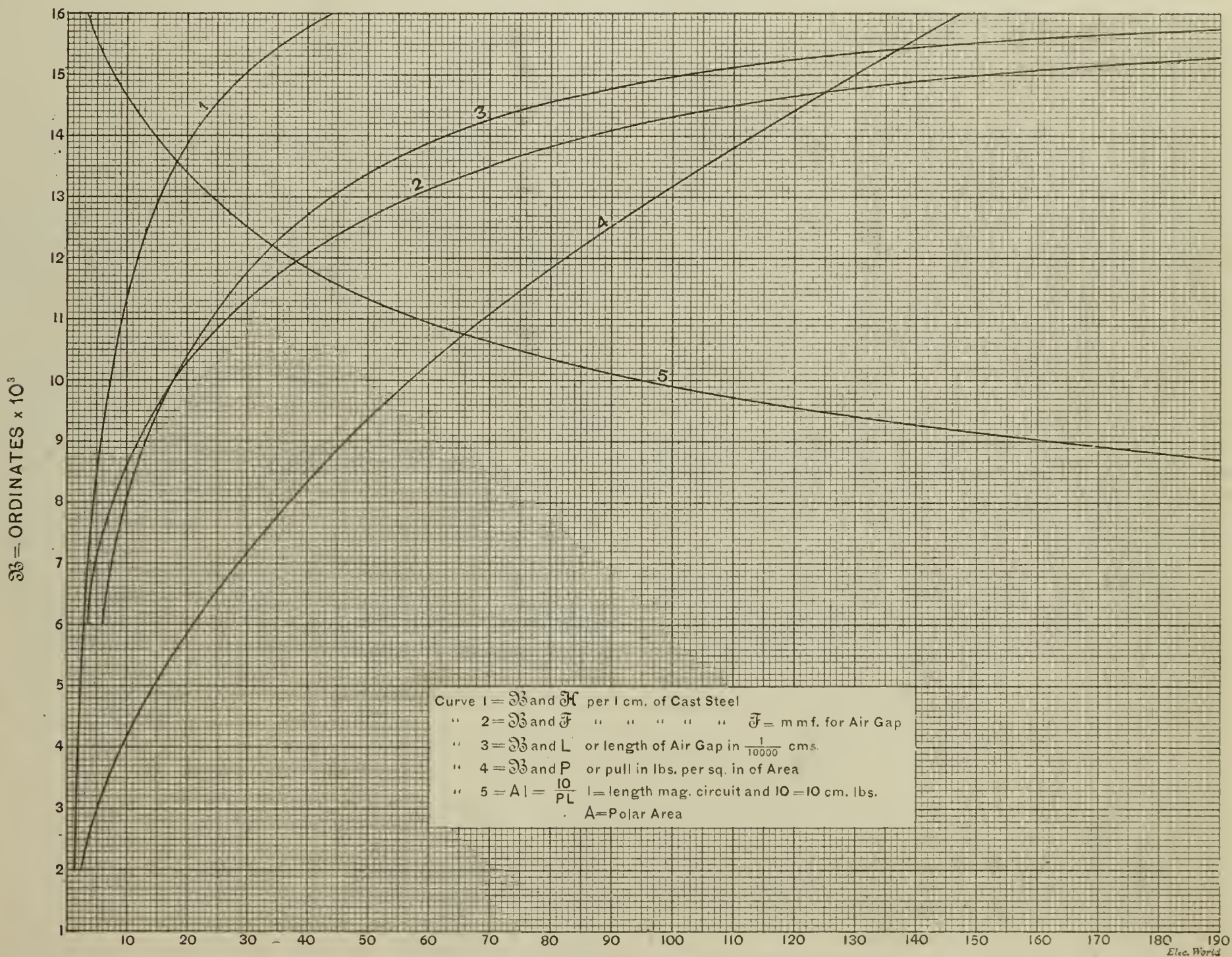


FIG. 1.—DESIGN OF ELECTRO-MAGNETS FOR SPECIFIC DUTY.

The total length of the air gap will be

$$Ll \text{ or } .00515 \times 20 = .103 \text{ centimetre.}$$

If the air gap is divided into two variable parts, it is evident that the movement of the armature can be only one-half of the total air gap, and a twenty to one lever will be required to move the 100 pounds over a distance of one centimetre, as required. But if one air gap only is variable, the other being an almost negligible constant, a ten to one lever will suffice.

A form of magnet sketched in Fig. 2 will afford one constant and one variable air gap. The constant air gap at the

the curves above and partly from calculations on the slide rule. It shows some very interesting relations.

If it is desired to move the lever arm against the increasing force of a spring, the magnet may be made to balance this force at two points of its travel by selecting the induction to give the required pull at these two points.

Much of this article and of the one preceding has been presented in the form of suggestions, which may be elaborated to suit individual cases.

The main facts that seemed to the writer as useful are that there is a certain length of air gap for any given magnet of

uniform cross-section where the pull between armature and poles is lessened if the polar area is either increased or diminished, and that the pull under these conditions, multiplied by the length of this air gap, is greater than the pull with any other air gap multiplied by the length of the latter.

The use of different systems of units may seem objectionable to some, but when accustomed to the calculation of magnets in pounds per square inch the term grows to mean something more definite to the average worker than dynes per square centimetre. It is a simple matter to change the relation, and those who prefer the use of the same dimensions throughout may pass a pleasant hour in drawing curves to suit the units they prefer.

On the Design of Electromagnets for Specific Duty.

BY P. MATTHEWS.

The editor of The Electrical World, in the last issue of this journal, may be pardoned, I think, for getting too enthusiastic in the editorial over a professed simple method of geometrically solving problems which have bothered the heads of many eminent men and every one who has had to design electromagnets for specific duty. Although the method may at first sight look plausible from the figure, a glance at the mathematical symbols will no doubt by this time have convinced him that he has only discovered a mare's nest. To begin with, the writer does not seem to have thought it necessary to state definitely the conditions of the problem he is trying to solve. What is fixed and what is variable? In his method for determining the polar section he speaks of "the part of the iron characteristic where we are working," from which one would infer that the induction in the iron was regarded as fixed, but this cannot be, for then the greatest tractive force would be obtained with the polar section = 0, and the tractive force would then be infinity. One is therefore driven to make an assumption as to what the conditions are intended to be, and the only plausible one that suggests itself is that the ampere turns, the iron circuit and the length of the air gap are fixed, leaving the induction and the air gap section variable.

But, under these conditions, what can be the meaning of the statement on page 113, The Electrical World, Jan. 27? From this we draw the conclusion that when the air gap reluctance is expressed by a line parallel to the tangent drawn at the part of the iron characteristic where we are working, there is no gain either by increasing or decreasing the polar area. Increasing or decreasing what polar area? There is no polar area specified. The direction of the line oF , Fig. 1, is altogether independent of this area, being the line expressing the relation between the flux per unit area, or induction, and the magnetomotive force. This line does change its direction with the length of the air gap, however. Let us then investigate the method as applied to what is styled the proper air gap for maximum power, viz., the pull $\times$ length of gap. Although I cannot agree that this expression gives the work to be got out of the magnetic attraction, yet we will proceed.

To take a simple case, suppose we are dealing with very small magnetizing forces in the iron, so that its reluctance is constant. Let reluctance of iron = r ; and of air gap = $\frac{l}{A}$, where l = length of air gap, A = area of air gap, total number of lines of force = N , air gap induction = $\mathfrak{B}$, magnetomotive force = $\mathfrak{F}$, mechanical force = f .

Then

$$f = \frac{N^2}{8 \pi A}.$$

$$N = \frac{A \mathfrak{F}}{A r + l},$$

$$l f = \frac{A \mathfrak{F}^2 l}{\pi (r A + l)^2}.$$

Differentiating with regard to l and equating to 0,

$$-\frac{2}{r A + l} + \frac{1}{l} = 0,$$

$$\frac{l}{A} = r,$$

or, in other words, by decreasing or increasing only the length makes the air gap reluctance equal to that of the iron.

Now, by following out the geometrical method under discussion, the line oF , Fig. 1, we see, becomes coincident with the tangent, which means: the polar section and iron section being determined, make the length of the air gap such that

$$\frac{\text{reluctance of air gap}}{\text{reluctance of iron}} = \frac{\text{area of iron section}}{\text{area of polar section}}.$$

(If Mr. Matthews will refer again to the article which he criticises, he will find that he has misunderstood the problem considered, which is as follows: With a given magnet having a definite number of ampere turns, the product of the pull and length of air gap is a maximum when $\frac{d \mathfrak{F}}{d \mathfrak{B}}$ is the same for the iron and air gap, and this equality may be produced in two ways, as shown—first by increasing or decreasing the polar area, the length of gap remaining constant; or, second, by shortening or lengthening the air gap, the polar area remaining constant. The author apparently considered that those interested in the subject would not require explanations on obvious and elementary points—such as, for example, that the polar area may be varied without changing the cross-section of the core—which accounts for part of a criticism that seems to be entirely due to a misapprehension of the strictly practical bearing of the article criticised.)

The Use of Steel in Electric Machines.

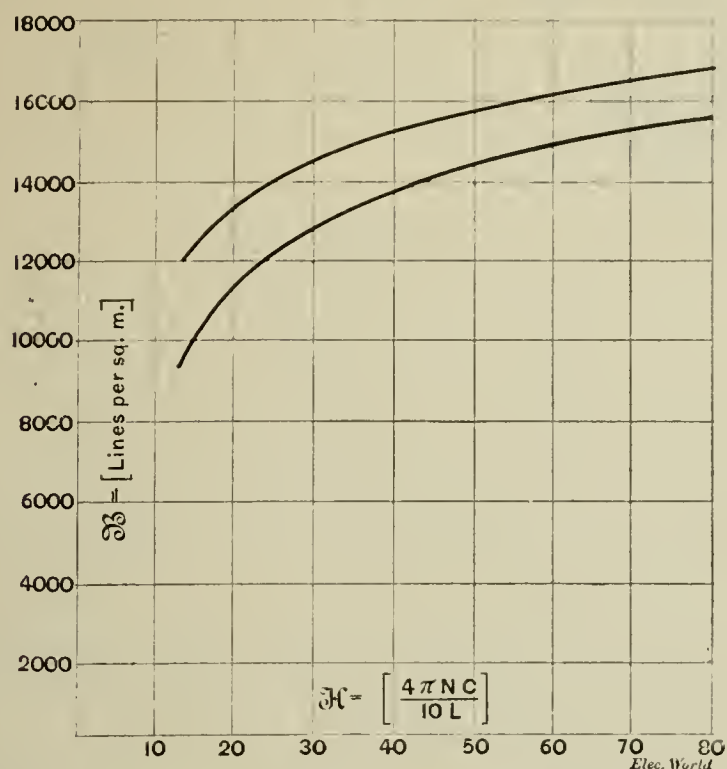
In a paper in the current number of the "Journal of the Franklin Institute" Mr. H. F. Parshall treats of the use of steel in the magnetic parts of electrical machines, and shows the great improvements that have resulted from its substitution in street railway motors in particular, due to its greater permeability over cast iron. It is stated that magnet frames made of steel are 25 per cent. cheaper than those of cast iron, and that a combination frame using steel in the polar projections, cast iron in the yokes and wrought iron in the cores costs about the same as one of cast steel, and possesses the advantage that both cast iron and forgings are more uniform in magnetic qualities, easier to machine, require less chipping and are more easily finished, but have the disadvantage of greater weight.

Referring to the quality of steel required for magnet frames, it is asserted that the effect of combined carbon or graphite is to lessen the magnetic continuity and greatly lessen the permeability, and that, roughly stated, good cast steel should not have greater percentages of impurities than are given in the following analysis:

Carbon.....	.25
Manganese.....	.60
Silicon.....	.20
Phosphorus.....	.08
Sulphur.....	.05

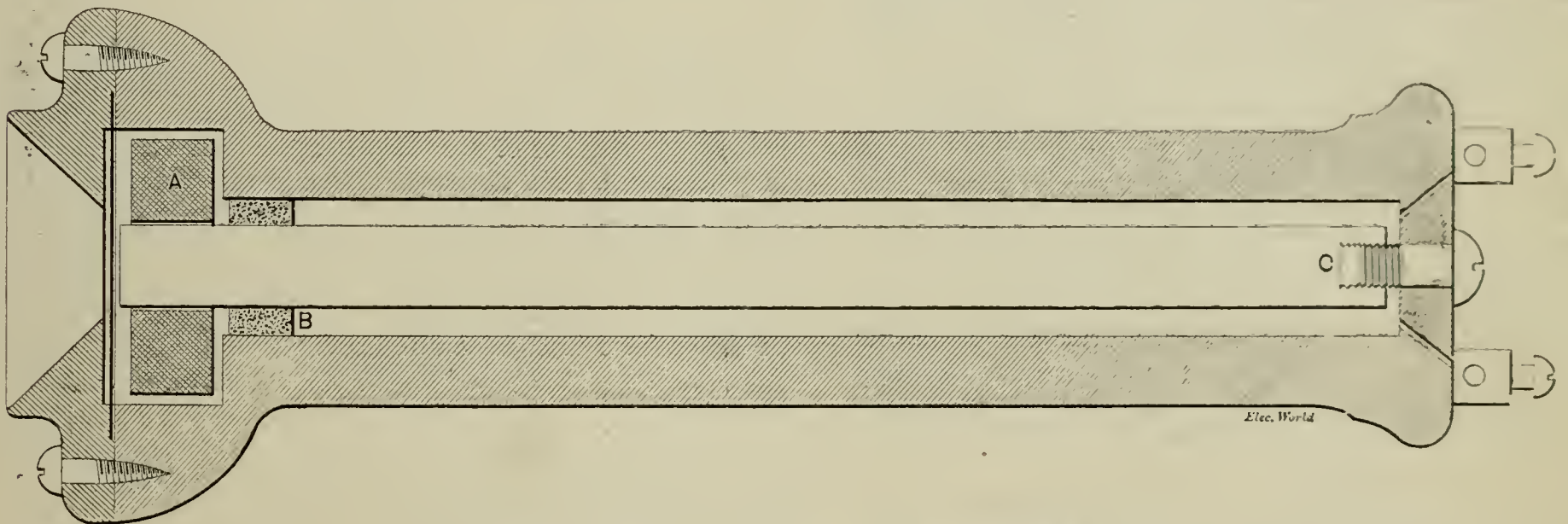
In practice, carbon is the most objectionable impurity, and can with advantage be restricted to smaller amounts than above quoted. The permeability seems to be proportional to the amount of carbon contained. Manganese below .6 per cent. has apparently little effect, but if present in large quantities deprives the steel of nearly all magnetic suscepti-

bilities, a 12 per cent. mixture having scarcely greater magnetic susceptibility than air. Silicon, at the magnetic densities used in practice, is less objectionable than carbon, but



PERMEABILITY CURVES FOR STEEL.

at high densities appears to diminish the magnetic qualities of iron to some extent, and is objectionable through facilitating the formation of blow holes and from its hardening effect. Phosphorus and sulphur, limited to the amounts stated above, are not objectionable. In the figure the upper



FULL SIZE SECTIONAL VIEW OF TELEPHONE.

curve shows what in ordinary practice is termed good steel and the lower curve what is termed poor steel.

The effect of annealing on the permeability of cast steel varies considerably, according to the foundry treatment, but seems to increase the permeability for low magnetizations, with a less marked effect for high magnetizations. Tempering reduces the permeability.

There is little difference between the analysis of the steel plates used for armature cores and that of wrought iron; in general, plates made by the steel process show more manganese, and those made by the iron process more silicon. From tests made up to the present time, the conclusions seem warranted that phosphorus is especially objectionable as regards hysteretic loss.

With respect to the use of steel in general for magnetic purposes, it may be stated that the most valuable products are those that are found to be softest and most homogeneous. In a given sample any physical change which increases the permeability correspondingly decreases the hysteresis. In

different samples steel of the highest permeability may not give the best results as to hysteresis; thus, a trace of uncombined carbon has a tendency to greatly lessen the permeability, but does not seem to greatly affect the hysteresis. The most hoped-for improvements in steel are in the making of castings free from blow holes and surface defects, requiring a minimum of finish, and which are soft and easily machined. Such castings would certainly prove satisfactory from a magnetic standpoint.

How to Make a Telephone.—II.

As the cut shows the telephone full size all of the necessary dimensions may be obtained from it. The magnet is of 3-8 inch Stubb's or other magnet steel, which can be obtained from any dealer in electrical supplies. The hole for a No. 8 machine screw, C, should be drilled and tapped before tempering. After tempering the rod may be magnetized by holding across the gap of a dynamo, or by simply letting it remain for a short time in contact with one of the pole pieces. Better results would be obtained if a half inch of the coil end of the magnet were cut off, a small hole tapped and a piece of 1-4 inch iron screwed in, and the coil placed around this.

The coil A may be wound on a paper spool, and should contain one-half ounce of No. 36 silk covered magnet wire. Heavier wires—say No. 22—should lead from the binding posts to the coil, and the two wires of the coil be soldered to these in the space underneath the diaphragm. Paper, as shown at B, should be wound about the magnet so that it may be held firmly in place; then by means of the screw, B, the necessary adjustment in relation to the diaphragm may be made and maintained. The case should be turned from

mahogany or other hard wood. The diaphragm is simply a piece of photographer's tin-type. The space above the diaphragm need not be as deep as shown, but merely sand-papered enough to clear.

Tinning Cast Iron.

A company in France tins cast iron by first covering it electrically with a coating of nickel and iron or cobalt and iron. One kilogram of sulphate, nitrate or chlorate of nickel is mixed with 3 kilograms of the sulphate of iron and 1 kilogram of citric or tartaric acid; or 1-2 kilogram of sulphate, nitric or chlorate of cobalt with 3 kilograms of sulphate of iron; this is dissolved in 100 litres of water, to which a sufficient quantity of a caustic alkali is added to neutralize the solution completely; a little bisulphate of potash, soda or ammonia may be added to increase the conductivity. The cast iron is immersed and a current is passed having a density of about 50 amperes per square metre of surface to be coated; about seven volts are required.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE
PRINCIPAL FOREIGN
ELECTRO-PHYSICS.

ELECTRICAL JOURNALS.
BY CARL HERING.

Mechanical Equivalent of Heat.—In the Digest, April 1, the result of the recent redetermination of Mr. Griffiths was given as 778.99, as stated by him in a recent Royal Society communication. According to the Lond. "Elec.," Jan. 26, he now announces that the corrected value in terms of a thermal unit at 15° C. is given as 4.1982×10^7 ergs, with an estimated limit of error equal to ± 0.0020 ; assuming that $g = 981.17$, the mechanical equivalent is equal to 779.77. (It will be seen that this corrected value is exactly 0.1 per cent. greater than the first one given; the figures given in the Digest April 1, deduced from the former value, should therefore be corrected by this amount.)

Cosmical Electricity.—The Lond. "Elec. Rev.," Jan. 26, discusses some statements made in Prof. Thomson's recent lecture on the subject (see The Electrical World, Jan. 6, 1894, page 4); the criticism is, on the whole, unfavorable, the statements being referred to as "crude theorizing"; if the earth's magnetism were due to the movement of its electrostatic field, the most violent disturbances could be expected during thunderstorms, amounting even to reversals of the terrestrial magnetism, which we know is not the case; it doubts the statement that the upper layers of the atmosphere are capable of carrying an electric "discharge" (charge?), as Heydweiller found it impossible to communicate electrification to air; regarding the idea that thunderstorms may possibly be due to flaws in the dense air, it stated that if this is the case, the earth's electrostatic field, and with it the earth's magnetism, must long since have disappeared, and it suggests that there must be some way of replenishing its outer coating, but it can imagine none; regarding the auroral display, belief is expressed that it is more probable that this consists of discharges in the upper rarefied layers of the atmosphere, due to changes in the magnetic field through which the earth is passing.

Discharges at Low Temperature.—According to the Lond. "Elec. Rev.," Jan. 26, Prof. Dewar, in his recent lecture, showed that by cooling a portion of a vacuum tube with liquid oxygen the resistance became so high that phosphorescence ceased entirely, and the discharge found another path, showing, as he states, that something had been frozen out, which had before enabled electricity to pass. By enormously increasing the voltage the current may be made to pass even through the frozen out mercury vacuum, but the discharge assumes a totally different form, the diffused phosphorescence giving place to luminous streaks.

Thermo-Couple of Electrolytes and Unpolarizing Electrodes.—The "Elek. Zeit.," Jan. 18, abstracts from "Wied. Ann.," volume L., page 606, an article by Mr. Goekel, in which he describes researches with a couple, each half consisting of mercury and solid mercury salts, connected together by a soluble salt, one side being warm and the other cold; he finds that, in general, the thermo-electric force increases with the dilution of the soluble salt; numerous soluble salts were experimented with.

Influence Machines.—The Lond. "Elec. Rev.," Jan. 19, reprints an illustrated description by Mr. Pidgeon and

another by Mr. Wimshurst on improved forms of their machines, as described before the Physical Society in June; the description has already been abstracted in the Digest July 22.

Theory of Electric and Magnetic Phenomena.—"La Lum. Elec.," Jan. 20, abstracts a paper by Mr. Vaschy, in which he develops a theory not based on any hypotheses, but based simply on mathematical deductions from experimental results.

Dynamical Theory of the Electric and Luminiferous Medium.—Mr. Larmor's Royal Society paper is concluded in the Lond. "Elec. Rev.," Jan. 19.

Propagation of Electric Waves Through Electrolytes.—The "Elek. Zeit.," Jan. 18, abstracts briefly an article by Mr. Yule from "Wied. Ann.," volume L., page 742.

Correlation of Solar and Magnetic Phenomena.—The Lond. "Elec.," Jan. 26, reprints from "Nature" letters from Dr. Veeder and Mr. Ellis.

Dielectric Constants of Biaxial Crystals.—Mr. Borel's article is continued in "La Lum. Elec.," Jan. 20.

MAGNETISM.

The Electromagnet.—A long and interesting paper by Dr. Froelich is reprinted in the "Elek. Zeit.," Jan. 18; he discusses the two present theories of electromagnetism, the development of a law of the electromagnet and the application of this law. He develops a simple mathematical expression, deduced partly from the straight line proportion shown some years ago by Mr. Kennelly; the article does not admit of being abstracted briefly, and will therefore be made the subject of a separate article, which will appear in The Electrical World in some future issue.

Increasing the Number of Phases for Rotating Fields.—In a short article by Dr. Behn-Eschenburg in the "Elek. Zeit.," Jan. 18, he states that when two equal currents of different phases generate the same ampere turns around the same magnet, the resulting magnetization will have a phase midway between the two phases, and the result is therefore the same as if a third and single current of a phase midway between the two, but of a different number of turns, had been used; if the original phases differ by 90° , and if their combined M. M. F., each having t turns, shall be the same as that of each current with T turns, then t must be equal to $T \div \sqrt{2}$. He then shows that the same method permits one to obtain a symmetrical distribution of the field with an unsymmetrical division of the phases, as, for instance, with two-phase currents differing by 60° ; phase 1 and 2 will differ by 60° , phase 3 and 4 are produced by the reversed effects of 1 and 2; between 2 and 3 and between 4 and 1 there will then be a phase difference of 120° ; but if 2 and 3 are combined, as above described, a phase will be obtained midway between them; the same is true of 4 and 1, thus giving six regular phases of 60° ; if, in general, there are m phases, then if T and t signify the same as above, then $\sqrt{2}$ in the above formula must be replaced by $\cos(\pi \div m)$.

Magnetization of Solid and Hollow Iron Cylinders.—The "Elek. Zeit.," Jan. 18, abstracts a paper from "Wied. Ann.," volume L., page 705, by Mr. Grotrian; the results in-

dicates that with weak magnetizing forces, the outer layers of the iron are magnetized first; for the construction of dynamos he draws the conclusion that for light machines hollow magnets are to be recommended. (The hollow cores seem to have been bored out after having been tested in solid form; the abstract contains no data to show whether a smaller solid core of an equal cross-section to that of the hollow core is better or worse; such a solid core would evidently require less watts and be higher than the hollow one.) He also calls attention to the fact that the magnetic reluctance at low saturation cannot be considered to be even approximately inversely proportional to the cross-section of the iron, in the case of hollow cylinders.

Pull of Magnets.—The series of editorials in "Ind. and Iron" is continued in the issue of Jan. 19, in which the subject of the relation of the self-induction to the pull of magnets is discussed; it is interesting reading, but does not admit of being abstracted; he states among other things that if the magnet is to exert a certain pull at a certain distance, the pull varies as the self-induction, from which it will be seen that, contrary to the claims of some inventors, it is impossible to make an electromagnet to have a good pull with small self-induction; the pull of any magnet is equal to half the square of the current multiplied by the rate of increase of the self-induction when the armature moves.

Magnetism at Low Temperature.—According to the Lond. "Elec. Rev." and "Elec. Eng.," Jan. 26, Prof. Dewar, in his recent lecture, verified the idea of Faraday and showed that a magnet at -200° C. had its power increased 50 per cent. This was shown by direct experiment by coiling a wire around a magnet and immersing the end of the magnet in liquid air, when an electric current was instantly generated in the wire.

Magnetic Measurements.—Under the title "More Magnetic Mysteries" Mr. Evershed, in the Lond. "Elec.," Jan. 26, quotes at considerable length a paper by Mr. Gray (of Rose Polytechnic Institute, written early in 1892) describing a modified method of measuring magnetic quantities in large masses of iron, in which he records, not the total value of the induction for each of several particular values of the magnetizing force, but the curve showing the rise of current with time immediately after the circuit is closed; the apparatus and the resulting curves are given; Mr. Evershed comments briefly on the method, pointing out errors.

Electro-Chemical Effects on Magnetizing Iron.—See under Electro-chemistry.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Injurious Effects of Electric Railways on Physical Measurements.—Messrs. Meyer & Muetzel, in a long article in the "Elek. Zeit.," Jan. 18, describe in detail measurements and calculations to determine the effect which an electric railway has on the measuring instruments in the Breslau University, around which an electric railway passes. It is shown that calculations and observations agree as far as the passing car is concerned, and that therefore calculations may be made in advance and depended upon; for an allowable error of 0.1 minute of arc, for instance, they calculate that a distance of about 500 feet is sufficient; but a great source of disturbance lies in the earth return current, which they measure and calculate, showing that this earth current has a very appreciable effect, but they found that this current also exists, though in a less degree, at night, when the railway currents have ceased. Their conclusions are that fine physical measurements of magnetic or electric quantities can be made only at night in this building.

Measuring the Light from Stars.—According to "Nature," Jan. 18, Prof. Minchin has employed his seleno-aluminium-aenanthol cells, 3 square millimetres in area, in connection with a large telescope, and obtained 40 divisions for Venus

at 1-4 disc, 9 for Sirius and none for Aldebaran; 460 divisions correspond to one volt.

Measuring Instruments.—In the serial of Messrs. Niblet and Ewing, in the Lond. "Elec. Eng.," Jan. 19, Jenkins' resistance measurer is described and illustrated.

Registering Instruments.—The Raps apparatus, described in the Digest Jan. 27, is described in detail in "La Lum. Elec.," Jan. 20.

DYNAMOS AND MOTORS.

Experiments with Brown Non-Synchronous Motors.—The Lond. "Elec. Rev.," Jan. 19, continues its article on this subject, the first part of which was abstracted in the Digest Jan. 13; the article appears to be the same as the one abstracted and illustrated in the Digest Jan. 20.

Irregularities in the Action of Dynamos.—The translation of this article from the French is continued in the Lond. "Elec. Eng.," Jan. 19 and 26, under the heading of "Faults in Dynamos." A translation of the article is also being published in the Lond. "Elec. Rev.," beginning with the issue of Jan. 26.

Mechanical Applications of Electricity.—In the profusely illustrated serial by Mr. Richard in "La Lum. Elec.," Jan. 20, illustrations and descriptions are given of cranes, hoisting apparatus, percussion drills and other apparatus.

ARC AND INCANDESCENT LIGHTS.

Arc Lamps.—"La Lum. Elec.," Jan. 20, publishes a table of measurements of various European arc lamps made in 1885, giving the current, voltage, spherical intensity and watts per candle, the mean of the latter being about 0.55 watts per mean spherical candle.

TRANSMISSION OF POWER.

Transmission of Power Plant in Russia.—The Lond. "Elec. Eng.," Jan. 26, reports that a German syndicate has secured a concession from the Russian government for the erection of a gigantic electric power installation for transmitting the energy from the Imatra Falls in Finland to St. Petersburg; no further information is given.

Transmission of Power in Sweden.—According to "Engineering," a plant has recently been opened at Gringesberg, in which 400 h. p. are transmitted seven to eight miles to some mines; the current is transformed from 400 volts up to 5,000; it is used in motors, but what kind of motors is not stated.

Niagara Falls Plant.—The Lond. "Elec.," Jan. 26, contains an editorial on the Niagara Falls plant, giving, however, nothing new.

ELECTRIC RAILWAYS.

High-Speed Railways.—In the Lond. "Elec. Eng.," Jan. 12, Mr. Wolff criticises Mr. Lea's statement (see Digest, Jan. 27), and claims that there is no real disparity between the air resistance values of Hopkinson and Crosby, and that the difference is due to the skin friction, which, although small per square foot, forms a large part of the resistance of trains and varies with the square of the velocity. In Mr. Lea's reply, in the issue of Jan. 19, he does not agree that the skin friction forms a large part of the resistance, nor that it varies with the square of the velocity; the latest experiments show that even the head resistance varies with the first and not with the second power of the velocity; the skin friction in the case discussed is extremely small; if the air resistance is assumed to be equal over the whole area of the train, 8,000 square feet, then its value hardly exceeds 3-8 pound per square foot, while if 15 pounds per square foot is taken for the head resistance, then the skin friction is only 1-5 pound per square foot, which, he says, may be taken as fair average values; in the usual railroad, side winds cause a much greater loss than those dead ahead, but this, he says, is not due solely to the air resistance, as the weight is thrown more

on one track, which increases the track resistance enormously; he doubts whether in a properly designed train the skin friction at high speeds requires the expenditure of any serious amount of energy, certainly not to the same extent as the head resistance, but the absolute lack of reliable data makes it impossible to be certain.

Heilmann Locomotive.—According to the Lond. "Elec.," Jan. 26, this locomotive was tried between Havre and Paris, drawing 13 cars at a speed of 75 miles an hour; no further information is given.

Accumulator Traction.—The Lond. "Elec. Eng.," Jan. 19, quotes from a communication by Mr. Epstein to the London "Standard," in which he answers the objections to accumulators, based on their great weight and cost of renewal; regarding the first, he said that the additional weight of an accumulator car over an ordinary electric car is only about 20 per cent., and as regards the cost of renewals, practical working has established the fact that a maintenance rate of 3 cents per car mile leaves a very fair margin of profit; it can be shown that the cost of working is not more than in the trolley system.

Regulations.—The Lond. "Elec.," Jan. 26, publishes a discussion at the council and committee meeting of the Tramways Institute of the Board of Trade rules, mentioned in the Digest Dec. 16.

Liverpool Overhead Railway.—According to the Lond. "Elec. Rev.," Jan. 19, the excellent manner in which this road has been equipped is shown by the fact that during the ten months in which it has been in operation 96 per cent. of the trains, which are run at 5-minute intervals, were on time.

City and South London Railway.—According to the Lond. "Elec.," Jan. 26, the loco and generating expenses during the last half year were 12.4 cents per car mile.

Douglas-Laxey Railway.—The Lond. "Elec.," Jan. 19, gives a short illustrated description of this railway.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Hours of Lighting.—The Lond. "Elec.," Jan. 19, publishes several curves, showing the average hour at which lights are turned on in London, covering a period of one whole year; a similar curve is given for the hours at which they are turned off in the morning; another curve is given for the time at which the sun sets and the hours of turning on the lights for two large London stations for two years, showing a uniformity; the average time at which lighting is begun seems to be but a few minutes before sunset; in estimating the total duration of artificial lighting throughout the year, it states that the time between sunrise and sunset may be taken as the average time of lighting; in determining the times of lighting up, it is assumed that the middle point of the steepest part of the load curve represents the average time for that particular day (as the curves will be different for different latitudes they are not reproduced here); the latest hours are about July 1 and the earliest on December 15; in the morning curve the earliest is Jan. 15 and the latest Dec. 31; another curve is given, deduced from the sunset curve, showing the total hours of lighting in a year from dusk to any given time, the ordinates representing the total hours of lighting and the abscissas the time of day.

Refuse Destructors for Electric Lighting.—"Ind. and Iron," Jan. 19 and 26, reprints a report of the Shoreditch electric lighting committee, in which they discuss a number of points and conclude that the use of the destructor by itself will effect a large saving (of at least \$7,500) on the present expenses, even without any complete utilization of its heat; opinion is expressed that to use the power for electric lighting is the most remunerative way, and that with the combined scheme a further saving of more than \$10,000 per year may be anticipated.

Gas Engines in Electric Lighting Stations.—Mr. Borquin's

article is continued in "La Lum. Elec.," Jan. 20; arc lamps, power, gas and the incandescent gas burners are discussed; numerous figures are given for making comparisons; at the rate of 5 litres per candle hour a cubic metre of gas will give 200 candle hours in a Wenham gas burner, while by means of a gas engine he shows that it can give 654 watt hours at the lamp, which, at the rate of one watt per candle of mean spherical illumination of an arc lamp, corresponds to 654 candle hours.

Siemens-Willans Combined Dynamo and Engine.—The Lond. "Elec. Eng.," Jan. 26, publishes an efficiency curve and a table of data, giving the results of a recent test made by Prof. Kennedy, showing excellent results; at full load the combined efficiency was 88 per cent., and the number of pounds of water per electrical h. p. was 23.8; for one-quarter load these figures were 63 and 27.9 respectively.

Willans Engines.—Messrs. Willans & Robinson publish a statement that they have received orders for about one-half of the entire horse power for public lighting stations in the United Kingdom.

Motive Power and Gearing.—In his serial in the Lond. "Elec.," Jan. 19, Mr. Carter discusses the "factor of under-loading" and "the character of load diagrams."

Load Line.—In the Liverpool station the maximum load in winter is said to be 100 times greater than the minimum load in summer.

Central Station Measurements.—A short discussion of Dr. Kallmann's article, mentioned before in these columns, is given in the "Elek. Zeit." Jan. 18.

Accounts.—The Lond. "Elec. Rev.," Jan. 26, publishes abstracts from the accounts of several English electrical companies.

Electrical Effects at Theatres.—The Lond. "Elec. Eng.," Jan. 19, publishes three full-page illustrations of some striking effects at the Lyceum and the Drury Lane theatres in London, which effects are spoken of very highly in that journal, as also in the Lond. "Elec. Rev."; among the effects in the pantomime of "Cinderella" may be mentioned the fairy slippers, the fire scene, the carriage, the floral sprays and the scent bottle, all of which are lighted with electric lights, producing various effects; at the Drury Lane Theatre may be mentioned the fish ballet, in which each of the dancers is decorated with 4-volt lamps, supplied by a 2-cell lithanode battery of one ampere hour; a short description of the electrical arrangements is given in these two journals.

London.—The Lond. "Elec.," Jan. 19, publishes its yearly supplement of a map of London, with the various lighting districts in different colors, showing mains actually laid up to the beginning of this year.

London.—The Lond. "Elec. Eng.," Jan. 26, gives a brief description, with a number of illustrations (limited entirely to the architectural features), of the electrical light installation at the Great Eastern station.

Huddersfield.—A profusely illustrated description of this station is given in the Lond. "Elec. Eng.," Jan. 26; the high-tension alternating system, with low-tension distribution, is used; the plant was installed by the English Brush Company.

WIRES, WIRING AND CONDUITS.

Resistance of Stranded Cables.—The Lond. "Elec. Eng.," Jan. 26, contains the first portion of an article by Mr. Everett, in which he discusses mathematically the calculation of the resistance of a stranded conductor; taking first one layer, he deduces a quantity by which the current that would exist if all the wires were insulated from one another must be multiplied in order to find the true current; he shows that contact between contiguous layers (which are always wound in opposite directions) does not increase the conductivity of

the whole conductor, but on the contrary diminishes it, but this factor is probably almost, if not quite, negligible.

Rules for Insulation Resistance.—A correspondent to the Lond. "Elec.," Jan. 19, in commenting on the rules regarding insulation published in that journal last week, states that the voltage was not taken into consideration in any of the rules, and that the number of lamps, irrespective of their candle power, should be taken into consideration, as they practically govern the surface leakage due to switches and cut-outs; for a rule he suggests to divide the voltage of the lamp by the number of lamps, and letting the result represent the insulation resistance in megohms; curves are given showing the results for lamps of three different voltages; in addition there should be a maximum and minimum, for which he suggests 5.0 and 0.1 megohms respectively. Editorially the journal adds that this rule, although simple and practical, can hardly be said to be the average of modern practice, as the resistance obtained thereby appears to be about double; half the volts, divided by the number of lamps, corresponds better with the rules in practice.

A correspondent to the Lond. "Elec.," Jan. 26, suggests that if the voltage is taken into account in any general formula for the allowable insulation resistance of house wiring, the minimum values for alternating currents should be raised 50 per cent. above those for continuous currents, because the maximum voltage is approximately 1.4 times as great. Editorially that journal suggests that as far as the leakage current is concerned, a lower insulation might be allowed for alternating currents, as the electrolytic action will probably be less.

Insulation.—In Mr. Guy's serial in the Lond. "Elec. Eng.," Jan. 26, he discusses the subject of insulation; a table is given of the specific insulation and other data of the electric light cables of various companies.

Increasing the Safety of High-Tension Distribution.—A translation of the article by Mr. Claude mentioned in the Digest last week is given in abstract in the Lond. "Elec.," Jan. 19, in which the cuts are also reproduced. In an editorial comment it is stated that the mains thus protected behaved like a Leyden jar, which, although very highly charged, may nevertheless be touched at one pole without danger, provided the whole jar is insulated from the earth; the mains, when thus protected, behaved as if there were no capacity effect to earth, and they can therefore be touched without danger, provided they are not connected to earth by a leak having no appreciable self-induction; it is thought to be probable that high-potential mains will be kept connected permanently to the earth in this manner; the expense of the coils would be very great.

Impedance of Aerial Lines.—The article by Mr. Hospitalier, abstracted last week, is translated and published in the Lond. "Elec. Eng.," Jan. 19.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telegraphy and Telephony in the United States and England.—See under Miscellaneous the paper by Mr. Preece headed "Electricity in the United States."

ELECTRO-CHEMISTRY.

Electro-Chemical Effects on Magnetizing Iron.—The Lond. "Elec. Rev.," Jan. 19, reprints an abstract from the proceedings of the Royal Society by Mr. Andrews under this heading. Experiments are briefly described in which opposite poles of two bar magnets were connected by an electrolyte, and it was found that the north terminal became electro-positive and the south pole negative; on first immersing the bars a momentary current was noticed, the direction of which was opposite to that of the subsequent steady current; the E. M. F. steadily increased; the average was 0.014 volt for the upper ends of the vertical magnets and 0.011 for the lower ends; Prof. Stokes suggested that it might be due to

the earth's magnetic force, which strengthened one of the poles and weakened the other, and it is stated that the difference in the above E. M. F.s. may possibly be due to this cause; "in the case of copper salts the ratio of the electro-deposition of the copper was apparently affected by these magnetic influences."

Electrometallurgy.—In an article in "Ind. and Iron," Jan. 19, on metallurgical progress in 1893, the electrochemical extraction of gold, known as the Hannay electrocyanide process, is briefly described, as are also a few other recent electrometallurgical processes.

Silver-Plating Industry.—In the serial in "Ind. and Iron" the subjects of filtering and the weight of the deposit are discussed in the issue of Jan. 19, and the subject of differential or localized electroplate in the issue of Jan. 26.

Electrolytic Estimation and Separation.—The Lond. "Elec. Eng.," Jan. 26, abstracts briefly a paper by Mr. Vortmann from the "Monatsh."

Electrolysis of Fused Salts.—Mr. Andreoli's serial is continued in "Ind. and Iron," Jan. 26, in which he continues his summary of what has been done in this field; several forms of apparatus are described and illustrated.

Purification of Sewage.—A translation of the unfavorable report on the Hermite process at Havre, mentioned in the Digest last week, is given in "Ind. and Iron," Jan. 26; the process is soon to be tried at Worthing.

MISCELLANEOUS.

Electricity in the United States.—The Lond. "Elec. Eng.," Jan. 26, publishes the first part of an Institution paper by Mr. W. H. Preece on "Notes of a Trip to the United States and to Chicago, 1893," and comments on it favorably in an editorial. After enumerating the various improvements in telegraphy and telephony which he found in this country on his former visits, and which he then introduced in England, he gives a very interesting description, including much data, of the telegraph in this country; a table is given of various statistics in 1884 and 1893, as also those for 1892 in Great Britain, in every item of which the figures in the United States are greater, except in the number of messages delivered, and, therefore, the cost of a message; the description does not admit of being abstracted, but some of his opinions are as follows: He states that the lines are not built as solidly nor have the Americans followed true engineering principles in the same way as the English have; as a rule, the lines are badly constructed, with poles that would not be looked at in England, but some of the trunk lines of the telephone companies and the new trunk line of the Postal Telegraph Company compare very favorably with the best modes of construction in England; he criticises unfavorably the use of dynamos in telegraphy and greatly prefers accumulators, with which so much success has been had in England; regarding apparatus, he states having observed little or no progress, neither company having made any advance in the systems over that in 1884; the working of the Wheatstone system between New York and Chicago, he says, is admirable, and the number of messages handled in a day on this circuit "is certainly astonishing," being 4,211 messages on one circuit in a day, "a number that we can scarcely hope to rival"; but this, he adds, is not due to speed, which is less than in England, but to the fact that the business day is longer. His conclusions regarding telegraphy, in which he makes a comparison, are given in full in another column of this issue. Regarding telephony, he states that gigantic strides have been made since 1884, which he shows by comparative statistics; the advantage of the telephone monopoly "is the establishment of a uniformity of working and practice that is highly and extremely beneficial"; he does not think the local working is any better, if as good, as that of

Newcastle-on-Tyne, but that in trunk and long-distance working the Americans are far ahead of the English.

Institution of Electrical Engineers.—The Lond. "Elec. Eng.," Jan. 19, reprints in full the conclusion of the inaugural address of Prof. Alexander Siemens; it is interesting reading, but appears to contain nothing new; progress in various directions is briefly referred to; in referring to long-distance transmission he expresses his belief that of the actually established plants the greater part are worked with continuous currents, stating that no hard and fast rule can be laid down, and that the proper conclusions can be arrived at only if the commercial aspect is allowed to decide the question. In referring to the subject of education, he says that the danger which is to be avoided in our scientific colleges is the tendency to teach our profession too much in detail, as it is apt to produce on the students the impression that on leaving college they know all that can possibly be known, and that anything that does not fit in with the theory of their pet professor must be condemned; "at school the mental powers should be principally exercised in a way to make them fit for learning; * * * after the mental powers have been prepared in this way, it is not of great consequence whether most of the details of the school teaching are speedily forgotten or not"; he advocates that teaching at engineering colleges should be confined to general principles. The Lond. "Elec.," Jan. 19 and 26, reprints this address and comments on it very favorably in an editorial; the "Elec. Rev." reprints it in abstract, and in an editorial comments unfavorably, saying that it was decidedly disappointing in many respects; the editorial dwells more particularly on the comparison of American and English methods.

Educational.—See the above abstract.

Technical Education.—The Lond. "Elec.," Jan. 26, reprints an article from "Engineering," Jan. 19.

Gutta-percha.—The Lond. "Elec.," Jan. 19, publishes an article from "Ann. Teleg.," by Mr. Lagarde. He gives an analysis of the gutta-percha extracted by the Serullas process from the leaves of the isonandra (the process was described in the Digest March 25; see also April 29); the analysis showed the following: Water, 0; impurities, 0.8 per cent.; fluavil, 1.72 per cent.; alban, 14.28 per cent., and gutta-percha, 83.2 per cent.; he accounts for the high specific insulation by the amount of alban as compared with fluavil, and especially to the absence of water; he is inclined to think that on account of the absence of water this gutta-percha will oxidize less rapidly and will consequently last longer; the resins (alban and fluavil), especially alban, increase the insulating power, but are a source of deterioration; analysis, he believes, is the only means of discovering whether the gutta-percha in a cable is of good or bad quality. Regarding the question whether pure gutta-percha from different sources has identical qualities, he considers that the best way to test it is to reduce it to very fine sheets and make condensers of it.

Liquid Air.—Prof. Dewar's lecture on "The Scientific Uses of Liquid Air" is abstracted in the Lond. "Elec. Eng.," Jan. 26; the parts of special interest to electricians are abstracted elsewhere.

Cause of Electric Currents in Plants.—The Lond. "Elec. Eng.," Jan. 26, abstracts an article by Mr. Haacke on this subject.

Time in Psycho-Physiological Phenomena.—"La Lum. Elec.," Jan. 20, contains a long illustrated article by Mr. Henry on this subject.

Central Station Currents in Therapeutics.—"La Lum. Elec.," Jan. 20, abstracts a paper by Mr. Gaiffe, in which he reviews the subject, but gives apparently nothing new.

Electricity and Artillery Practice.—The Lond. "Elec. Rev.," Jan. 19, contains an editorial on this subject, calling attention to it as a new field of enterprise.

National Laboratories.—A translation of the article by Mr. Guillaume, mentioned in the Digest last week, is published in Lond. "Elec.," Jan. 19.

Biographical.—The Lond. "Elec.," Jan. 26, publishes a short biography of Alexander Siemens, together with a supplement in the form of a large steel-plate portrait.

Werner von Siemens.—The Lond. "Elec. Rev.," Jan. 19 and 26, publishes under the heading "A Pillar of Science" an abstract from the English translation of the book "Personal Recollections of Werner von Siemens."

From the Capital of Pennsylvania.

IT IS INDISPUTABLE that this is the electric age, hence to be up with the times it is advisable to keep posted on the advance in matters electrical. This cannot be accomplished more easily than by perusing The Electrical World.

—Harrisburg Call

An Opinion from the City of Churches.

THAT MAGNIFICENT JOURNAL, THE ELECTRICAL WORLD, is a marvelous illustration of what can be done in these days in furnishing the earliest, the fullest and most accurate information on the subjects of which it treats. There is no department of human knowledge to-day in which intellectual minds are more interested than in electricity, and no serial has as yet appeared in which they can find more to engage their attention. The articles bear evidence of high mathematical attainments united with fine literary ability. The Electrical World, having been established nineteen years ago, may be said to have kept pace with the science of electricity in all its later and most wonderful achievements. It is printed on fine super-calendered paper, profusely and beautifully illustrated, and furnished to subscribers at the insignificant price of \$3 per year, including postage.

—Brooklyn (N. Y.) Blade.

Unipolar and So-Called Unipolar Dynamos.

A correspondent, referring to a recent article in our columns on unipolar machines, asks us to explain why the Ball dynamo generates a current with only a single pole piece. Although this question has been asked and answered many times, we will say again that this dynamo is not really a unipolar machine in the true sense of the word. A true unipolar machine is one in which the *induction* is unipolar, or more popularly speaking, in which the current always flows in the same direction in the armature wire, and therefore does not need to be reversed at every half revolution of the commutator. The very fact that the Ball dynamo has such a commutator, shows that it is not a true unipolar machine. A simple exploration with the compass needle will show that there is a true magnetic pole diametrically opposite to the pole piece; it might be said that this second invisible pole piece was made of air. A less attractive but more correct name for this machine might be "a unipole-piece bipolar dynamo."

To say that a unipolar machine has only one magnetic pole is absurd, as every line of force or magnetic field has two opposite polarities at any two points in the direction of the flux. The machine may have only one *pole piece*, but there will always be a second *pole* somewhere, even though there may not be a pole piece; even every true unipolar machine must have two magnetic poles.

Mr. Preece's Comparison of the Telegraph in the United States and in England.

In a recent paper by Mr. William H. Preece, of London, on "Notes of a Trip to the United States and to Chicago, 1893," he gives a very good description of the telegraph in the United States, a reference to which will be found in our Digest. After this description, he summarizes his conclusions as follows:

"It is quite impossible to inspect the telegraph system of the United States and compare it with our own system without drawing comparisons between the way in which the work is done in the two countries. The result of my previous visit was to confirm my view that we do our work better in England than they do in the States. Our apparatus is better, our speed is higher. Messages are handled with greater reliability. A message can be sent and its reply received with certainty in an hour in England. I fancy such rapidity would astonish the users of the telegraph in the States, except those in such busy centres as New York and Chicago, and generally the speculative branches of the community. The domestic telegram scarcely seems to have reached the United States, and this is owing probably to the fact that the districts of private residences, the small towns and the villages do not possess telegraph offices, unless they are supplied by the railway company at the railway station, or by the Western Union Company, who do the work for the railway company. I fail to see any superiority in the manipulative skill of American operators. They certainly have not made the same advance in technical education that we have, and altogether it may be said that the management of the telegraphs in the hands of private enterprise does not compare favorably with the management of the telegraphs by the state at home. At the same time, it must not be assumed because the government has advantageously taken the telegraphs in hand at home that such a process would be possible in the States. In my opinion, it would be absolutely impossible. The civil service of the United States is in a very chaotic condition. The principal appointments are four-year appointments only, and are filled politically. The principal postmasters come in and go out with each new president. We in England scarcely consider that a postmaster is fit to be a postmaster until he has had many years' experience in the working of the post office system. In the States a man is made a postmaster because he has been a political supporter. At one or two offices I found the new post office officials absolutely ignorant of simple facts they ought to have had at their fingers' ends. A business like that of telephones or telegraphs can only be conducted properly by those who possess a considerable amount of enterprise, and who look primarily to the necessities of the community. The reason why our post offices and our telegraph offices at home work so well is because the public exercises such a useful and such a determined supervision over the work. The free opening of the press to complaints; the readiness with which members of the House of Commons ask questions—though at times, perhaps, irritating and vexatious—are undoubtedly good for the service, for they keep us all alive. Such a state of affairs is impossible in the States. The government of the United States must first reform its civil service, and when it gets officials into the service whose tenure of office is secure, and whose zeal is as unquestioned as it is in England, then there will be some chance of their government acquiring the telegraphs; but under existing circumstances, the acquisition of the telegraphs by the government of the United States would amount virtually to the deterioration of the service. The commercial management is at present, as I have pointed out, characterized by great energy. I do not, however, acknowledge that they show greater energy than we do in England.

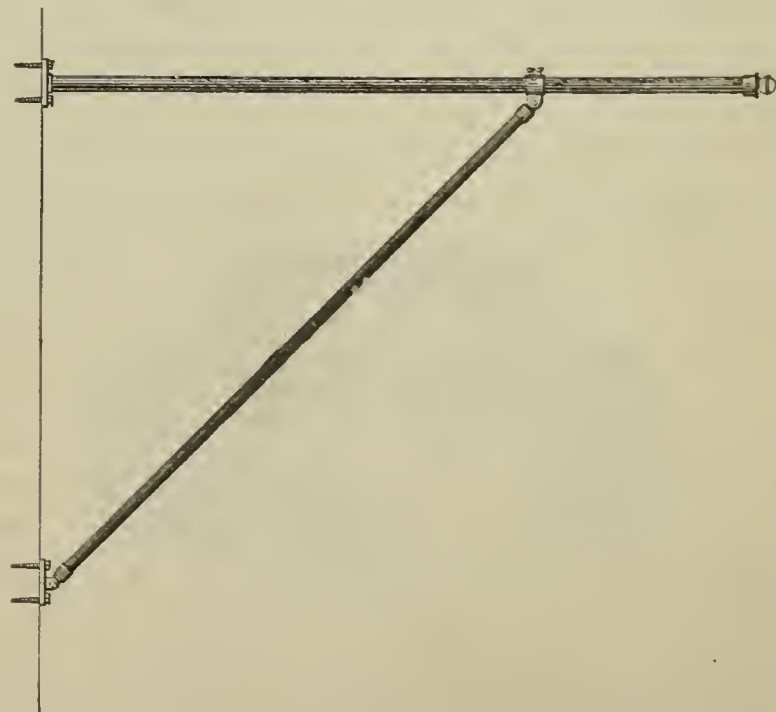
Competition may make it more conspicuous, but it is not more reaching. Our speculative business, stocks and racing is done as well as theirs. The management at home is characterized in all particulars with similar energy to that which I observed in the States; and I come back without any views or wrinkles which I think could be impressed with advantage on the commercial or technical management of our system at home, unless it be the encouragement of offices in hotels, for it is found everywhere that a telegraph office at one's door prompts the desire or want to telegraph. The capital of the Western Union Company was in 1877 \$22,000,000; that of the British Post Office was £10,000,000. The capital of the former is now \$123,000,000, while that of the latter remains virtually the same. Scarcely a single vestige of the old telegraph companies' systems purchased by the state in this country now remains. Whence, therefore, this splendid system of cables, underground lines and new pole lines in this country, spreading everywhere, and transacting an annual business of £2,500,000, instead of the £600,000 handed over to us? It has all been paid for out of revenue! The government keeps no capital account. How do we do our work? The proof of the pudding is in the eating thereof. The criterion of telegraph working is rapid dispatch. 'Time is our only competitor,' said Dr. Norvin Green. The time occupied in its transit from the hands of the sender to those of the receiver is the pudding. The whole of the messages arriving in Newcastle on the morning of Jan. 20 were examined and analyzed. The mean time of transit from all parts of the United Kingdom averaged 7.8 minutes. A similar examination at Glasgow on Jan. 15 gave a mean result of 8.7 minutes. This cannot be beaten, and it certainly will not be believed. The late Mr. Patey was once asked why express telegraph service at higher rates was not introduced in England. His answer was: "All our messages are expressed already."

An Acknowledgment from a Competitor of the Electric Light.

"In recounting the history of electric lighting for the past year," says the "Journal of Gas Lighting," "it is better to begin by acknowledging that this industry has made a certain amount of progress."

Iron Pipe Trolley Bracket.

We illustrate a strong and light trolley bracket made by



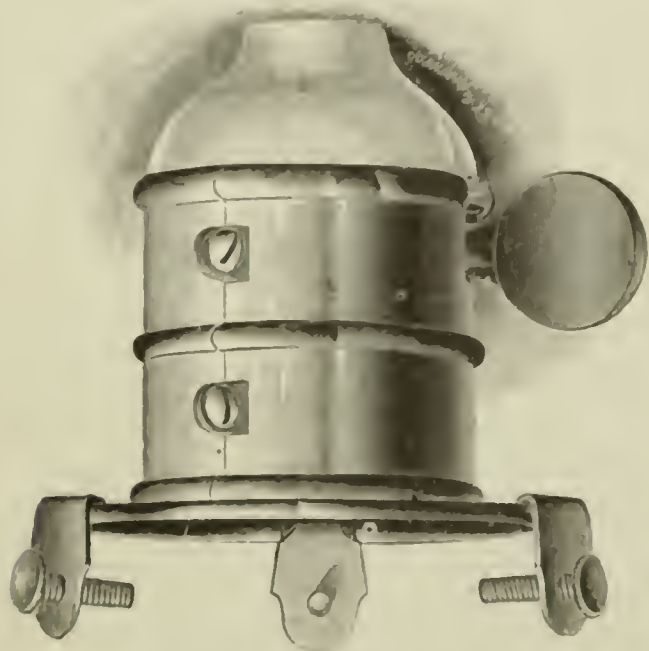
IMPROVED TROLLEY BRACKET.

James R. Gwilliam, 115 North Sixth street, Philadelphia, which is easily erected, being put together with bolts and

nuts. The horizontal arm is of 1 1-2 inch, and the brace of 1 inch wrought iron steam pipe. The principal fittings, which take the strain, are of malleable iron. The bracket is adjustable, so that the horizontal arm can be kept level, regardless of the contour of the pole. The brace is fastened to the horizontal arm by two cup-pointed set screws.

A Cord Lamp Socket.

The cord socket, manufactured by the Newton Electric Company, of 39 and 41 Cortlandt street, as shown in the cut.



CORD LAMP SOCKET.

consists of a porcelain base, on which the terminal pieces, or clamps, are mounted, the spring clamp making direct contact against the inner shell. The porcelain base dispenses with the necessity of an insulating bushing, and the whole socket has in it but four screws. In appearance it is light, but the strength of it is so well placed that additional metal would be unnecessary. This statement also applies to the holder, but a 5-pound shade can be suspended from it without any danger whatever.

The cord pendant this company has just put on the market is made up of a standard rosette, six feet of cord and one of their sockets, as described above, with holder.

Improved Shade Holders.

Those who have had experience with the older forms of shade holders will appreciate the one we illustrate, manufactured by the McCreary Electrical Specialty Company, 136 Liberty street, New York, which has no screws or loose parts to drop out and besides is of a handsome appearance.

Fig. 1 shows the holder complete ready to be attached to



FIG. 1. SHADE HOLDER

an Edison socket. The neck of the holder, which is of stiff spring brass, fits over the ring on the Edison socket, and is held firmly so that it is moved only with the socket. In Fig. 2 the holder is shown with clasp ready to be attached to a Thomson-Houston or Westinghouse socket.

The shade holder is made of polished brass and gives a very neat finish to the fixture. It is instantly attached to the socket and as quickly removed. No tools are required, and its great simplicity is one of its good qualities. The brass is of sufficient thickness so that it is not easily injured or

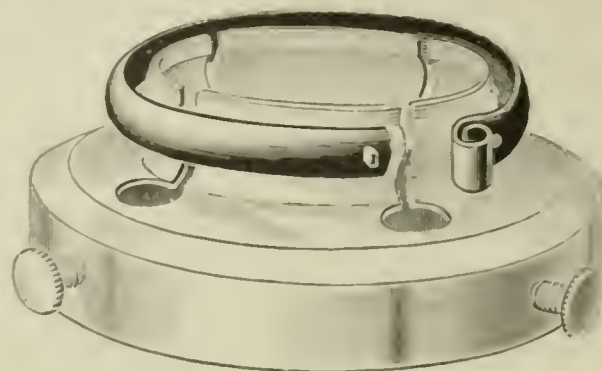
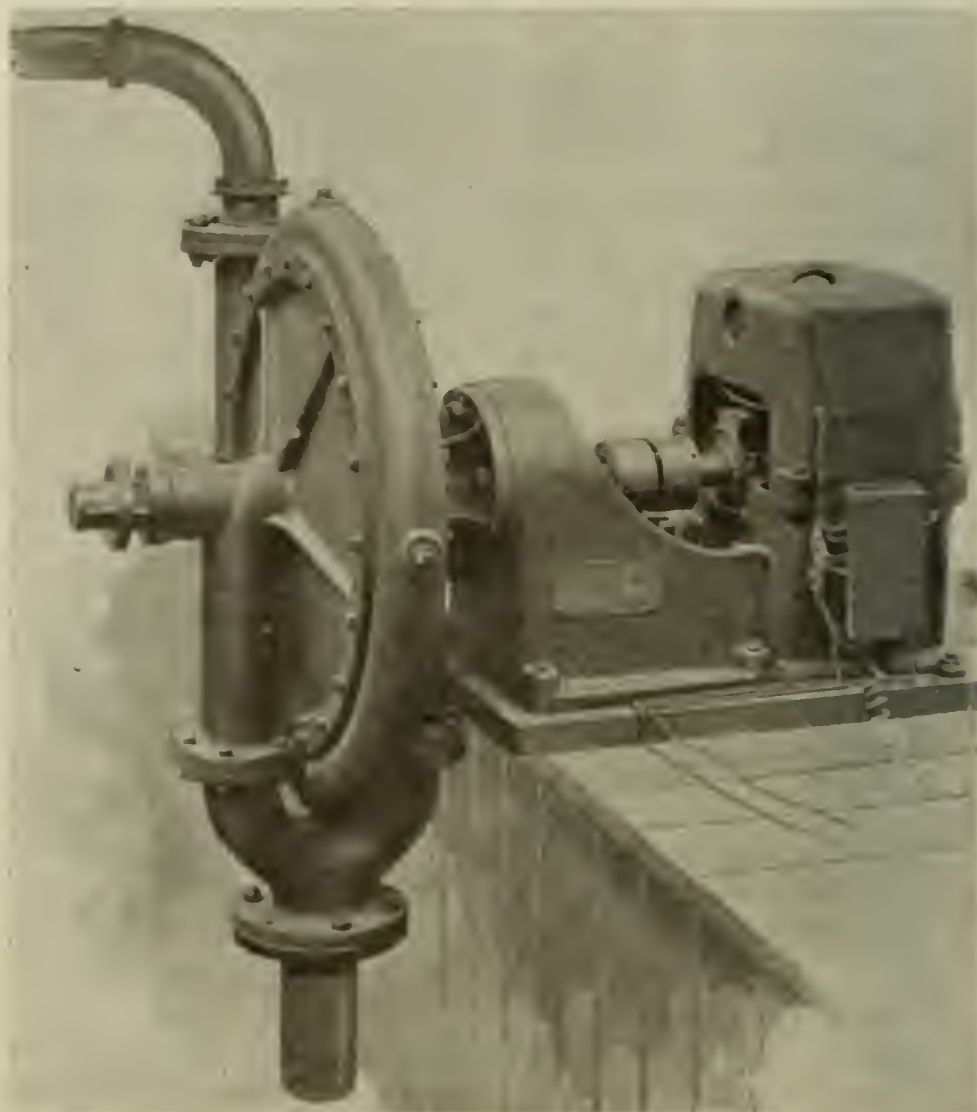


FIG. 2—SHADE HOLDER.

bent out of shape. It holds the shade firmly and still gives abundance of room for the top of the shade.

Electric Centrifugal Pump.

Among the many types of electric pumps exhibited by the General Electric Company in its power and mining section at the Chicago Exposition, the electric centrifugal pump, ejecting its broad stream of water into the reservoir in Electricity Building, attracted considerable attention.



CENTRIFUGAL PUMP.

The pump itself is a No. 4 4-inch centrifugal pump, manufactured by the Lawrence company. The shaft of the pump is directly connected to the shaft of the armature of a General Electric ironclad No. 2 1-2 W. P. motor, running at 400 revolutions, at which speed it developed 3 h. p.

This pump is intended for use where muddy or dirty water is encountered, which would quickly destroy the usefulness of the valves of an ordinary pump. It has proved remarkably efficient wherever it has been used, especially in raising water for irrigation purposes.

New Books.

A STANDARD DICTIONARY OF THE ENGLISH LANGUAGE. Upon Original Plans. Prepared by More Than Two Hundred Specialists and Other Scholars, Under the Supervision of Isaac K. Funk, D. D., Editor-in-Chief. Volume I. New York: Funk & Wagnalls Company. 1893. 1,060 pages. Price, complete, Russia binding, \$12.00.

There are two methods of treating words, first, the lexicographic, where the source of derivation, etymology, etc., are the chief ends in view, and, second, the encyclopaedic, in which the things of which the words are the names, or to which they apply or pertain, are the chief ends. The work under consideration is intentionally constructed with the encyclopaedic features as the primary object, and the lexicographic features as a secondary consideration, in the belief that this method will enhance its value as a popular work. In the lexicographic features it is somewhat inferior to Webster's, but in the encyclopaedic features it is for the most part superior.

We will note, however, in passing a single instance from the exceptions to the latter rule. Brachistochrone is given instead of the brachystochrone of the older dictionaries, which is an improvement for etymological reasons, but the definition fails to state that the brachistochrone is the same as the cycloid. This information is given by Webster, and for the most part by those dictionaries that define the word at all, and is moreover one of the most important things to be said about the curve.

The etymology of the word electricity is given as derived from the Latin *electrum*, which is derived from the Greek *elektron*. This is in accordance with the older dictionaries, but there has been some discussion during the past year as to the real value of this etymology, and it is of some interest to know that this new dictionary supports the older ones. Both *electricute* and *electrocute* are given as correct, which would seem to settle the matter, but to many electricians this uncouth word has been from its inception as unwelcome as the act to which it applies.

Hysteresis is defined as "Molecular friction due to magnetic change or stress; that property of a medium by virtue of which work is done in changing the direction or intensity of magnetic force among its parts." This is very nearly the idea conveyed by most of the definitions of hysteresis given by others than the author of the word, Prof. Ewing. It is, however, incorrect for molecular friction, for, although it may be considered as the cause of hysteresis, it is not identical therewith. We do not wish to stand for hair-splitting distinctions; to our mind there is an important and fundamental difference. A wire may be heated red hot by the passage of an electric current, but no one would in consequence of this fact think of calling a red-hot wire an electric current, and yet the offense against the rules of language and the principles of physical science in so doing would be no greater than that contained in the foregoing definition of hysteresis. Immediately after this definition is given the following quotation, in which the word hysteresis is properly used: "The permeability varies enormously with the amount of magnetizing force, and in a manner desperately complicated by magnetic retentiveness, hysteresis according to Ewing's designation. William Thomson, Math. and Phys. Papers, volume III., Article CI., page 478 (C. P., '90)." The best short definition of hysteresis is that just quoted; magnetic retentiveness. It is the tendency of iron (or other magnetic substance) to persist in any given state of magnetization. That is, if it is unmagnetized it resists magnetization, and if it is magnetized it resists demagnetization. There are analogous phenomena in other cases, so that the meaning of the word hysteresis has been broadened of late to include the whole class, and is often used with a qualifying adjective as magnetic hysteresis, dielectric hysteresis, etc.

The electrical vocabulary is very full, containing conductance, impedance and other coins from Mr. Oliver Heaviside's mint. The practice of giving exact references to book and page, and even paragraph, in some cases, for quotations in illustration of the proper use of words, which is carried out in this work, is certainly commendable.

The mechanical get-up of the work is excellent. The paper is of a good quality, the typography clear and the binding is handsome and substantial. There are six full-page colored plates (two of which, those for birds and gems, deserve special mention), and an abundance of other illustrations. For its size and price it is probably the best dictionary in the English language.

THE ELECTRIC TRANSFORMATION OF POWER, AND ITS APPLICATION BY THE ELECTRIC MOTOR. Including Electric Railway Construction. By Philip Atkinson, A. M., Ph. D. New York: D. Van Nostrand Company. 1893. 244 pages, 96 illustrations. Price, \$2.

The author in his preface states that the design of this book is to give, in plain, untechnical language, the means by which electricity is employed as an agent for the transformation and transmission of power, and its application to the operation of machinery.

This book is in many respects a typical compilation, and one in which the text was apparently determined to a great extent by the collection of cuts made from trade and other sources, and then written up to. For example, descriptions of two electric elevators occupy more space than is devoted to the entire subject of alternating-current motors, the space given to electric drills is but little less, and a description of a deck hoist is of about the same length as that of the Liverpool and of the City and South London electric railways together.

While the book is thus mostly a compilation and its contents apparently largely written up to the cuts available, evidence is everywhere given of care in statement and a desire to present the material in such a manner as to be most easily comprehended by the reader. The descriptions are good and, in this respect, unlike most compilations, the reader will not be misled by the information given. For the general reader and the first year student of electrotechnics the work will be found useful, and satisfies a real need in this respect.

A TEXTBOOK ON ELECTRO-MAGNETISM AND THE CONSTRUCTION OF DYNAMOS. Vol. I. By Dugald C. Jackson. New York: MacMillan & Co. 1893. 289 pages, 132 illustrations. Price, \$2.25.

In the preface the author states that the primary object in publishing this work is to supply a satisfactory textbook to be used as the basis of instruction to college classes, and it can be said that this object has been admirably attained. While the great condensation of matter and omission of minor explanations and details may render the work somewhat difficult to the unassisted student, this objection does not apply when it is used as a college textbook, and is even an advantage to the professional engineer, who would refer to such a work for information on important principles, which he will find here developed without an incumbrance of details unnecessary to him.

Chapter I. is introductory and deals with primary definitions and evaluations. The discussion of magnetic potential and force is very satisfactory, the special cases developed assisting very greatly to the conception of the important principles concerned. Chapter II. is on simple electromagnets, in which some of the more important principles of their design are treated at length. Chapter III., on the magnetic properties of iron, describes different methods of determining curves of magnetization and permeability, of which curves a large number are illustrated, and the magnetic properties of different irons, steels, etc., are discussed in a thorough manner and with a distinctly practical bearing.

The subject of hysteresis is also treated in this chapter in a clear and satisfactory manner.

The first part of Chapter IV. is on electro-magnetic induction with reference to dynamos, the treatment of which subject does not differ materially from that given in other books, though the representation of Siemens' winding, adopted by the author, is different and much less satisfactory than the one usually employed. The remainder of the chapter, on armature losses and calculations, brings out the various points connected with these subjects clearly and with particular reference to their practical bearing, which, it may be here said, is a characteristic of the book throughout. The principles relating to the magnetic circuit of the dynamo are developed in Chapter V., particular attention being paid to the subject of magnetic leakage. Examples of calculations of field windings are given, toothed versus smooth armatures discussed, and the subject of armature reactions introduced. Chapter VI. is on the compensation for cross turns and the effect of brush contact, and thoroughly explains the Sayre and Ryan devices to accomplish the former, and refers to other methods of reducing sparking.

Chapter VII. is on characteristic curves and their determination and on regulation, the latter being treated with reference to characteristics and the principles laid down for the different kinds of windings and classes of dynamos. The latter part of the chapter deals with connecting dynamos for combined output, in which this important subject is more thoroughly considered than in any other work of which we know. Chapter VIII., on efficiencies, might, we think, be given a greater value if the absolute practical worthlessness of electrical efficiencies for even the purpose of comparisons were pointed out, and the effect on commercial efficiency of change in speed and design for a given output explained at length. Methods of separating the various factors that enter into efficiency are given and the variation of efficiency with weight, cost and output discussed. The final chapter is on multipolar dynamos, or rather is a discussion of their advantages and disadvantages.

We have no hesitation in recommending this work as the best, within its compass, of any yet published on the important subject of which it treats. While primarily intended for a college textbook, the electrical engineer will find it of value, not only in bringing his knowledge up to date, but as a reference book on a number of the most important points in dynamo design.

L'ANNUAIRE DU BUREAU DES LONGITUDES POUR 1894. Paris: Gauthier-Villars et Fils. 886 pages with two magnetic charts. Price, 1 fr. 50.

Besides the practical information which this valuable annual contains each year, the present issue has articles by authorities on coinage, statistics, geography, mineralogy, etc., and the following special articles: Light and Electricity, according to Maxwell and Hertz, by M. Poincare; The Origin and Employment of the Mariner's Compass, by Rear Admiral Fleuriat; Four Days of Observation on the Summit of Mont Blanc, by Prof. Janssen. There are also funeral discourses by MM. Faye, Bouquet de la Grye and Rear Admiral Fleuriat on Admiral Paris, and addresses delivered at the unveiling of the statue of Arago, by MM. Tisserand, Cornu and Mouchez.

FIRST PRINCIPLES OF ELECTRICAL ENGINEERING; Being an attempt to provide an Elementary Book for those who are intending to enter the profession of Electrical Engineering. By C. H. W. Biggs. New edition, partly re-written and extended. London: Biggs & Co. 1893. 260 pages, 152 illustrations. Price, \$1.00.

If the term "electrical engineering" is understood in England as in America, we should say that the title of this little volume is most decidedly a misnomer, or, if it can there be properly called a treatise on the first principles of electrical engineering, then that profession has there a much more

limited application than in this country. Electrical distribution, for example, is disposed of in about eight small pages of text, and but little more space is given to electrical measurements, or the two together occupy about the same space as static machines and voltaic cells. On the other hand, the book will be found a very satisfactory elementary work on general electricity and magnetism, and particularly on those parts dealing with electro-magnetic induction and circuits. A valuable feature of the book is that the academic method of treatment is avoided, the various phenomena and principles being explained by reference to concrete examples and accompanied by comments having a practical bearing.

THE SCIENCE OF MECHANICS. A Critical and Historical Exposition of Its Principles. By Dr. Ernst Mach, Professor of Physics in the University of Prague. Translated from the second German edition by T. J. McCormack. Chicago: The Open Court Publishing Company. 1893. 534 pages, 235 illustrations. Price, \$2.50.

The present volume, says the author in the preface, is not a treatise upon the application of the principles of mechanics. Its aim is to clear up ideas, expose the real significance of the matter, and get rid of metaphysical obscurities. The little mathematics it contains is merely secondary to the purpose.

Mechanics will here be treated, he continues, not as a branch of mathematics, but as one of the physical sciences. The positive and physical essence of mechanics, which makes its chief and highest interest for a student of nature, is in existing treatises completely buried and concealed beneath a mass of technical considerations. Here is taught how the principles of mechanics have been ascertained, from what sources they take their origin, and how far they can be regarded as permanent acquisitions.

To the teacher this work should be of value in showing the growth of various ideas, their different mutations and their interconnection with other ideas, thus enabling him to appreciate their difficulties and also to arrive at the natural method by which to impart them to others. By this method a principle becomes a thing of life with a personal history connected with the great names of science, and is thus infinitely more interesting than if stated as a mere abstraction, with no reference to what we may call the human process, by means of which it became established.

At the end of the volume the author gives a list of great masters of all time who have built up the science of mechanics, and whose ages seem to indicate that this science is especially conducive to longevity. Of the 42 names, two lived to be over 85 years, seven between 70 and 75, five between 65 and 70 years, and five between 60 and 65 years, while only 11 died younger than 60 years, among whom are numbered four of the greatest names, Descartes, Kepler, Pascal and Torricelli, the latter two having died at the early ages of 39 and 37 respectively.

The National Electric Light Association.

We are informed by Mr. C. O. Baker, Jr., master of transportation, that the concession of a fare and one-third to the Washington convention has been received from all sections of the country except that portion west of the Mississippi and north of Chicago, Peoria and Burlington, the cities named being included in this rate. Negotiations are being made with the Western Traffic Association, and it is hoped that a concession may be secured from them. The following gentlemen will have charge of transportation matters in their respective sections: A. C. Shaw, Boston, Mass.; C. F. Hesser, Cincinnati, Ohio; H. A. Cleverly, Philadelphia, Pa.; E. H. Heinrichs, Pittsburgh, Pa.; M. I. Sullivan, Chicago, Ill.; James I. Aver, St. Louis, Mo.; E. R. Weeks, Kansas City, Mo., and W. W. Borst, Denver, Col.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, Feb. 10, 1894.

GENERAL ELECTRIC STOCK, as a result of being heavily undersold, shows a tendency to rise, from which much is presaged by the friends of the stock. The short interest is understood to be particularly large in Boston, and the stock is so scarce there that it is impossible to borrow 100 shares without paying a good round premium. Efforts have been made by the people working for lower prices to again spread the old report of a lack of harmony between President Coffin and other officials, but the "officials" hasten to hush this up as quickly as ever. Insiders make very cheerful statements just now. Drexel, Morgan & Co. say: "We are paying no attention to fluctuations, but, so far as General Electric is concerned, all that is to be told is this: The machinery, brains and necessary capital are there; when business improves, so that the question of ordinary expenses will not be considered, the General Electric Company will be in a flourishing condition—and a dividend paper." An official of the company, speaking about its business, says: "Our company has been receiving new work steadily of late, almost wholly in the railway department for motors, the orders on hand at the moment calling for about four hundred. The orders are not from any one source, but come from various roads over the country. The force employed on the regular pay roll is between 1,500 and 1,600 hands. The new work may necessitate the employment of some extra labor. On the whole, this improvement is expected in the early spring, and is not unusual." In order to reduce expenses, the several departments in Lynn will be consolidated in one or two buildings. A new general manager, Mr. G. E. Emmons, formerly auditor at Lynn, is now in charge of the factory there. He replaces Mr. Rice, who has taken charge of the Schenectady plant. There was a meeting of the directors of the company some days since, at which Mr. J. P. Ord was chosen second vice president, General B. F. Peach, treasurer, with Henry W. Darling as first assistant and C. G. Arnedberg as second assistant. Mr. Ord, as vice president, will have charge of the treasury, credit and accounting departments. The local officers of the company state that, as far as they are aware, General Electric was not a creditor, as stated, of the Nashville, Tenn., Electric Railway, which made an assignment this week with liabilities of \$1,000,000. The books which would show the exact facts have been removed to Schenectady. This is another proof of the removal of departments from New York. Only the president's and treasurer's offices are now in this city.

WESTINGHOUSE ELECTRIC MATTERS are attracting a deal of attention just at present. Several items, of which exclusive announcement was first made in these columns, received official confirmation this week. Mr. Geo. Westinghouse himself substantiates the statement first made public in these letters two months ago, to the effect that the big World's Fair plant is to be installed here. Eight of the twelve dynamos exhibited by the Westinghouse Electrical Company at Chicago last summer, together with two additional ones, which have just been completed at the Pittsburg shops, are now on their way to this city, where they will be installed in the United Electric Light and Power Company's building for immediate use. The four remaining dynamos of the big World Fair's plant are to be sent to Baltimore for the Brush Electric Light Company. It is now announced that Mr. Westinghouse may have constructed at his residence, near Pittsburg, Pa., a private railroad one-quarter of a mile long for the purpose of conducting experiments with his new third rail system of electric railway. Mr. Westinghouse himself is responsible for the prediction that it will revolutionize present methods of street car propulsion. Work has also been begun on the new shops, mentioned not long ago, for the Westinghouse Electric and Manufacturing Company at Brinton, near Pittsburg. The first buildings, to cost about \$500,000, to be built are the machine shop and the warehouse. The new buildings will allow of the consolidation of departments and consequent great saving in operating expenses. These many favorable factors have created a deal of bullish sentiment on the stock, and its quotations are well held and steady. An early advance is also predicted.

WESTERN UNION TELEGRAPH stock at times this week almost monopolized stock market transactions. Selling of the stock has been on a scale large enough to confirm every one's suspicion that only inside sources could supply the large blocks of shares so freely offered. Of course the whole trading fraternity has hastened to participate in the bear campaign, with the result that no single stock on the whole Stock Exchange list is as heavily oversold, and a reaction of a couple of points consequent upon a scaring of shorts to cover would not be a bit surprising. It is true that the company's earnings are falling off at a great rate. As compared with last year a decrease of \$200,000 a month is being recorded. The March quarterly report is expected to show a decrease in gross earnings of 33½ per cent., but a saving in expenses may pull up net earnings a little.

AMERICAN BELL TELEPHONE matters do not bear ex-

actly a rosy hue just at present. Already no less than five bills relating to telephone matters are now pending in the Massachusetts Legislature providing for increased taxation and lessened telephone rentals, while at Albany a bill has been introduced fixing the maximum telephone charges at \$50 annually. Adverse legislation of a similar character is also threatened in other States.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York.....	50	20	40
Detroit Electrical Works.....	10	2	3
Cleveland General Electric Co.....	—	85	90
East River Electric Light.....	100	—	65
Electric Con. & Supply Co., pref.....	15	15	16
“ “ “ “ “ com.....	15	15	17½
Edison Electric Ill., New York.....	100	95	90
“ “ “ “ “ 1sts.....	—	105¼	105½
Edison Electric Ill., Brooklyn.....	100	99	100
“ “ “ “ “ Boston.....	100	112	115
“ “ “ “ “ Chicago.....	100	145	150
“ “ “ “ “ Philadelphia.....	100	115	120
Edison Electric Light of Europe.....	—	—	3
“ Bonds.....	—	80	85
“ Ore Milling.....	—	5	12
Fort Wayne Electric.....	—	4	0
General Electric Company.....	100	85¾	36
“ “ “ “ “ deb. 5's.....	—	72	74
Interior Conduit and Ins. Co.....	100	20	30
Mount Morris Electric.....	—	—	65
Westinghouse Consolidated.....	50	45	47
“ “ “ “ “ pref.....	50	20	27
Western Union Telegraph.....	—	82¾	83

New Incorporations.

THE BILOXI ELECTRIC LIGHT COMPANY, Biloxi, Miss., capital stock \$18,000, has been formed to construct and operate an electric light, heat and power plant, telephones, street railways, etc. E. G. Burklin, E. Gennan, J. W. Swetman, J. J. Semon, J. Buck, S. Sopez, W. A. White, H. T. Howard, C. E. Theobald, J. Bradford, S. Bradford, L. Bradford, J. Welder, C. Redding and W. K. M. Dukate are all interested.

THE HAZLEWOOD ELECTRIC COMPANY, Pittsburg, Pa., capital stock \$20,000, has been formed to supply light, heat and power by electricity. T. M. Jenkins, H. O. Hornberger and W. A. Haller, Pittsburg, Pa., are the promoters.

Special Correspondence.

New York Notes.

16175 TIM OFFICE OF THE ELECTRICAL WORLD,
ES BUILDING, NEW YORK, Feb. 10, 1894. }

THE NEW YORK-PHILADELPHIA electric railway project is again being discussed by the daily press, but no new facts are brought forth.

BROOKLYN, N. Y.—The applications for franchises of the Kings County Electric Light and Power Company and the New York State Electric Light and Power Company were referred to a special meeting, when they will be given a public hearing.

SPRAGUE, DUNCAN, HUTCHINSON & CO. have been appointed consulting engineers in connection with the electrical plant for the new Congressional Library Building at Washington. This will be one of the most important isolated installations in America, comprising over seven thousand lights.

THE NEW YORK ELECTRICAL SOCIETY will hold its next meeting at Columbia College, Forty-ninth street and Madison avenue, New York, on Thursday, Feb. 15, at 8 P. M. Mr. Joseph Sachs will deliver a lecture on "Electric Canal Boat Propulsion. With Special Reference to the Erie Canal."

MR. A. L. DANIELS, sales agent for the Miambsburg Electric Company, Miambsburg, Ohio, was in New York last week in the interest of his company. Mr. Daniels reports the sales of the Burnley cartridge battery and the Imperial dry battery as far in excess of the corresponding time last year.

MR. HARRY W. COLBY has opened an office in the Central Railroad Building, Liberty and West streets, for the Holtzer-Cabot Electric Company. Mr. Colby was formerly selling agent for the Mather Electric Company and the General Electric Company. This office will look after all motor and dynamo work outside of New England.

THE CLARK ELECTRIC COMPANY has issued an unusually handsome catalogue devoted to its well known arc lamps, dynamos and apparatus. Excellent engravings are giver of ornamental arc lamps and of the Clark arc lamp for alternating circuits, which is especially adapted for interior lighting on account of possessing the valuable property of being noiseless.

A QUEER ELECTRICAL FIRM.—The New York "World", of Feb. 9 devotes considerable space to the "F. Holman Electrical Company, 128 Pearl street, New York," which for several months has been conducting a mysterious business on Myrtle avenue, near Fulton street, Brooklyn. Loaded trucks arrived and departed at all hours of the night, and various other singular circumstances were noted. Some days ago the firm decamped, and an

inspection of the building afterwards revealed about \$1,000 worth of baled tobacco, which they had apparently been abandoned.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., Feb. 10, 1894.

FAIRHAVEN, MASS.—J. K. Nye is looking into the feasibility of establishing an electric light plant.

A BILL has been introduced into the Massachusetts Legislature for the appointment of three telephone commissioners.

MAYOR BANCROFT, OF CAMBRIDGE, appeared before the committee on mercantile affairs of the General Court and urged action favorable to the petition of his city for permission that cities and towns be allowed to construct, maintain and lease conduits for electric wires.

THE COMMITTEE ON RAILROADS of the Boston City Council is considering the question as to whether the city should ask the Legislature to pass a law requiring the West End Railroad Company to remove all overhead wires except trolley and span wires. The Council has passed an order directing the committee on mercantile affairs to urge in the Legislature the passage of an act granting a charter to the E. Moody Boynton bicycle system, or some other form of elevated road to be built in Boston.

THE GENERAL ELECTRIC WORKS in Lynn have started up again after a week's shut down to take an inventory of stock. There are now employed in the Lynn works about 1,700 men, and the weekly pay roll is more than \$16,000. The formal notification of the appointment of George E. Emmons as superintendent of the Lynn shops, in place of E. W. Rice, resigned, has been posted in the buildings. It is understood that the officers of the General Electric Company are considering the expediency of consolidating the several departments in Lynn in one or two buildings. It is likely that factories C and L will be thus utilized for most of the work. This would require that these factories be run on full time to do the work now on hand. Little or none of the machinery of the other factories will be moved.

Pittsburgh Notes.

PITTSBURGH, Feb. 8, 1894.

THE ALLEGHENY COUNTY LIGHT COMPANY is erecting a new marble switchboard in the central station building, on Twelfth and Pike streets, which, it is said, will be the finest and largest in this State.

GROUND WAS BROKEN yesterday for the new works of the Westinghouse Electric and Manufacturing Company at Brinton Station, on the Pennsylvania Railroad, and 200 men were started to work on the excavation of the machine shop, which is to be the largest of the buildings.

THE BOROUGH OF HOMESTEAD, about ten miles up the opposite bank of the Monongahela river from Pittsburgh, is bound to have all the electric rapid transit facilities needed. The borough council met last night and gave franchises for entering the borough limits to four different street railway companies.

LOCAL ELECTRIC MEN are evincing a great deal of interest in the coming convention of the National Electric Light Association at Washington, D. C., this month, and a large attendance is expected from here. Special transportation facilities have been promised by Mr. E. D. Smith, the district passenger agent of the H. & O. R. R. Co., in the shape of Pullman cars.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY is now making the "Sawyer-Man stopper lamp" at its own glass furnace in the Pittsburgh Exposition Building. The operation of this glass works was commenced yesterday with one "shop," and the men engaged will only make lamp bulbs and stoppers. The place is in charge of Mr. L. M. Cargo, who stated that within a few days he would be able to operate two "shops," and that he could then turn out 10,000 incandescent lamps per day.

THE LOCAL ELECTRICAL FRATERNITY has suffered a sad bereavement through the deaths of two young men, Messrs. L. W. Robinson, Jr., and G. T. Fricke. The former had been connected with the Westinghouse Electric and Manufacturing Company since 1888. He was 21 years of age, and a son of Chief Engineer L. W. Robinson, U. S. N., so well known in connection with the Centennial Exposition and the Chicago World's Fair. Mr. Fricke was a son of the owner of the Penn Electric Works, of this city, and a young man with a very promising future.

WHILE SPEAKING to a reporter of the "Post," of this city, on the practicability of applying electricity as a motive power along country roads, Mr. George Westinghouse, Jr., is quoted as follows:

"The cheapening in the cost of equipment and in the maintenance of electric roads will tend to make their general use, both for freight and passenger carrying, much more extensive than has been the case. The value of electricity as a motive power

is only beginning to be popularly recognized, and the progress being made from year to year is cheapening the cost of the apparatus, while simultaneously adding to its stability and effectiveness, will tend to a more general use for carrying purposes. I should think that electric roads through the farming districts, especially from their feature of forming a connection between the railroads and the portions of the country most remote from them, would assist in developing the country, and for this reason would meet with favor. The nearer a farmer gets to his market, the more he is inclined to branch out, and the cheaper he can convey his produce thither the more profitable becomes his business; besides that, he is able to sell his goods at a lower price. But, of course, the establishment of electric roads is dependent not upon their availability or the extent to which they convenience the community, but upon their capacity to pay interest upon the money invested in them. It is easy to plan out a road and exhibit its usefulness through the districts, but it is not always so easy to show that it will pay. Speaking generally, I would say that electric roads will become more popular year by year. As time passes the builders of the apparatus will improve on present methods, and in time to come the system may be so far ahead of what it is to-day as that in vogue at present is advanced on the earlier efforts at transportation by electric power."

Mr. Westinghouse being asked whether he believed that electricity would displace steam power for long distances, replied that he did not think so.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
137 Monarch Building, Chicago, Feb. 10, 1894.

MR. F. B. BADT has severed his connection with the General Electric Company, and can be addressed, until further notice, care "Western Electrician," Room 6, Lakeside Building, or 6,506 Lafayette avenue, Chicago.

THE ELECTRIC APPLIANCE COMPANY, appreciating the demand which has existed for some time for a stock of high grade electric light carbons in Chicago, has made arrangements to carry a stock of the celebrated Crouse-Tremaine carbons sufficient to meet all reasonable demands for prompt shipments. It is also prepared to bid on large quantity orders for direct shipment from factory.

THE METROPOLITAN ELECTRIC COMPANY, general Western agents for "N. L. R." wire and cables, has recently had some very satisfactory tests from two of the largest buildings in Chicago in which its wire is used. The "N. L. R." factory has enlarged its line of products, and is now making electrolier wire, lamp cord, rubber and friction tape, as well as its regular wires and cables, which have so generally been regarded by the trade as first-class in every respect. A full stock of these goods will be carried by the Metropolitan Electric Company, at prices to suit the times.

News of the Week.

Electric Light and Power.

CISSNA PARK, ILL.—Cissna Park will have electric lights in the near future.

BROOKLYN, N. Y.—It has been decided to readvertise for bids for electric lighting.

GREENWOOD, S. C.—R. M. Freeman is in the market for an electric lighting plant.

PROSPECT, OHIO.—The electric light station at Prospect has been destroyed by fire.

CENTRALIA, KAN., residents are moving in the matter of an electric lighting plant.

GADSDEN, ALA.—The Etowah Ice and Cold Storage Company will buy a small dynamo.

TOPEKA, KAN.—Fire destroyed the boiler house of the Topeka electric light plant.

QUITMAN, GA.—The town of Quitman will soon issue bonds for an electric lighting plant.

PARIS, KY.—The Paris Electric Light Company is in the market for electrical machinery.

NEW BRITAIN, CONN.—The new Roman Catholic church at New Britain is to be lighted by electricity.

DONALDSONVILLE, LA.—The City of Donaldsonville will soon receive bids for an electric lighting plant.

MERCHANTVILLE, N. J.—The Merchantville Electric Company is extending its electric lighting system.

MAHAFFEY, PA.—Residents of Mahaffey are moving strongly in the matter of a municipal electric lighting plant.

FAIRHAVEN, MASS.—Owing to poor light J. K. Nye is trying to form a company to build an electric lighting plant.

CONFLUENCE, SOMERSET COUNTY, PA.—Residents are talking of an electric light plant for Confluence and Ursina.

HALLSTEAD, SUSQUEHANNA COUNTY, PA.—Hallstead and

Great Bend are talking of electric lighting for the streets.

GREENWOOD, MISS.—Marye & Wright will make the Board of Aldermen a proposition to put in twelve 1,200-candle power arc lights.

BROOKLYN, N. Y.—The property of the Edison Electric Light Company, at 358 Pearl street, Brooklyn, has been badly damaged by fire.

LYONS, IOWA.—The Council has instructed City Clerk Manville to purchase a new belt for the dynamo in the electric light building.

PORT JEFFERSON, L. I., N. Y.—The authorities of Port Jefferson are contemplating placing electric lights on the breakwater at the entrance of Port Jefferson.

RUSHVILLE, ILL.—Rushville will soon have a new electric light plant. Work is to be begun at once, and it will likely be completed and the plant be in operation within six months. J. Foote & Son will be the proprietors.

THE COLFAX ELECTRIC LIGHT AND POWER COMPANY, Colfax, Iowa, capital stock \$25,000, has been formed to construct, maintain and operate electric light plants. L. H. Ong, J. Watland and P. Ratliff, New Sharon, Iowa, are interested.

OMAHA, NEB.—At a meeting of Council Comptroller Olsen was instructed to receive bids for furnishing the city with not less than 200 nor more than 300 arc street lights for the period of three years.

The Electric Railway.

KINGSTON, N. Y.—Residents are talking about building an electric road to Ellenville, but nothing has been done.

CHICAGO, ILL.—The Chicago City Railway Company is being urged to improve the Indiana street line.

ANDOVER, MASS.—The Selectmen of Andover have given a favorable hearing to the petition for the proposed South Side Street Railway Company.

WESTFIELD, MASS.—There is talk, but nothing definite has been done, in the matter of an electric road from the centre of the city to Woronoco Park.

CINCINNATI, OHIO.—The barns of the Cincinnati Street Railway Company, located at Avondale, a suburb of Cincinnati, have been burned. Loss over \$180,000.

BOSTON, MASS.—Captain Joe V. Meigs is now before the House with an application for a franchise for a \$10,000,000 company to build an elevated railway in Boston.

BOSTON, MASS.—William B. Mack and others have filed a petition with the Clerk of the House for a charter to build an elevated road in Boston and vicinity.

DOWNINGTOWN, PA.—The Borough Council of Downingtown has granted right of way to the Penn Traction Company for its proposed line from Philadelphia to Lancaster.

WORCESTER, MASS.—The directors of the North End Street Railway Company states that as soon as business revives it will surely extend the line from Worcester to Clinton.

GOSHEN, N. Y.—The Middletown-Goshen Traction Company has been granted a franchise to build an electric railway. Secretary Wightman of the company will give details.

PETERSBURG, VA.—Captain Thomas Hannill, of Petersburg, has asked for a franchise to build a street railway and operate it either by horse power or electricity. Action was deferred.

CHELSEA, MASS.—The West End Street Railway Company has petitioned for leave to establish and maintain a trolley line, and the petition has been referred to the committee on laying out streets.

EASTHAMPTON, MASS.—A motion has been carried to grant the Consolidated Road a franchise to extend from Northampton to Easthampton, with such restrictions as may be deemed advisable by the Selectmen.

AMSTERDAM, N. Y.—A bill has been introduced into the Legislature to authorize the Amsterdam Street Railway Company to supply light, heat and power to the residents and municipal authorities of Amsterdam.

BROCTON, CHAUTAUQUA COUNTY, N. Y.—The Brocton Street Railway Company has been incorporated with a capital of \$10,000 and the following directors: Owen W. Powell, T. C. Moss and C. F. Rycjman, of Brocton.

PROVIDENCE, R. I.—The Graham Equipment Company proposes to build a plant in Providence to build the Graham truck. C. S. A. Gardiner, of 1 Weybosset street, will give details. He is vice president and treasurer of the company.

TORONTO, ONT., CANADA.—The Toronto Railway Company has decided to strengthen the mechanical equipment at the power house by the addition of a new complete 6,000-h. p. outfit, which will include the engines, boilers, dynamos, etc.

PORTSMOUTH, N. H.—A party of capitalists, of Portland, Me., is in Portsmouth trying to buy up the charter of the Portsmouth Horse Railroad Company. This, it is stated, is part of a scheme for an electric road from Portland to Boston.

Personal Notes.

MR. GEORGE M. PHELPS, president of the "Electrical Engineer," has the sympathy of the entire electrical fraternity in his sad affliction in the loss of his wife, whose death occurred in Brooklyn on Saturday, Feb. 10. The charming personal qualities of Mrs. Phelps had endeared her to a large circle of friends in an unusual degree.

DR. COLEMAN SELLERS has been so prominently identified with the scheme for the utilization of Niagara Falls for power purposes, almost from its inception, that his name is almost invariably associated with it. Dr. Sellers' training throughout his long career has been along lines which would best fit him for work of such a magnitude as this. Born in Philadelphia in 1826, he received his early education in private schools there, and later attended a boarding school at West Chester, Pa. At the age of sixteen he was apprenticed to a farmer, but after spending three years at this work, went to Cincinnati, Ohio, where he joined his brothers in the Globe Rolling Mills. After three or four years there, he entered the Niles Locomotive Works, where he remained



until 1856, when he returned to Philadelphia as engineer for William Sellers & Co. He continued there as engineer and as member of the firm until the incorporation of the present company, and then with the new firm until obliged to resign on account of ill-health, in 1888. He then carried on an independent business as consulting engineer, and later became associated with the Cataract Construction Company. He was one of the five members of the International Commission, and is president of the Niagara Falls Power Company. He is past president of the American Society of Mechanical Engineers, member of the British Institution of Civil Engineers, professor of applied science at Steven's Institute and of mechanics at the Franklin Institute, etc.

MR. CLEMENS HERSCHELL, who, as hydraulic engineer for the Cataract Construction Company has been largely responsible for the success of that great undertaking, was well equipped for the work. He was graduated from the Lawrence Scientific School, Harvard University, in 1860, and completed his technical education in the scientific school at Karlsruhe, Germany. After spending three years in this school, on his return to the United States he immediately began the practice of his profession, which he continued for fifteen years at Boston. During the last two years of this period he was connected with the main drainage works. Then he went to Holyoke, Mass., as hydraulic engineer for the Holyoke Water Company, where he remained for ten years. He then connected himself with the New Jersey Water Company, a position which he held until he became interested in the work at Niagara. Mr. Herschell is a member and ex-director of the American Society of Civil Engineers and also a member of the British Institution of Civil Engineers. The consummation of this great piece of engineering work in the successful starting of the mills of the Niagara Falls Paper Company a few days ago reflects great credit upon Mr. Herschell and sustains his reputation as one of the foremost hydraulic engineers of the world.



Miscellaneous Notes.

THE NEW ORLEANS ELECTRIC CLUB held its regular meeting at its new room on Friday, Feb. 2. Mr. Warren B. Reed, of the Edison Illuminating Company, read an interesting paper on "Chemical Meters." Prof. Brown Ayres entertained those present with a working diagram showing the action of alternating currents.

A TROLLEY WIRE DECISION.—The Louisiana Court of Appeals has affirmed a judgment against the city of Shreveport and the City Railway Company, of the same place, for the value of a horse killed by a fire alarm wire in contact with a trolley wire. The court held that both appellants were guilty, the former for not insulating the fire alarm wire, and the latter for not having guard wires.

A LEADING TRADE PAPER.—"The Jewelers' Circular" celebrates its silver anniversary by the issue of a 142-page number, with a handsomely designed and silvered cover. An interesting sketch is given of the history of the various firms that advertised in the first number, and other features are sketches of prominent houses in the jewelry trade and a collection of bright trade notes and commercial sketches by the various correspondents of the "Circular." There are also a number of special articles dealing with various phases of the jewelry trade, a novelette with a pearl necklace as the theme, and a volume of advertising that shows that the high merits of this class journal are appreciated by those in whose interest it is published.

AN ELECTRIC HEATING PATENT.—The Carpenter Enamel Rheostat Company, as the assignee of C. E. Carpenter, has recently had issued to it a patent which, it claims, controls broadly all commercial forms of enamel rheostats and heaters. The patent is No. 511,467 of Dec. 26, 1893. A sample claim reads as follows: Claim 1.—"The improvement in the method of constructing resistances, which consists in attaching to a suitable support a coating of enamel by fusing the same; placing upon the surface of the coating an electrical conductor, covering said conductor with a coating of enamel having fusing point lower than the enamel already applied, and raising the whole to a temperature sufficient to fuse said second layer of enamel, substantially as described."

Trade and Industrial Notes

McDOUGALL, LUCAS & CO., manufacturers' agents for central station specialties, The Rookery, Chicago, are successors to the firm of McDougall & Cummings, of the same city.

W. C. STERLING, Monroe, Mich., the well-known dealer in cedar telegraph poles, admitted his son, Will C. Sterling, Jr., to partnership on Feb. 1, and the name of the firm will hereafter be W. C. Sterling & Son.

THE JOHN T. NOYE MANUFACTURING COMPANY, Buffalo, N. Y., is no longer represented in the West by Fairbanks, Morse & Co., and all business will be transacted through the main office in Buffalo until a new Western agent is appointed.

THE LUNKENHEIMER COMPANY, Cincinnati, Ohio, has issued an illustrated price list of the "Lunken" renewable seat gate valve, which gives a comparison of its advantages in simplicity, strength and compactness over the old-style valve.

ELLIOTT BROS., 101 St. Martin's Lane, London, England, have issued a prospectus devoted to Ayrton & Mather's new electrostatic reflecting and gravity voltmeters, containing descriptions and other information relating to these instruments.

MR. GEO. E. PRATT has resigned his position as contracting agent of the Lamkin Car Works of Philadelphia, where he had been employed four years, and accepted a position with the Jackson & Sharpe Company, of Wilmington, Del., representing them in their street car department.

N. S. LARGE & SON, 221 Chestnut street, Philadelphia, has issued an illustrated price list, No. 1, of single and double and three-pole knife switches and main fuse blocks. This firm also manufactures general electrical supplies, and special attention is given to model, repair and experimental work.

THE TAYLOR ELECTRIC TRUCK COMPANY, Troy, N. Y., has issued a catalogue devoted to its improved electric steel truck. That the company includes the Messrs. Gurley, the world-known instruments makers, is in itself evidence that the claims made for the superior merits of the truck rest on a firm basis of fact.

THE WROUGHT IRON BRIDGE COMPANY, Canton, Ohio, has secured a contract for the erection of a steel bridge for the Pittsburgh, Coraopolis and Neville Island Electric Railroad Company. The bridge will be 1,086 feet long, having three spans and five piers, and will cost about \$60,000. Work is expected to commence about March 1 next.

JONES BROS. ELECTRIC COMPANY, of Cincinnati, Ohio, is about to bring out a new lightning arrester, which, it claims, will be much the simplest arrester on the market, and can be sold at very reasonable prices. It will be made in three designs, one for station work, another for outside work and a third for use on electric street cars.

MR. J. POTTER, so long and so prominently identified with the Brush Electric Company in Cleveland, has associated himself in an executive capacity with the Buckeye Electric Company. The recent decision in favor of the Buckeye Company seems to be bringing it lots of business. Messrs. Prentiss, Rockwell and Potter, however, will provide facilities for handling all the business that comes to the company.

WARREN & BURHORN, 126 LIBERTY STREET, NEW YORK, have been appointed as consulting engineers to draw up plans and specifications for a complete isolated electric light plant, to be installed in the Trenton asylum for the insane, which, with others, is under the control of the State Board of Managers of Asylums. The plant will include engine, possibly direct connected, and wiring complete for about 1,000 lights.

WILLIAM HAZLETON, 3rd., Havemeyer Building, New York, has been made the general Eastern agent of the Fulton Truck and Foundry Company, of Cleveland, Ohio, which manufactures steam and street railway specialties. Its goods have been very thoroughly introduced in the West and it has just completed a new factory in Mansfield. It manufactures a complete line of electric, steam and street railway supplies.

THE E. P. GLEASON MANUFACTURING COMPANY, 189 Mercer street, New York, has recently published a new folder describing and illustrating some of its specialties in silvered porcelain reflectors for electric lighting. Its newest reflector is a cluster of 4, 5, 6 or 8 incandescent lights with a porcelain shade above which is covered on one side with quicksilver, which makes a very ornamental fixture. It is constantly increasing its line of cut glass shades and globes for electric fixtures and has an immense line of brass goods and fancy colored globes.

CHARLES RETTIE, is Geraint street, Liverpool, England, sends us a handsome calendar containing a number of colored views of applications of electricity. Among the views is one of a large Atlantic liner, labelled "The Ship of the Future, Driven by Electricity—Across the Atlantic in Three Days—30,000 B. H. P." Assuming that "B. H. P." means battery horse power, and that a storage battery may be invented that will develop an hourly horse-power on a weight as low as 50 pounds, to develop the power referred to will require 54,000 tons of storage battery.

THE MASON REGULATOR COMPANY, 10 Central street, Boston, Mass., has added a new volume to its admirable series of practical manuals, the title of the present one being "What An Engineer Should Know About Electricity." (50 cents.) The same company has in preparation a "Chief Engineer's Record Book and Engineer's Log," and has published the following works for the engineer: "Key to Engineering" (30 cents); "Common Sense in Making and Using Steam" (25 cents); "The Engineer's Epitome" (50 cents); "Key to Engineering" (50 cents); "Engineer's Catechism" (25 cents).

M. T. DAVIDSON, 43 to 53 Keap street, Brooklyn, N. Y., finds business extremely good, particularly with the Davidson Independent Air Pump and Jet Condenser, which is now in use in many prominent electric street railway and power stations, notably the Ishpeming Street Railway Company, Ishpeming, Mich.; Wilmington Street Railway Company, Wilmington, N. C.; Utica Street Railway Company, Utica, N. Y.; Toronto Street Railway Company, Toronto, Can.; the Akron Electric Light Company, Akron, Ohio; Erie Electric Light Company, Erie, Pa., and Oshkosh Electric Light Company, Oshkosh, Mich. This apparatus has given very satisfactory results in every case where it has been adopted.

THE PURITY OIL FILTER MANUFACTURING COMPANY, 20 Water street, Pittsburg, Pa., in one day, recently, shipped the following orders: Port Deposit (Md.) Electric Light Company, Market Street Electric Railway Company (third order), San Francisco, Cal., and Oakland, Cal., Gaslight and Heat companies and Ella Coal Company, Milesville, Pa. The following letter from the superintendent of the San Francisco Edison Light and Power Company is a sample of many received: "The Ideal Oil Refiner has proved satisfactory in every respect. I have tried several oil filters and prefer the Ideal to any of them. The oil comes out clear and cool, and cannot be distinguished from new oil."

WARREN WEBSTER & CO., Camden, N. J., has published an account of the tests of the Webster steam and oil separators made at the World's Columbian Exposition by George H. Barrus. The conclusions are that the steam separator in handling 17½ per cent. of the moisture intercepted the whole quantity. In the test of the oil separator it was found that 86.7 per cent. of the oil was accounted for. The balance, namely 12.3 per cent., covers that which disappeared in the process of lubricating the cylinders and working parts, that which clung to the sides of the pipes and the sides and plates in the separator, and that which passed on with the steam and collected in the water of condensation. There was a slight trace of oil on the surface of the water drawn from the condenser, which appeared in the shape of an exceedingly thin film, barely perceptible.

THE AUTOMATIC TELEPHONE AND ELECTRIC COMPANY, 25 Wall street, New York, sole licensee of the Strowger automatic switch for New York, whose primary object is to establish telephone systems throughout the State, calls attention in a circular to the benefit of its system. Among the advantages mentioned are: Immediate connection with the number desired or person with whom you wish to converse; entire absence of the frequent tedious delays occasioned by indifference of operators or inability to handle business promptly as desired and the equally frequent and unsatisfactory response to calls "They are busy"; absolute secrecy of conversation when desired, at times so essential to business men as well as in private life; continuous service both day and night, rendered impracticable in many towns under the present system by reason of the necessary additional expense involved in the employment of night operators; economy in operating, insuring the subscribers lower rentals than can be possibly obtained under any other systems, bringing its use within the reach of thousands heretofore unable or unwilling to pay the rental demanded; perfect adaptability to the smallest towns and villages as well as to cities; impossibility of interruption or disconnection during conversation; disconnection automatically when through talking.

THE AMERICAN SILK MANUFACTURING COMPANY, 311 Walnut street, Philadelphia, manufacturers of silk wipers especially adapted for wiping dynamos and all fine parts of electrical machinery, is very much gratified with the large increase of orders for its wipers during the month of January, which were 100 per cent. larger than those of the previous three months, notwithstanding the fact that January is usually a very dull month in this line. A portion of this increase may be due, in a measure, to the fact that this company is now furnishing a new and improved compound for washing these wipers, which is very much superior to the compound furnished heretofore. The new compound is not affected by heat or air, and will in no manner injure the fibre, and is furnished free of charge. The American Oil Company, of San Francisco, upon application, has recently been appointed sole agent for the Pacific coast, and has already sent in a large order. One of the leading cotton waste dealers in Pittsburg, Pa., has also sent in a nice order. The greater portion of the orders come from electrical firms.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., is again actively in the field for business, having been entirely reorganized, and being now under the control of a syndicate of practical Connecticut capitalists, among them being M. S. Chapman, its president, who is also president of the Waring Electric Company and Perkins Lamp Company, and in charge of the government envelope works at Hartford, Conn.; Henry A. Redfield, president of the Phoenix National Bank of Hartford; Charles E. Perkins, the well-known patent lawyer of Hartford; who has been permanently identified with all the recent lamp litigations; T. C. Perkins, son of Charles E. Perkins, who is vice president of the company, and who is well known to the electrical fraternity through his connection with the Ball & Wood Engine Company; C. M. Jarvis, president of the Berlin Iron Bridge Company, who needs no introduction; John L. Bunce, secretary and treasurer of the company, formerly connected with the Schuyler Electric Company and Perkins Lamp

Company, and Norman McD. Crawford, electrician of the Hartford Street Railway Company, originally from Philadelphia, where he obtained prominence as an electric railway engineer through his connection with the Philadelphia Traction Company in an advisory capacity. Under the reorganization the company introduces itself free from debt and with ample working capital. Its general selling agency in Boston is discontinued, as is also its agency representation anywhere, with the belief that it is in the line of wisdom and economy to sell direct to customers, or through contractors of undoubted reliability and financial standing. All its business hereafter will be transacted at Manchester, Conn., and efforts will be directed particularly to the construction of large dynamos and generators for electric lighting plants, electric railways and railway equipment, for which its factory is admirably adapted; its new erecting shop, 200x50 feet, being especially designed and constructed by the Berlin Iron Bridge Company, with its electric traveling crane for the expeditious handling of large apparatus. The Mather system of incandescent lighting and transmission of power is too well known to require special mention, and it is sufficient to say that the high standard of its manufacture in the past will be sustained in every respect in the future, and with such a prominent organization it would appear that success must attend it. Vice President Perkins and Secretary-Treasurer Bunce are both young men of ability and energy, and should earn for themselves enviable reputations.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED JAN. 30, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

- 11,400. Reissue. SYSTEM OF ELECTRICAL DISTRIBUTION; W. Stanley, Jr., and J. F. Kelly, Pittsfield, Mass. Application filed Nov. 29, 1893. This comprises primary coils connected in series with the source of electricity, secondary coils forming the source of current for local working circuits and condensers in series with the secondaries, and adjusted to neutralize the electromotive force of self-induction in the secondary circuits.
- 513,482. ANTI-INDUCTIVE CONDUCTOR; Horace F. Chick, Waretown, Mass. Application filed May 29, 1893. The combination with a metallic circuit composed of two branches or wires of a separator of textile material, wound about and between the branches or wires throughout the length of the circuit to separate and yet bind them, and which separator is attached to one of the wires at the points where it crosses or intersects the same.
- 513,498. TRAIN-OPERATED DEVICE; Johann Heinrich Frischen and Robert Pfeil, Berlin, Germany. Application filed Nov. 28, 1893. In an electrical train-operated mechanism, a pair of track instruments; circuit-making devices connected therewith; and electrically actuated signal device controlled by one of said circuit-makers; and means controlled by the opposite track instrument for closing the circuit through the circuit-maker to the signal device.
- 513,526. FIRE ALARM TELEGRAPH SYSTEM; Michael J. O'Sullivan, Baltimore, Md. Application filed June 7, 1893. In a device of the class described, the combination of the main line circuit wire, connected to the circuit-breaking wheel, a sliding contact bar adapted to alternately make and break contact with the circuit-breaking wheel when the wheel is turned; the main line circuit wire, attached to the contact bar; a stationary guide piece for the sliding contact bar and having contact points; insulation between the sliding contact bar and the guide piece; a ground wire in electrical connection with contact points; an electric bell in the line of the ground wire; and contact points on the sliding contact bar normally separated from, but adapted to contact with the contact points on the guide piece, and thus cut in the ground wire, when the main line circuit is broken by turning the contact-breaking wheel.
- 513,534. SIGNALING SYSTEM FOR TELEPHONE CIRCUITS; John I. Sabin and William Hampton, San Francisco, Cal. Application filed Aug. 18, 1893. Individual calling indicators on a local battery circuit, in combination with subscribers' metallic circuits, each composed of two line wires, connected to opposite sides of the said local circuit at the switchboard to form part of the local circuit, and means for uniting the two line wires at the subscriber's telephone to close the battery upon the said indicators.
- 513,537. SIGNALING SYSTEM FOR TELEPHONE TRUNK LINES; Charles E. Scribner, Chicago, Ill. Application filed June 16, 1893. The combination with a trunk line of a signaling cir-

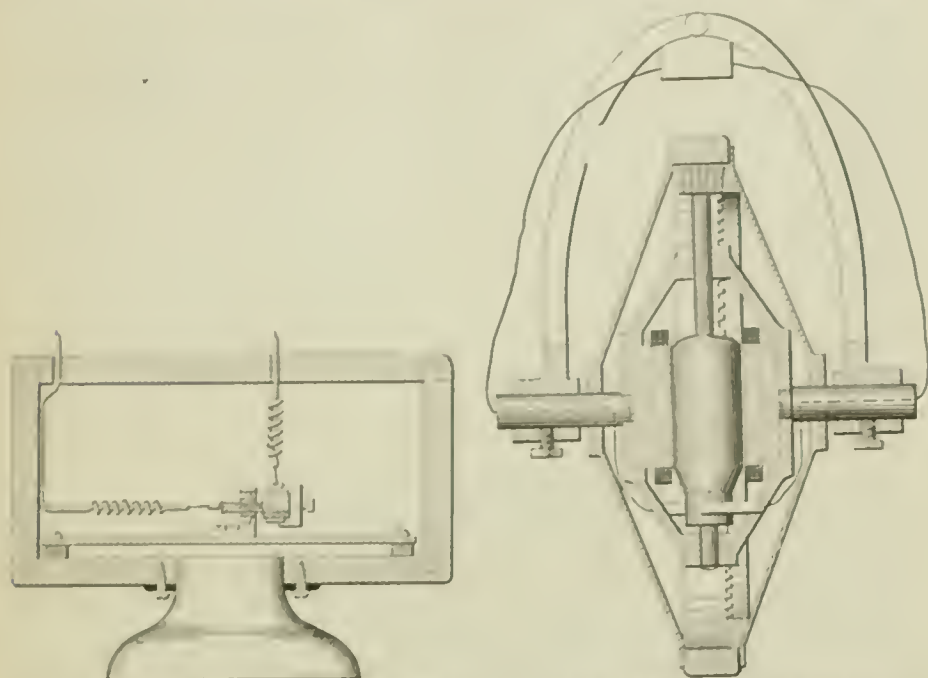
cuit extending between the terminal stations thereof and normally including a signal indicator at each of said stations, a local branch circuit at one of said stations, including a source of electric current, and a key at that station adapted to connect the corresponding signal indicator alternately into the signaling circuit and the local circuit.

- 513,545. CIRCUIT CONTROLLER FOR REGULATORS; B. B. Ward, New York, N. Y. Application filed May 10, 1893. The combination with an expanding and contracting member of a fixed contact, and a retarding device controlling the movable contact.
- 513,564. ELECTRIC WIRE CLEAT FOR HOLDER; A. W. Fuller, Saugus, Mass. Application filed March 13, 1893. This consists of a many sided block having two parallel grooves formed upon two or more of its sides.
- 513,566. TROLLEY WIRE FINDER; E. Gale, Peoria, Ill. Application filed Nov. 21, 1892. The combination of the trolley pole and wheel with a revoluble guard extending laterally beyond the vertical planes of the sides of the wheel.
- 513,587. ELECTRO-MECHANICAL DEVICE FOR BELLS; W. O. Meissner, Chicago, Ill. Application filed Sept. 11, 1893. The combination with a spool magnet and projecting pole pieces of an armature pivotally supported on both poles at one side of the spool and adapted to be moved to and from the pole pieces toward the other side of the spool.
- 513,592. ANNUNCIATOR; J. H. McEvoy, Waterbury, Conn. Application filed May 8, 1893. This comprises a spool magnet, having its armature supported beneath the core, and having upwardly projecting parts at one side of the core and adapted to embrace the ends thereof, so that two armatures lie on one side of a vertical plane passing through their support.
- 513,593. ELECTRIC BELL; J. H. McEvoy, Waterbury, Conn. Application filed May 8, 1893. This comprises a bell having an arm carrying a rigid notched piece to engage and secure one end of the box or cover of the bell.
- 513,601. MECHANISM FOR CONTROLLING ENGINES; Benjamin Frank Teal, Chicago, Ill. Application filed Aug. 14, 1893. An apparatus of the character described, comprising a cylinder, the escape port of which is provided with a controlling valve, a position within cylinder provided with an operating rod, an electromagnet for shifting escape port valve, and an adjustable connection between the armature of magnet and escape port valve, whereby the shift can be regulated.
- 513,611. DYNAMO BRUSH; Wilfred H. Fleming, Bayonne, N. J. Application filed Nov. 13, 1893. A dynamo brush, consisting of successive layers of wire gauze to the length of the brush, compacted together by pressure.
- 513,612. ELECTRICAL REGISTERING DEVICE; Frederick Von Hefner-Alteneck, Berlin, Germany. Application filed Nov. 3, 1893. In an electrical recording apparatus, the combination of a generator, an electric circuit therefrom; a recording tool in said circuit and normally operated by generator; a tape adapted to be punctured by recording tool; a feed device carrying said tape

and normally out of circuit, and a switch adapted to contact with said feed device and automatically short-circuit the recording tool there through upon the giving out or breaking of said tape, substantially as described.

512,626. AUTOMATIC RHEOSTAT; C. J. Sturgeon, Erie, Pa. Application filed March 21, 1893. This comprises a rheostat acting automatically to cut out its own resistance coils until the full volume of the current flows into the motor or other apparatus in circuit therewith.

512,629. DETACHABLE ELECTRIC WIRE HOLDING DEVICE; C. Beard, Brookline, Mass. Application filed Oct. 20, 1893. This



NO. 512,720.—TELEPHONE. NO. 512,859.—ELECTRICALLY PROPELLED DRIVE WHEEL.

consists of a looplike clip adapted to embrace the support and provided with a wireholding eye, through which a wire is passed and thereby secured to the fixture.

512,720. TELEPHONE; Herbert S. Page, Somerville, Mass. Application filed May 15, 1893. In a microphonic telephone transmitter, the combination of a diaphragm of glass, or other insulating material, the outer surface of which is carbonized and the inner surface of which is platinized; of two electrodes in contact suspended by suitable conducting supports, one of the electrodes being in contact with platinized surface, all included in a battery circuit.

512,725. ELECTRIC ARC LAMP; F. A. Perret, Brooklyn, N. Y. Application filed Nov. 7, 1892. This comprises a pivoted frame carrying a train of gear engaging with the carbon rod, a rotary armature in the form of a disc or star controlling the train and a solenoid having its core connected with the frame and also extending into attractive distance of the rotary armature.

512,729. TELEPHONE TRANSMITTER; Francis H. Richards, Hartford, Conn. Application filed Dec. 4, 1893. In a telephone instrument, the combination of two electrodes adapted and in position for sliding contact, the one upon the other, and one of them having a compound working face comprising relatively electrical and non-electrical fields, and means for operating one electrode relatively to the other.

512,730. TELEPHONE TRANSMITTER; Francis H. Richards, Hartford, Conn. Application filed July 31, 1893. In a telephone transmitter, the combination with a plate sensitive to sound waves and with the compound electrode operatively connected therewith and having a working face comprising an electrical and non-electrical field, of the opposite electrode bearing against said working face and having a supporting pivot, and an electrode carrier supporting electrode by its pivot to bear against working face. (See illustration.)

512,745. SWITCH-BAR; Franklin A. Weller, Boston, Mass. Application filed Feb. 27, 1893. In a motor switch, the combination with the stationary contacts of the switch-bar, the movable and extensible contact arm carried thereby, a latch for holding said arm and an operating handle.

512,775. ANNUNCIATOR; Mansour Garl, Akron, Ohio. Application filed June 28, 1893. The combination of the magnet provided with flanges, the collar, the indicator shaft provided with an indicator, an armature provided with arms extending below the magnet, the extended wire located below the magnet, the arm and hooked arm, the gravity arm provided with the curved slot and the rib.

512,777. ELECTRIC CONNECTION FOR RAILWAY RAILS; Alfred Green, Rochester, N. Y. Application filed Sept. 20, 1893. The combination with the rails of an electric railway of the conductor wire and wire connections, provided with stems and slots, said wire being removably fixed in the slots and the wire extending and supported beyond the ends of one or more rails in each direction, whereby, when the wire is unfastened, as by unsoldering, the rails may be removed without interrupting the current.

512,796. AUTOMATIC CIRCUIT-CLOSER; Henry Lowers, Carson City, Nev. Application filed July 11, 1893. In an automatic circuit-closer for fire alarm circuits, the combination of an inclosing

tube permanently stopped at one end, a spring placed in the tube and abutting against the closed end of the tube, a perforated stopper provided with two contact pieces, a circuit-closing pin inserted in the perforation of the stopper and resting on the spring, and means for holding the circuit-closing pin out of contact with the contact pieces.

512,829. ELECTRIC ALARM; David S. Schureman, Rockford, Ill. Application filed May 6, 1893. A thermometer having a dial of conducting material, and insulated bushings extending through and attached to the face of the dial.

512,839. SYSTEM OF ELECTRICAL DISTRIBUTION; Charles H. Talmage, St. Louis, Mo. Application filed March 31, 1893. The combination with a solenoid plunger having a ratchet-toothed stem and a ratchet wheel operating therewith, of a detent pawl for the ratchet wheel, and an adjustable trip carried by the plunger stem to disengage said pawl, and adjunctive devices operating therewith.

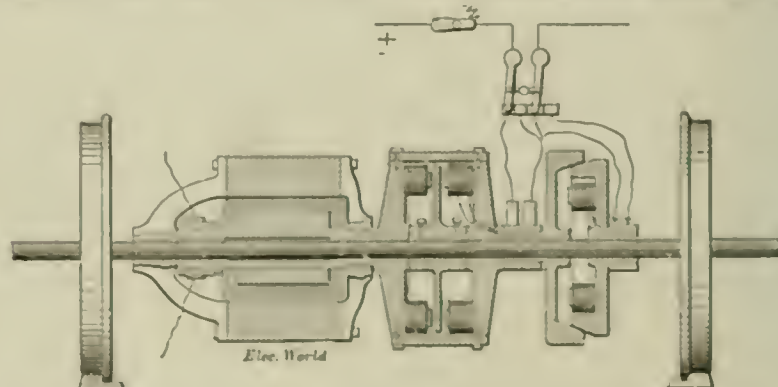
512,846. TROLLEY POLE STAND; Gustaf Valley, Cleveland, Ohio. Application filed May 6, 1893. In a trolley pole stand in combination, a trolley pole plate bearing a socket for engaging the trolley pole, such socket being tapering externally, and having a split free end with a compression band engaging the same, such trolley pole plate being suspended by links, a semi-elliptic spring and cross-head for holding the link taut.

512,847. TROLLEY POLE STAND; Gustaf Valley, Cleveland, Ohio. Application filed May 11, 1893. In combination a base plate for attaching to the car top, a trolley pole plate bearing a socket for engaging the trolley pole, such trolley pole plate being suspended by means of links, the links from the one side thereof engaging hooks or opposing members of the base plate, the links from the other side of the trolley pole plate engaging a cross-head, a coiled spring connected with and acting on the cross-head in the direction to hold the links taut.

512,859. ELECTRICALLY PROPELLED DRIVEWHEEL; Carl G. Anderson, Lynn, Mass. Application filed Sept. 1, 1892. In an electric driving wheel, the combination with the shafts upon which said wheel is loosely mounted of a stationary electric motor arranged within the wheel and secured to the shafts, and intermediate gearing connecting the motor and wheel whereby a rotary motion is imparted to the latter. (See illustration.)

512,894. SECTIONAL ELECTRIC RAILWAY; George W. Demmick, Lynn, Mass. Application filed July 20, 1893. In combination, shelves and diaphragm and the rods provided with the convex flanges or guards.

512,895. POWER-TRANSMITTING MECHANISM FOR ELECTRIC LOCOMOTIVES; Mark W. Dewey, Syracuse, N. Y. Application filed April 17, 1891. The combination with an electric



NO. 512,895.—POWER TRANSMITTING MECHANISM FOR ELECTRIC LOCOMOTIVES.

motor and a shaft or wheel to be driven, of an electric speed reducing mechanism connected to the moving part of the motor and to the shaft or wheel, and consisting of two parts in close proximity to and adapted to electrically attract or repel each other, and a conical friction clutch mechanism connected to the moving part of the motor and the shaft or wheel. (See illustration.)

512,921. ELECTRIC-ARC LAMP; Manuel Rafael Gutierrez and Milton T. Thompson, Jalapa, Mexico. Application filed Aug. 8, 1893. In an arc lamp, the combination with a cross-bar of insulating material, carbons pivotally connected with the cross-bar, levers connected with the pivoted ends of the carbons for moving the carbons simultaneously in opposite directions, and feeding mechanism connected with the cross-bar for lowering the carbons and turning them on their pivots.

512,948. AUTOMATIC DAMPER REGULATOR; H. F. Maxim, Norfolk, Va. Application filed March 14, 1893. This comprises a motor having a crank arm extending on each side of its axis and actuating the shifting lever, a thermostat, a magnet connected therewith, spring supported armature for the magnet, having a slot adapted to receive the ends of the crank arm alternately and a spring partly filling the slot and engaging the ends to prevent their recoil.

512,949. CONNECTOR FOR ELECTRIC WIRES; E. H. Munson, New Britain, Conn. Application filed May 9, 1892. This comprises a shell adapted to be secured to one end of one wire, a plug secured to the other end of the other wire and adapted to fit closely within the open end of the shell and having a soft packing for sealing the open end, the ends of the two wires being electrically connected within the shell.

512,950. INSULATED RAIL CHAIR; L. McCarthy, Boston, Mass.

Application filed Sept. 27, 1892. The combination with an insulated rail chair of cheek-pieces extended laterally and provided with a skirt or overhang.

513,951. INCANDESCENT LAMP SOCKET; James McFarlane and William Burgess Edgar, Glasgow, Scotland. Application filed March 31, 1893. In a switch for incandescent electric lamp sockets, the combination of the insulated base formed with the openings, the key and piston fitting in said openings, the bent contact spring carried by said piston and the spiral spring surrounding said contact spring, substantially as shown and described.

513,956. ANNUNCIATOR; F. W. Ross, Boston, Mass. Application filed Oct. 6, 1893. This comprises a single helix having a sliding armature core and mounted vertically upon a face-plate; an unequally balanced lever carried upon a spindle and having a ratchet adapting it to be tripped by the core; a sleeve attached to the face-plate and a spindle within the same, one end carrying the lever and an index finger carried upon the opposite end of the spindle.

513,960. AUTOMATIC TELEPHONE SWITCH; A. C. Wheat, Chicago, Ill. Application filed June 5, 1893. This comprises a pivoted lever having compartment receptacles, insulated end pieces, terminals, and a conducting substance placed within the compartments and adapted to be shifted therein.

U. S. PATENTS ISSUED FEB. 6, 1894.

513,975. INDUCTIVE MECHANISM FOR ELECTROSTATIC INSTRUMENTS; W. E. Ayton and T. Mather, London, England. Application filed May 1, 1893. The combination of a skeleton needle and curved fixed sheet inductors, embracing both faces of the needle peripheries.

513,982. ELECTRIC CONDUCTOR; H. F. Chick, Watertown, Mass. Application filed May 1, 1893. This consists of one or more insulated conducting strands or wire, a braided fibrous jacket enveloping the same, and a braided wire protecting jacket.

514,018. CUT-OUT BLOCK; E. J. McEvoy, New York, N. Y. Application filed July 29, 1893. This comprises a block adapted to receive the main wires, contact plates mounted on the block, hooks adapted to engage projections on the plates, a cap block and cap wire terminals mounted in the cap block.

514,019. CIRCUIT CONTROLLER; E. J. McEvoy, New York, N. Y. Application filed Aug. 31, 1893. This consists of a rotatable shaft, mounted in a box and adapted to close and open a circuit when a door is opened or closed.

514,030. LOAD GOVERNOR FOR ELECTRIC CURRENTS; F. E. Pritchard, Oswego, N. Y. Application filed Nov. 19, 1891. This consists of a resistance coil adapted to be connected with the conductors as the load is decreased.

514,047. DYNAMO AND MOTOR; M. Waddell, Bridgeport, Conn. Application filed March 13, 1893. This comprises two conducting rings insulated from each other, commutator brushes carried by the rings, and a spider for supporting the rings.

514,056. CONDUIT ELECTRIC RAILWAY; R. C. Beardsley, Lafayette, Ind. Application filed Jan. 28, 1893. The combination of a slotted conduit and switch boxes arranged alongside the same, switches in the boxes, movable parts of which project into the conduit, and removable covers for the boxes, upon which a portion of the switches is mounted.

514,057. HOOD FOR ELECTRIC ARC LAMPS; S. Bergmann, New York, N. Y. Application filed Jan. 10, 1893. A hood having its upper part provided with a depending flange and its lower part arranged to fit into the same, the two parts being held together by screws.

514,058. ELECTRIC ARC LIGHT FIXTURE; S. Bergmann, New York, N. Y. Application filed Jan. 10, 1893. A removable lower carbon holder provided with an ash pan or dust receptacle.

514,075. ELECTRICAL MEASURING OR INDICATING INSTRUMENT; S. E. Hitt, Rockford, Ill. Application filed April 7, 1893. A measuring instrument arranged with a spherical magnetic shield entirely surrounding the same.

514,077. ELECTRIC MOTOR; J. D. Ihlder, Yonkers, N. Y. Application filed Sept. 29, 1893. A compound wound motor having a shunt field magnet coil connected to the terminals of the supply circuit, a series field magnet included in the armature circuit and a resistance arranged in parallel with the series field magnet circuits.

514,078. ELECTRIC ELEVATOR MOTOR; J. D. Ihlder, Yonkers, N. Y. Application filed Sept. 29, 1893. A compound wound motor having means for reversing the current in a portion of a series field magnet coil in one or more sections included in the armature circuit.

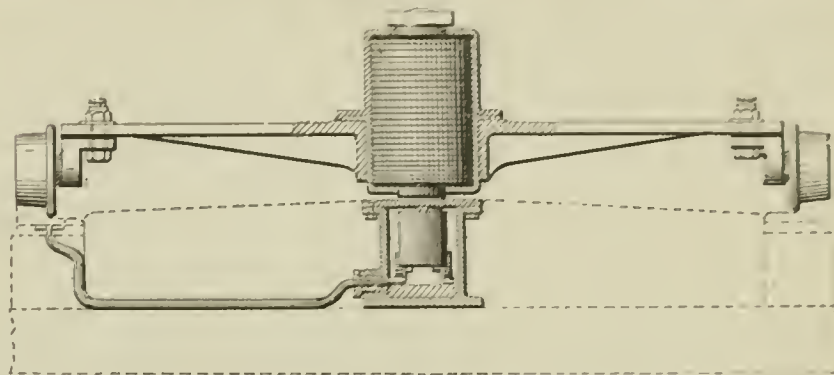
514,083. DEVICE FOR PREVENTING RAILWAY COLLISIONS; G. F. Klaffky and F. Faltinowsky, New York, N. Y. Application filed Nov. 3, 1893. This comprises a disc fixed on the throttle valve to turn therewith, a mutilated worm wheel on the valve stem and a motor adapted to operate the same.

514,109. ELECTRIC CAR TRUCK; C. F. Winkler, Kingston, N. Y. Application filed May 22, 1893. The combination of a motor having two armatures and a single field magnet, two axles geared respectively to the armatures and a flexible connection between each armature and its corresponding axle.

514,112. CLOSED CONDUIT ELECTRIC RAILWAY; F. M. Ashley, Hawthorne, N. J. Application filed Dec. 23, 1892. The combination of two abutting ends of rails, the ends being provided with openings leading to a drain.

514,113. ELECTRIC RAILWAY; F. M. Ashley, Hawthorne, N. J. Application filed Dec. 23, 1892. The combination of two sections of a trolley wire and a hanger located at a joint between them, the hanger consisting of plates, insulating block, collar and hook.

514,114. ELECTRIC RAILWAY CONDUIT; F. M. Ashley, Hawthorne, N. J. Application filed Dec. 23, 1892. This comprises a conduit divided into two compartments in the same horizontal



NO. 514,112.—CLOSED CONDUIT ELECTRIC RAILWAY.

plane, one closed and the other open, a traveling switch moving in the former, and rails located above and below the switch upon which it runs, one of the rails being sectional, and a sectional conductor located in the open compartment.

514,115. ELECTRIC BATTERY; F. Bayer, New York, N. Y. Application filed Aug. 24, 1893. In a positive electrode the combination of a central insulated rod and insulated cup containing mercury on its lower end and blocks of zinc strung on the rod, the lower block lying in the mercury.

514,120. ELECTRIC RAILWAY; O. A. Enholm, New York, N. Y. Application filed Oct. 3, 1892. This comprises a conduit divided into a closed and an open compartment, a circuit controller running in the sealed compartment, a collector running in the open compartment and electromagnetic apparatus carried with the collector and controlling the movements of the circuit controller.

514,128. SIGNALING SYSTEM; J. G. Noyes and L. Winterhalter, Milford, Conn. Application filed July 3, 1893. This comprises a want wheel and a locality wheel, each manipulating a separate circuit to a central station, and a cut-out device controlled by the movement of the want wheel operating to cut out the locality wheel until the want wheel has sent in its signal.

514,131. ELECTRIC METER; C. Raab, Kaise, Slautern, Germany. Application filed Jan. 21, 1893. A motor meter having an armature lying in shunt, and consisting of solenoids, solenoids comprising the magnetic field, and a damping disc.

514,133. UNDERGROUND ELECTRIC CONDUCTOR; H. A. Seymour, Washington, D. C. Application filed Aug. 30, 1890. This consists in inclosing the main conductor in a yielding envelope of insulating material and providing the lower portion of the envelope with conducting devices adapted to be forced into contact with the main conductor by the pressure of a trolley wheel against it.

514,134. CLOSED CONDUIT FOR ELECTRIC RAILWAYS; H. A. Seymour, Washington, D. C. Application filed Aug. 29, 1892. This comprises a conductor secured to the under side of an inverted shell, a flexible water-tight diaphragm secured to the under side of the shell and electric conducting contacts attached to the diaphragm.

514,136. MOTOR CONTROLLING DEVICE FOR ELECTRIC LOCOMOTIVES; S. H. Short, Cleveland, Ohio. Application filed Jan. 6, 1890. This comprises two operating shafts and switches connected therewith for reversing the motion or rotation of the motor and varying its speed.

514,139. ELECTRIC ARC LAMP; G. G. Wagner, New York, N. Y. Application filed Nov. 15, 1892. This comprises a fixed carbon holder attached to a vertical shaft connected to a train of gearing, and a single solenoid coil extending through two solenoid coils, one of which is in circuit with the carbons and the other in shunt circuit.

514,140. ALTERNATING DYNAMO; J. J. Wood, Fort Wayne, Ind. Application filed June 20, 1893. The combination with the field magnet poles and coils of a pair of U-shaped plates fastened against the front and back of the poles, with their legs extending along the sides thereof to support the coils.

514,146. ORGAN; R. Hope-Jones, Birkenhead, England. Application filed Aug. 8, 1892. The combination with the electrical connections of a keyboard of a compound switchboard, whereby the connections with the keyboard can be changed one or more half notes.

514,150. COMMUTATOR BRUSH; J. F. Kester, Buffalo, N. Y. Application filed Nov. 23, 1893. A lubricator leaf for commutator brushes provided with interstices filled with a lubricating material composed principally of beeswax.

514,167. ELECTRICAL CONDUCTOR; N. Tesla, New York, N. Y. Application filed Jan. 2, 1892. A conductor composed of a wire for carrying the current, an insulated coating or covering and a surrounding conducting sheath or screen divided into insulated sections.

514,168. MEANS FOR GENERATING ELECTRIC CURRENTS;

N. Tesla, New York, N. Y. Application filed Aug. 2, 1893. The combination with discharge points immersed in oil of a conductor adapted to periodically bridge the space between such points.

514,170. INCANDESCENT ELECTRIC LIGHT; N. Tesla, New York, N. Y. Application filed Jan. 2, 1892. The combination of an exhausted globe, a refractory light-giving body therein, a conductor leading into the globe and connected to or supporting the body, and a conducting screen surrounding the conductor.

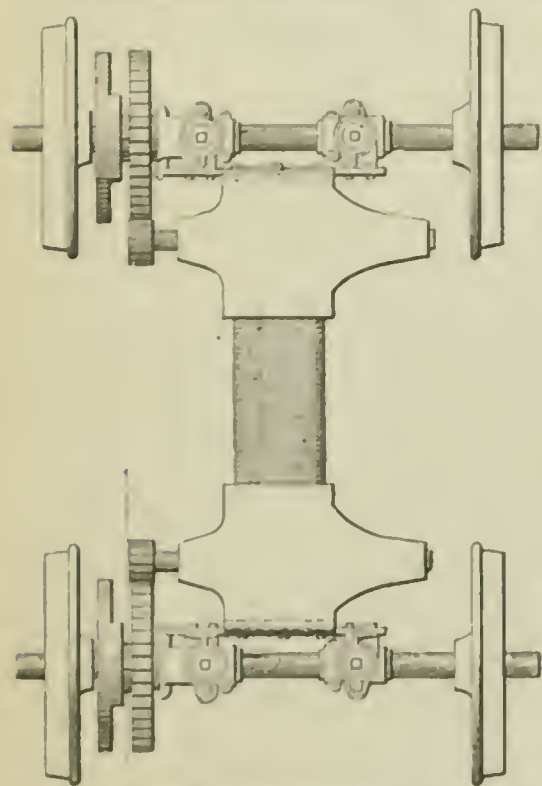
514,202. ELECTRIC ALARM; F. Sauer and C. Hentzschel, Berlin, Germany. Application filed July 8, 1892. This consists of a spring pressed lever normally kept out of contact with the two poles of an electric circuit by a bolt of a lock when the latter is in position in the striking plate.

514,212. ELECTRIC SIGNALING DEVICE; J. N. Connolly, New York, N. Y. Application filed Nov. 9, 1893. This consists of a box upon which is mounted signaling apparatus, provided on one side with an opening to receive the centre post of a bell-pulling outfit and means for locking the box in position on the post.

514,221. INSULATOR; L. B. Gray, Boston, Mass. Application filed June 22, 1893. This comprises a main section having a petticoat and shoulder, and a supplemental section entering the recess formed by the petticoat and abutting against the shoulder.

514,228. ELECTRICAL TRANSMISSION OF POWER; R. M. Hunter, Philadelphia, Pa. Application filed Nov. 18, 1889. This comprises a generator of alternately increasing and diminishing potential, line circuits, a secondary coil having its fine wire coil in a local circuit, a movable soft iron core for the coil, and means to insert or remove the same.

514,229. ELECTRIC ARC LAMP; R. M. Hunter, Philadelphia, Pa. Application filed May 9, 1893. This comprises a frame having



NO. 514,109.—ELECTRIC CAR TRUCK.

tubular guides, supporting rods guided therein and carrying at one end a condenser lens, means to adjust the guide rods upon the tubular guides, and a lamp proper supported upon the frame and adapted to produce an arc at a fixed distance from the condenser.

514,241. MAGNETO ELECTRIC MACHINE; A. J. Potter, New Hartford, N. Y. Application filed June 15, 1893. This comprises a rotating shaft and vibratory pinion engaging with another pinion fixed to the shaft and connected with an operating switching plate moved by the forward rotation of the shaft.

514,258. TEMPERATURE COMPENSATING DEVICE; W. H. Bristol, Hoboken, N. J. Application filed Oct. 31, 1893. The combination with a resistance of a thermometer and a metallic device secured thereto and arranged in contact with the resistance for varying the length of the resistance wire.

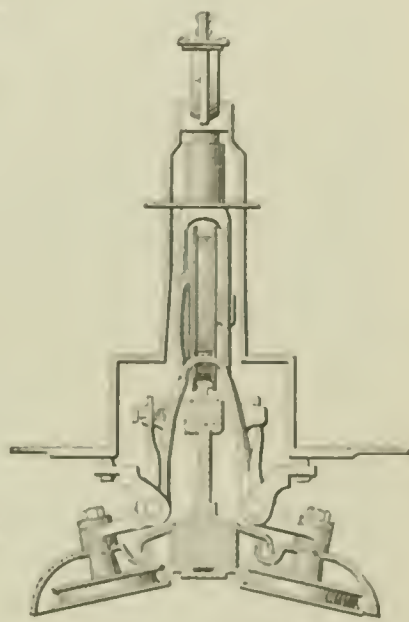
514,260. SECONDARY BATTERY; H. H. Carpenter, St. Louis, Mo. Application filed Dec. 21, 1892. This consists of a bare copper wire located in a lead pipe, the pipe being devoid of active material and having one of its ends sealed to prevent entrance of the electrolytic fluid, and the pipe being coiled.

514,267. ELECTRODE FOR SECONDARY BATTERIES; J. Legay and L. Legay, Levallois, France. Application filed Oct. 13, 1890. An electrode composed of spirally twisted wires twisted together in the form of a cable.

514,274. ELECTRIC TROLLEY WHEEL SHIELD; H. S. Pruyn, Hoosick Falls, N. Y. Application filed May 10, 1893. A trolley wheel provided with a guttered shield.

514,279. AUXILIARY FIRE ALARM TELEGRAPH; J. Sachs, New York, N. Y. Application filed April 20, 1893. The combination with a main and a duplicate or auxiliary signal mechanism of a small wire in an electric circuit to prevent the duplicate mechanism from operating until released by the melting of a small wire.

514,297. SIGNALING APPARATUS; E. R. Wilder, New York, N. Y. Application filed May 1, 1893. A signal tape having the



NO. 514,274.—ELECTRIC TROLLEY WHEEL SHIELD.

signals embossed therein, in combination with a circuit closer moved by contact with the embossed surface and a bolster to hold up the embossed portions while acting on the circuit closer.

514,301. RHESOTAT; J. T. Birch, Pittsburgh, Pa. Application filed Nov. 16, 1893. The combination of two rotatable wire helices, the members of the coils of the helices being insulated from each other, and a contact plate movable along the helices while in electrical contact therewith.

514,303. SERIES ELECTRIC RAILWAY; M. A. Cattori, Rome, Italy. Application filed May 18, 1893. This comprises a movable conducting piece located at the point of intersection of the tracks and adapted to be brought in line with the conductor of either track, electric connections between the opposite sections of each conductor adjacent to the crossing point and means for electrically connecting the movable conducting piece with that conductor, which is brought in line.

514,304. INSULATED PIPE COUPLING; E. E. Clift, Philadelphia, Pa. Application filed Oct. 10, 1892. This comprises a casing, a block of non-conducting material therein, an electrolier, a threaded stem thereon extending up through the block, a nut on the stem resting in a recess in the block, with cement between the walls of the recess and the nut.

514,305. ELECTROLIER; E. E. Clift, Philadelphia, Pa. Application filed July 1, 1891. This comprises a coupling having a slot therein, a wire, spring arms adapted to the wire, and a sleeve having a struck-up piece securing the arms to the wire.

514,325. INSTRUMENT FOR MEASURING AND REGULATING ELECTRICAL RESISTANCES; G. B. Lawrason, New Orleans, La. Application filed June 13, 1893. This comprises a rotatable non-conducting cylinder and a conducting rod composed of two aligned but insulated parts.

514,353. TROLLEY WIRE SHIELD; L. Eschner, Philadelphia, Pa. Application filed April 20, 1892. This comprises an open bottomed shield inclosing the conductor, and having mounted on its inside an insulating block supporting the conductor, and a feed wire also supported on the insulating block.

514,361. AUTOMATIC ELECTRIC FIRE ALARM; W. A. Guthrie, Durham, N. C. Application filed Aug. 19, 1893. This comprises a weight suspended by a wire of fusible alloy adapted to fall and make contact with a plate to complete an electric circuit when the wire is melted.

514,362. FIRE ALARM AND SPRINKLER; W. A. Guthrie, Durham, N. C. Application filed Oct. 17, 1893. This comprises a sprinkler cock controlled by a lever suspended by a fusible wire and adapted to open the cock and ring an electric bell when the wire is melted.

514,398. ELECTRIC SIGNALING APPARATUS FOR RAILWAYS; E. C. Wiley, Bristol, Tenn. Application filed May 11, 1893. This comprises a housing having lugs and contacts within the same, and a rail plate with an adjustable flange and lugs.

514,417. GLOBE HOLDER FOR ARC LAMPS; J. T. Dempster, Summit, N. J. Application filed Feb. 13, 1893. The combination with the lower lamp frame, provided with a projection, a globe holder provided with a longitudinal groove to co-operate with the projection, and a clamping screw to clamp the globe holder in any desired position.

514,425. ELECTRIC ARC LAMP; W. B. Luce, Brooklyn, N. Y. Application filed March 16, 1893. This comprises a rotary friction part, operatively connected with the upper carbon, a brake to act on the same, a solenoid in shunt circuit having a core which coacts with the brake, an electric magnet in the main circuit, an armature for the magnet normally held away from the same and coacting with the brake device, whereby the brake is held off the rotary part and a lower carbon connected with the armature.

514,429. REGULATOR FOR ELECTRIC MOTORS; S. H. Short, Cleveland, Ohio. Application filed Jan. 26, 1891. The combination with the axes of a car of a multipolar motor connected with each axle, of two commutating switches for connecting the coils of different field magnets in multiple or in series, the switches being inclosed in separate casings and insulated from each other, and a pulley applied to the insulated connection for simultaneously actuating both switches.

U. S. PATENTS EXPIRED JAN. 30, 1894.

186,755. MAGNETIC HOLDERS FOR FEEDING SCREW AND OTHER BLANKS; E. E. Quinby, Orange, N. J. Filed Oct. 20, 1876. This comprises a magnet and a divided armature and a detachable clamp for the purpose of mechanically maintaining the contact of the poles of the magnet with the soft iron pieces composing the divided armature.

186,787. ELECTRIC TELEGRAPHY; A. G. Bell, Boston, Mass. Filed Jan. 15, 1877. In a system of electric telegraphy or telephony, consisting of transmitting and receiving instruments united upon an electric circuit, the production in the armature of each receiving instrument of any given motion by subjecting said armature to an attraction varying in intensity, however such variation may be produced in the magnet, and hence I claim the production of any given sound or sounds from the armature of the receiving instrument, by subjecting said armature to an attraction varying in intensity, in such manner as to throw the armature into that form of vibration that characterizes the given sound or sounds.

186,887. FIRE AND POLICE ALARM SIGNAL APPARATUS; C. Selden, Cincinnati, Ohio. Filed May 26, 1876. This comprises a loop circuit and a secondary battery, a resistance and bell relay, the whole connected together.

The Electrical World.

Vol. XXIII.

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1880 contained 25 different adv'ts.	1887 contained 154 different adv'ts.
1881 " 28 " "	1888 " 175 " "
1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 289 " "
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ENGLISH ANTICIPATIONS.

In an otherwise able and interesting paper, descriptive of the electrical industry in the United States, Mr. Preece, of London, makes the following remark, in referring to the World's Fair: "The American public were surprised to find how much we had anticipated their work." We would be interested to know who those Americans were who expressed surprise at the supposed English anticipations, and also what those alleged anticipations were. We can think of only one, and that is the holding of exhibitions, as there were doubtless exhibitions in London before Columbus arrived here, and we do not think the American Indians held any. Probably Mr. Preece's sweeping statement was based on a passing flattering remark made by some Anglomaniac to tickle the vanity of an Englishman.

ECONOMY VS. VANDALISM.

Secretary Carlisle has written a letter to Speaker Crisp recommending that in the interest of economy the electric lighting of the Statue of Liberty, in New York Harbor, be discontinued, claiming that by this means the munificent sum of \$9,251 can be annually saved to the government; from which we infer that the epidemic of "peanut politics" has extended from the Senate to the Treasury Department. The apology that the light is no aid to navigation is disputed by mariners, but aside from this there can be no excuse for this puerile attempt to sacrifice one of the objects of the statue in order to save an amount that could, perhaps, be easily economized in the Secretary's own office. Since the Light House Board has joined in this recommendation, it might be well for the New York Congressmen to see if the necessary funds to continue the lighting of the statue might not be economized from the salaries of the officials of this Board.

FORMULAS FOR RESISTANCE COILS.

The formulas and tables given by Mr. Gustav Rennerfeldt in another column will be found in some cases useful for the speedy calculation of resistance coils and the comparison of different materials used for this purpose. The calculations are only for resistance wires, the entire surface of which is exposed and different parts not in contact, so that they would not apply to coils wound in layers on bobbins. The results arrived at are interesting, as it is shown that under the conditions given the weight of different substances having the same resistance in ohms necessary to carry a given current with a given temperature limit are in the proportion, if wires of circular cross-section are used, of 6.53 for copper, 10.5 for iron, 13.5 for German silver and only 2.37 for aluminium, which would make an aluminium coil cheaper than one of German silver and only about twice as dear as one of copper.

MULTIPHASE MOTORS.

In another column we publish a translation from the "Elektrotechnische Zeitschrift" of an important article by Mr. C. P. Steinmetz on multiphase motors. As will be seen, the author makes most sweeping statements, many of which are not in accordance with current opinions. For example, it is stated that multiphase motors can be built equally well and with the same efficiency for 130 as for 30 periods: that variations in speed can be made as wished without affecting the

other properties of the motor; that such motors can be calculated with greater accuracy than even continuous-current motors, and that the starting torque can be even made two or three times as great per watt as at full speed. The criticism of present mathematical theories is also severe. Instead of the self-induction of the armature being made as high as possible, as held, the reverse should be the case, it is stated, while hysteresis has also been improperly assigned a wrong function. The historical resume will be found interesting, as it shows that the principle of the rotary magnetic field was described by Walter Baily in 1879, and points out that multiphase generators were made in 1879 and before. To the list given might have been added the Gramme dynamos, made at the same period as an attempted solution of the problem then popularly referred to as the "sub-division of the electric light." While the opinions expressed by Mr. Steinmetz are in some respects radical, and will probably give rise to discussion, his opportunities have been such as to render him peculiarly qualified to speak on the subject, and there is no doubt of his ability to abundantly defend his statements.

THE SENATE AND THE TARIFF BILL.

We believe we echo the opinion of every one connected with the electrical industries, regardless of their individual opinions as to the economic merits of the measure, when we ask that the United States Senate shall take speedy action, one way or the other, on the tariff bill now before it for consideration, and not repeat the performances connected with the passage of the silver bill, which were as disastrous to the business interests of the country as they were to the prestige of the Senate. During the period when that body was engaged in its extraordinary proceedings over the silver bill, when weeks were wasted in order that the social feature called the "Courtesy of the Senate" might be preserved, business almost came to a standstill, factories remained closed and tens of thousands of people suffered for the necessities of life—all that the Senate might retain its character of what has not inaptly been called "the millionaires' club." As soon as the silver bill passed business at once revived, and were it not for the necessity of awaiting the fate of the tariff bill now before the Senate and, above all, the general distrust of that body and fear that it will again waste months in another unseemly wrangle, the near future would have nothing to fear. The outlook for the spring and summer is bright. The effect of the business depression has been to place the electrical industries on a firm basis. The stocks of manufacturers are low and the deferred needs of consumers large. The number of projects for new street railway, lighting and power plants is very large, as our news columns for the last two months will testify, and if the uncertainty in regard to the measure now before the Senate were removed, electrical business would probably be affected to an extent that would amount to little less than a "boom." As a consequence we trust that the Senate will this time act more in accordance with the traditions of that once famous body, and by speedy action relieve the present uncertainty and thus enable the business interests of the country to again adjust themselves on a permanent basis.

MISDIRECTED ZEAL.

One of our contemporaries in a series of articles on telephone patents seems to be needlessly subservient to a powerful interest, which probably little relishes the special pleading in its favor in view of the antagonism likely to be aroused through it. The American Bell Telephone Company has always been frank in its business methods, and its more recent action in regard to selling telephones was a notice to the public that its policy is to rest content with a legitimate manufacturing profit on its apparatus upon the expiration of the patents covering them. With its accumu-

lated technical knowledge and great manufacturing facilities it does not fear competition, and therefore is probably not grateful for an advocacy that places it in the light of a monopoly that will brook no rivalry, however legitimate, and one seeking to deter this competition by covert threats. In these articles the intending competitor is informed that the "Bell company should unquestionably be able to make by far the best telephone receivers, through their ability, acquired by long practice, to produce a compound steel magnet of surpassing strength and durability—a perfectly legitimate claim if made by the Bell company itself, but scarcely so coming from a presumably disinterested source, and in regard to a constructional feature that is generally not thought to involve the superlative skill implied. Perhaps the claim that the Edison transmitter patent has not expired is merely due to ignorance, which, however, would be dense indeed in view of the unbroken series of decisions in favor of the principle upon which its invalidity is based and the weakness of an appeal, which, after over ten years' application of the principle, is only now being pressed to a final decision. The manufacturers of telephone apparatus are informed that if they "will only be as careful and as conscientious in respecting existing telephone patents as are the American Bell Telephone Company and the Western Electric Company, the future of the telephone business in this country will indeed be bright." As the companies named have been supposed to hold the fundamental patents relating to telephony, it will probably occur to the reader that it would have been difficult for them to find an opportunity to infringe, and as the articles in question leave little hope to the intending competitor as to the future, the conclusion he will probably draw is that the advice quoted merely conceals a threat directed at him. The interests so fulsomely lauded are amply able to take care of themselves, and, as remarked before, probably little relish the obsequency of which they are made the object, particularly with a recollection of the sequel to similar conduct in the case of the General Electric Company.

Trolley Balloons.

In a recent issue of *The Electrical World* attention was called to a novel system of electrical propulsion, which is to form one of the attractions at the exhibition at Antwerp this year. It consists of a balloon, which is to be driven by an electric motor of 125 h. p., the current for which is to be taken from an overhead conductor by means of a traveling trolley. The balloon is to carry passengers to and from the exhibition. It is no more than just to Americans to call attention to the fact that the original invention was made in this country, as the system was described by its inventor, Dr. W. G. A. Bonwill, of Philadelphia, in a paper read before the Franklin Institute Dec. 16, 1891, a copy of which has been submitted to us.

Municipal Electric Lighting.

Under the auspices of the Philadelphia Nationalist Club a petition is being circulated in Philadelphia asking councils to establish an electric light and power plant, to be owned and operated by the municipality. In the address to the people which accompanies the petition, it is argued that the city of Philadelphia could very advantageously establish a complete electric plant for its own purposes, from which it could light all streets and public buildings at far less cost than the city now pays to private companies for the same service. It could also furnish electric lighting for all private parties desiring it for mercantile and manufacturing establishments and dwellings at a comparatively small cost, and yet with a moderate profit, and electric power for light manufacturing purposes, running sewing machines, &c., the present prices being practically prohibitive in this respect.

Multi-Frequency Machines.

To the Editor of The Electrical World :

Sir—Mr. Arnold's note in your last issue concerning the multi-frequency machine has come to my attention. It deserves notice because there seems to be so much hasty writing of the sort among inventors of standing—writing that leaves the impression that priority of invention is a personal question, rather than one for proper courts of jurisdiction.

Absolute knowledge of priority does not justify the assumption that another inventor may not have independently invented the same thing. It would seem to be so in the present case, for I had no previous knowledge of Mr. Arnold's work. The assertion that I copied his machine is not warranted by the facts in evidence, and I think a little hasty charity might well be mixed with the hasty judgment used in such matters.

New York, Feb. 17, 1894.

F. JARVIS PATTEN.

A Service of Good Will for the Electrical Fraternity.

To the Editor of The Electrical World :

Sir—Kindly inform your readers that I will be very glad to oblige any of them in such ways as may be by them desired to make their attendance at the convention of the National Electric Light Association, to be held in this city February 27 and 28 and March 1, enjoyable. It may be especially serviceable to some to have arrangements made for hotel accommodations, for printing cards, circulars, etc., before their arrival. If so, I shall be glad to attend to these and similar matters for them, as an expression of my good faith.

I should be addressed as follows: Allen R. Foote, care the National Statistical Association, Washington Loan and Trust Company Building, Washington, D. C.

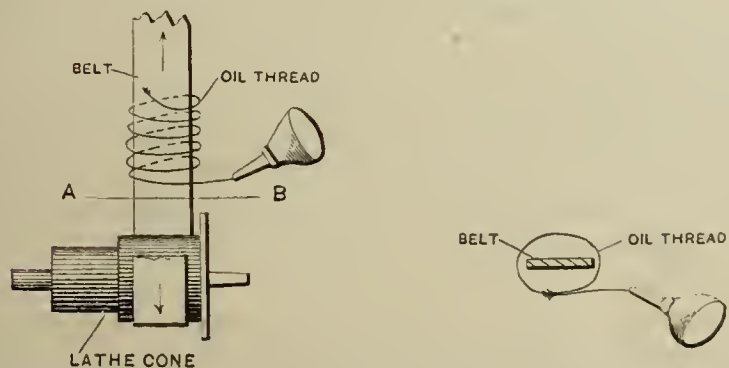
ALLEN R. FOOTE.

A Current Without a Difference of Potential.

BY OLIVER B. FINN.

The articles on "A Current Without a Difference of Potential," recently noted in The Electrical World, recall an interesting phenomenon, bearing somewhat on the subject, observed a few years ago while studying at the University of Pennsylvania.

On a cold, dry day, while oiling some machinery, the nozzle of an inverted oil can was brought within two or three inches of the ascending portion of the driving belt near the pulley, when a very fine thread of oil was drawn from it horizontally toward the belt and up around it spirally, making about six turns. The free end of the thread was dissipated in the form of a spray, and the flow was continuous for some moments.



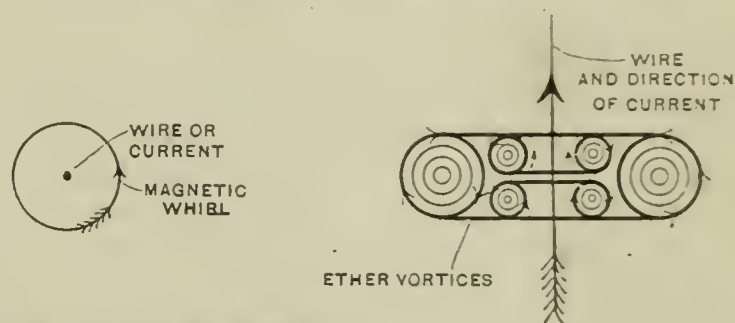
ELEVATION OF CONE AND BELT. SECTION THROUGH BELT AT A B.

As is well known, on a cold, dry day, quite a long spark can be taken from that portion of a belt leaving a flywheel or pulley. This, of course, is static electricity. And is not this static electricity traveling with the belt, a current of electricity, i. e., electricity moving relatively to everything

but the belt which conveys it, or a current by convection, instead of conduction, absolutely without a difference of potential? There is no E. M. F. causing flow, and none caused by "an increasing flux." But the charge is gradually dissipated by air convection.

I explained the drawing out of the oil thread to be due to the attraction of the static electricity on the belt for the induced charge of opposite sign on the oil at the nozzle of the can, but was puzzled to know why the oil did not go to instead of going spirally around the belt. The air current due to the movement of the belt would tend to make the oil rise. But was the circular path of the oil caused by the magnetic lines of force which encircled this, paradoxically speaking, current of static electricity? Of course the moving of the charged thread of oil produced a second static current, which should have its magnetic lines of force, the planes of which, in this instance, would be presented at right angles to those of the first. Of the two forces in equilibrium, to produce the circular path, assuming the centripetal to be the attraction of the electricities of opposite sign, what constituted the initial centrifugal force? What prevented the oil going directly to the belt, but forced it to take the circular path around it? Can this be explained by the laws of the magnetic influence of currents upon one another?

Does not this phenomenon indicate that two currents, flowing at angles to one another, first simply tend to direct one another into parallel planes, and until this position is reached resist attraction? If this is so, then does not this indicate that the lines of force encircling a wire carrying a current are probably not whirls around the wire in a plane at right angles to it, as indicated in the accompanying plan sketch, but that they are ether vortices, as shown in the sectional



ELEVATION OF ETHER VORTEX FORMED BY A PLAN OF LINE OF FORCE PERPENDICULAR AS- CENDING CURRENT.

elevation; that whatever electricity is, its passage through the ether causes ether vortices, each cylindrical enveloping tier causing another tier of large vortices to envelop it, and so on, until the outside vortices are too feeble to generate others? And cannot all the laws of electromagnetic induction and attraction be explained by this hypothesis of ether vortices?

The Boynton Bicycle Railroad.

An exhibition was given of the Boynton Bicycle Railroad between Hagerman Station and the Great South Bay, at Bellport, L. I., on the 16th, which was witnessed by 27 members of the Massachusetts Legislature, including the members of the Senate Transit Committee, the Senate Committee on Street Railways and the House Committee on Transit. In addition to the above there were about 100 prominent railroad men from different parts of the United States, as well as a large press representation. They were entertained by Mr. Dunton, a nephew of Austin Corbin, who is president of the company, and by Mr. Boynton, the inventor. The system was fully described in The Electrical World of April 15, 1893. The road is two miles long, but in that short distance a speed of over 50 miles an hour was obtained. Mr. Boynton explained the details to those present, and Mr. Dunton delivered an address, pointing out the commercial features.

A Modified Instrument for the Determination of the $\mathfrak{B}$ $\mathfrak{H}$ Curves of Iron.

BY LEWIS T. ROBINSON.



THE writer has had in mind for some time an instrument by which the $\mathfrak{B}$ $\mathfrak{H}$ curves of iron samples could be easily and quickly obtained without troublesome calculation, the use of standard bars or a ballistic galvanometer, and which would be, when once calibrated, direct reading in C. G. S. units of both $\mathfrak{B}$ and $\mathfrak{H}$.

Prof. Ewing's "magnetic curve tracer" accomplishes this result, but is hardly suitable for workshop use. Mr. Kennelly's instrument, recently described in *The Electrical World*, is commercial, but is not direct reading, requires standard bars of iron and some interpolation between readings. The proposed instrument is identical in principle with the $\mathfrak{B}$ part of Prof. Ewing's device, save that the stretched wire and mirror arrangement is replaced by a D'Arsonval coil, suspended in a gap in the main circuit and carrying a constant current. Measurements are taken of the magnetic flux by its action on this coil.

Suppose we make a yoke piece of good annealed iron, provided with suitable clamps on its ends, by which the test bar can be attached, completing the magnetic circuit of the yoke, and that we surround the bar with a number of turns of wire per unit of length equal to some convenient multiple of 4π . We can then read $\mathfrak{H}$ directly from the ammeter in circuit with this coil, or at any rate the readings can be readily converted into $\mathfrak{H}$ values mentally and written down or plotted as such at once.

To observe $\mathfrak{B}$ let us cut our yoke piece, at the same time broadening the surfaces of the gap, until the permeance of the same is several times that of the sample to be tested at its highest value. We must now introduce into this gap something by which we can measure the entire number of magnetic lines passing across it, or a constant portion of them. For this purpose we will use a D'Arsonval coil, carrying a constant current and held at zero by a small torsion wire or a light spring. The coil, of course, is to be of such number of turns and carrying such a current as will allow it to become deflected over its entire scale with such a number of lines as will be developed by the samples to be tested.

Referring to the sketch, which is simply a diagram, and no attempt at a dimension drawing,

- Y Y is the soft iron yoke;
- I , sample to be tested;
- T , the winding on the same;
- A , ammeter in the circuit with T ;
- C , the suspended coil;
- R , resistance in circuit with it;
- B , the storage or other cell for furnishing the current to C ;
- G , a galvanometer;
- S , a standard cell.

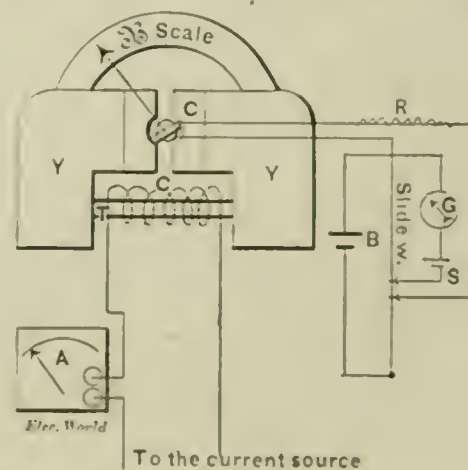
If our bars have an area of, say, 1-2 square centimetre, we can produce with the poorest iron we would be likely to test about 5,000 lines, and if in order to make our gap of great comparative permeance we are obliged to allow only 1-20 or less of these lines to be influential in moving the coil, this number will be sufficient to deflect a coil carrying a small current through its entire range.

Presuming that we can secure an arrangement of coil and field such that the angular movement of the coil is proportional to the number of lines developed in the sample, we can then number this uniform scale in such a way as to be readable as $\mathfrak{B}$ values in the sample directly. If we do not secure this result, we can easily graduate a scale to suit the instrument.

To graduate the instrument, let us assume, in the first place, that we can calculate the permeance of the gap and contacts with sufficient accuracy for our purpose, which accuracy need not be great, as the quantity in question will be very large in comparison with the permeance of the bar. We will place the bar to be tested, surrounded by a coil of, say, 79.5 turns, and over this again a secondary of a suitable number of turns to use in observing the $\mathfrak{B}$ in the bar with a ballistic galvanometer; obtaining this value, we can adjust the current in the suspended coil until we obtain a corresponding reading on the scale of the instrument. We can repeat this test at as many points of the scale as we see fit, thus calibrating it for future use.

From the instrument thus standardized we can obtain the necessary values to determine the permeability of the samples to be tested by applying a correction for the effect of the joints and the gap. We can make this correction small and of such value numerically that the results can be mentally corrected and give the values belonging to the sample alone.

In case we would prefer to determine, rather than calculate, the influence of the gap, we can proceed to graduate the instrument by means of a bar of a known quality of iron, retaining the coil for ballistic connection used before, thus testing the bar in and out of the machine, determining the influence of the gap and at the same time calibrating the scale. This would probably be the best method to use, and we would prepare a ring and bar from cast iron poured



INSTRUMENT FOR DETERMINATION OF B H CURVES.

from the same ladle, test the ring by the usual methods and be reasonably sure of having determined the quality of the bar also.

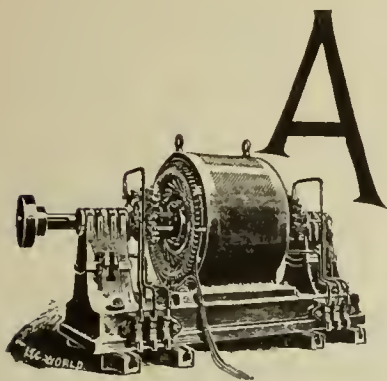
The only troublesome thing about using the instrument apparent at first sight is the maintaining of a constant current in the moving coil. A well cared for Daniell's cell would probably remain constant enough in E. M. F. to be used for this purpose; or, if this is not sufficiently reliable, the arrangement shown in the diagram could be made use of; the terminals of the moving coil circuit are applied to a slide wire joining the poles of a small storage cell, to which is attached a Clark cell in the circuit of a galvanometer. By this means a voltage capable of accurate adjustment and determination can be used.

In taking tests with the instrument the resistance of the circuit containing the moving coil can be made even parts or multiples of that required to read the values marked on the scale, thus allowing us to use the instrument with a deflection easily read and as easily converted into absolute units.

The instrument is also suitable for the determination of the hysteresis of the samples, although this property of iron, which could be readily prepared in bar form, is of little importance in commercial work. In case strips of sheet iron can be attached to the clamps in such a manner as to give good contact with the yoke, satisfactory results might be obtained. The writer hopes to construct one of these instruments soon, and to find the same both convenient and satisfactory in its operation. Once standardized, it should re-

main constant as long as any sort of test instrument and give results of sufficient accuracy for all purposes in which the magnetic properties of iron are made use of commercially.

Multiphase Motors.



AN interesting article by Charles P. Steinmetz on "Multiphase Motors" is published in the "Elektrotechnische Zeitschrift," Jan. 23. As it appears to be of an eminently practical character and differs from most of the theoretical articles which have been published recently in foreign papers, we have here abstracted a number of

the most important parts.

The paper deals with the history, the theory and the construction of multiphase motors, more especially of the induction type, usually called "non-synchronous." Regarding the history, he abstracts from a paper by Walter Baily, read at the Physical Society of London, June 28, 1879, on "A Mode of Producing Arago's Rotation," published in the "Phil. Mag.," October, 1879; in it are discussed the production of a rotating magnetic field by means of stationary electromagnets excited by currents of different phases; his motor was constructed of two electromagnets and a copper disc, the magnets being excited by alternating currents differing by a quarter of a period obtained from a battery by means of a commutator. Mr. Steinmetz calls attention to the multiphase generators used about twenty years ago in Paris for the Jablochkoff candles; also to the two-phase synchronous motors of Marcel Deprez; also to the Thomson-Houston arc light machine of 1879, which, he says, is probably the first practical application of the star connected three-phase winding. In referring to the Lauffen transmission plant, he claims that it was a mistake to use an induction motor, as a synchronous motor would have been better. He ridicules the idea of the fluctuations in a rotating field, about which so much has been written. Regarding the question of the priority of invention of multiphase motors, he claims that the reinventions are from five to ten years later than the work of Baily, Deprez and Ferraris.

Among the recent improvements he mentions a better arrangement of the magnetic circuit, the diminishing of the self-induction, the constant self-induction coefficient for all positions of the armature; regarding the many frequently advanced mathematical theories, he says no two of them agree together nor with the results of practice, which he explains by the fact that the authors are such as have never constructed a motor and perhaps have never even seen one; they conclude that the self-induction of the armature should be as high as possible, while practical experience shows that the chief factor in the construction is to make it as small as possible; another claims that the theory of hysteresis is at the foundation of the action of the motors, while practice shows that the lower the hysteresis the better the motor; regarding the starting torque, diminution of speed, phase differences, etc., he says there exists the worst kind of confusion; it is therefore easily understood that the present state of the multiphase induction motor industry, as shown at the World's Fair and in journals, is very discouraging: if these motors cannot start with full load with a normal current there is no use for them, for without a load the simple alternating-current motor will start, the efficiency, output, etc., being the same. All the multiphase induction motors at the World's Fair, except one, had the same faults, namely, small starting torque, great current at starting, some being even

incapable of starting loaded; high self-induction, great phase difference and great diminution in speed, all of which he calls faults, as he claims that they can be overcome.

He gives briefly a few conclusions which were substantiated by properly constructed motors; such motors can be calculated more completely and with greater accuracy than even continuous-current motors; the same torque per watt can be obtained at starting, and even more, as at full speed and full load; the motor can therefore start with full load without requiring more current than at full speed. With a special construction the starting torque may be made two or three times as great per watt as at full speed; they can stand considerable overloading, the amount depending on the purpose for which the motor is to be used; in some cases it may stand several hundred per cent. overloading; the reduction in speed between no load and full load can be made as low or as high as one wishes, without its materially affecting other properties of the motor; in general, however, the drop in speed at full load is less than in an ordinary shunt motor of equal size; the efficiency should be at least equal to that of a continuous-current motor; the current for no load, or the exciting current, should not exceed 20 to 30 per cent. of that at full load; the shifting of the phase of the current behind that of the E. M. F. should be small and the ratio of the true to the apparent watts should therefore be great; in large motors between one-quarter load and 50 per cent. overload it is equal to 0.9, and even in small motors should not below 0.8; this phase shifting is due to three factors, the self-induction of the armature, that of the primary circuit, and the exciting current; the latter diminishes while the other two increase, so that with an increasing load the phase shifting diminishes from a maximum at no load, reaches a minimum and then increases. Regarding the frequency, he states that they can be built equally well and with the same efficiency for 130 periods as for 30, provided the magnetic disposition is the same, to arrive at which the peripheral velocity must be greater for higher frequencies; motors can be built for 130 periods, which will start at full load and normal current and differ only from motors with lower frequency by an increased current at no load and a somewhat greater phase shifting. Single-phase induction motors have only 50 to 60 per cent. of the starting torque per watt, and unless multiphase motors are better in this respect, there is no advantage in their introduction. It is a mistake to use induction motors wherever alternating-current motors are required; as synchronous motors are so much better, they should be used in preference whenever possible: they have a higher efficiency, are smaller and may have a negative phase shifting at no load, the current being proportional to the load.

Edison Wire Gauge.

Prof. Hospitalier, in the new edition of the "Formulaire des Electriciens," gives the following formulas for finding the equivalent of the Edison wire gauge in millimetres, or French wire measure:

$$s = .5067 n \text{ mm}^2$$

$$d = .8031 \sqrt{n} \text{ mm},$$

where s is the section, d the diameter and n the circular mils.

News to Hawaii by Telegraph.

Our contemporary, London "Electricity," contains an article on Pacific cables, in which it sums up the length of the routes by which President Cleveland's decision reached the Sandwich Islands via New Zealand; it gives all the various cables and land lines forming the circuit, the total length of which was 19,123 miles from New York to New Zealand.

Unipolar Dynamos of the "Inoperative" Type.

BY BRUCE FORD.



THE interest in this subject demonstrated by recent articles appearing in *The Electrical World* prompts me to put my finger in this pie and advance a theory upon the subject of the rotating magnet with stationary exciting coil, under discussion by Messrs. Carl Hering and A. Randolph in the issue of Feb. 3.

First, it may be well to describe, by the aid of the accompanying figures, a machine built as an experiment by me a year ago, and from which my conclusions are deduced.

As may be readily seen in Fig. 1, the machine consists essentially of three parts, two main spider-like castings, as Fig. 2, constituting the stationary part of the field, and one revolving piece, Fig. 3, which I shall call the armature, although it is only a part of the field, of opposite polarity to the spiders. Each of the spiders has six poles and is excited by a single coil, like the magnet of the Mordey alternator; the two parts combined, however, have this difference: The extremities are of the same polarity, and so are bolted together at the poles. The armature, Fig. 2, is a wheel-like casting, consisting of an iron rim connected to a hub by three spokes of large cross-section, the latter serving to com-

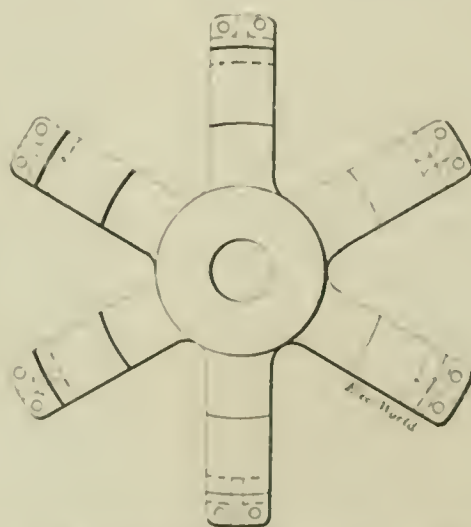
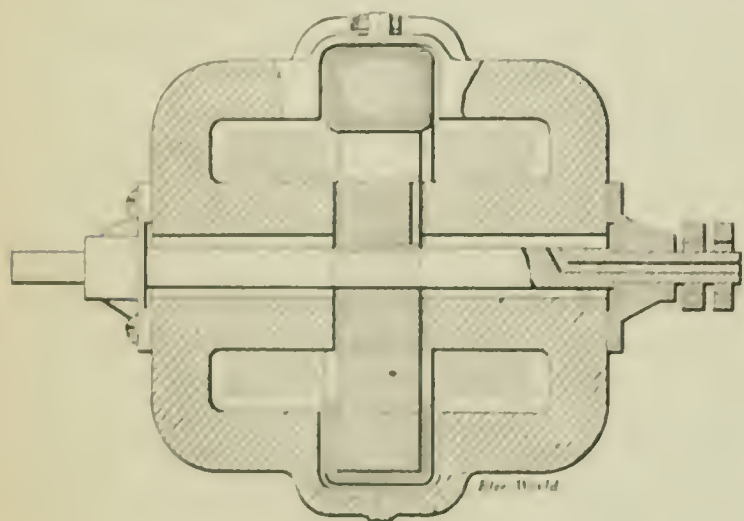
nearly 100 volts. I next disconnected all the armature windings, except a small coil of a few turns. Upon starting the machine the wagging of the voltmeter needle at both sides of zero showed an alternating current. The meter of course failed to show this as the speed increased, and, alternating meters not being at hand, the machine was not tested as an alternator. The alternating effect was due doubtless to different densities of the field at different points during the revolution.

I also tried to make this machine run as a motor, but with no success. Could the lines of force have been twisted upon themselves infinitely, so that only the entering lines of force would have been cut, the experiment would have been successful.

Mr. Hering, in his article, Jan. 13, states that the lines of force are said to follow the coil which generates them. Mr. Randolph differs in his belief and cites some examples, one of which is a proposed stationary exciting coil on the rotating field magnet of the Mordey alternator.

Where part of the core rotates and part remains stationary, Mr. Randolph states that the lines of force might follow either part.

In the last case it is my belief that the lines of force remain wholly with neither part of the core. For instance: Imagine two mushroom-shaped magnets of equal size, each excited in opposite polarity by a coil wound upon the part corresponding to the stem of the mushroom. Place the two magnets together in line "stem" to "stem"; between the two we have



FIGS. 1, 2 AND 3.—UNIPOLAR DYNAMOS OF THE "INOPERATIVE" TYPE.

plete the magnetic circuit between the rim and the hub. Only the rim is wound, a single wire being wound in a continuous coil all the way around the armature. Part of the winding is shown in place. The terminals pass down a groove in the side of the armature hub into a hole in the shaft and out beyond the bearing to the collector rings.

In the assembled machine the magnetic lines excited by the coils on the hubs of the spiders pass out through the six limbs of the spiders to the pole pieces, jumping across the gap into the armature rim. The armature windings cut these entering lines of force here, and in one direction. The magnetic circuit is completed through the spokes of the armature. The fact that these spokes revolved led me to believe that the magnetic lines in them would also revolve and that the wire would not cut any lines of force leaving the rim of the armature. My mistake lay in the assumption that part of the magnetic circuit could revolve while the remaining part was stationary.

In testing the machine the fields were excited from storage batteries, and showed strong excitation. The armature shaft was coupled directly to the shaft of a motor, and the terminals were connected to a Weston direct-current voltmeter. The current was then turned on to the motor, and the speed came up to about 1,000 revolutions per minute. The voltmeter showed absolutely no deflection, although, had the machine been successful, it should have shown

one complete magnetic circuit. Now rotate one of the "mushrooms" and its coil about its axis. Is the magnetic circuit broken? Scarcely. Is the magnetic circuit twisted upon itself infinitely? According to Mr. Hering and to my own machine, it cannot be. Naturally, then, the lines of force cannot remain with both cores or with both coils, and my conclusion is that in this case the magnetic circuit, tending to remain with both parts, revolves at one-half the velocity of the rotating magnet.

If, as in this example, where the magnetic circuit has two coils, the lines of force do not always follow the coil that generates them, may it not also be true that when only one coil is used the lines of force tend to move (though perhaps not coincidentally) with the core when the core revolves and the coil remains stationary?

(In replying to this communication, I merely wish to add that I constructed a precisely similar but smaller machine in 1884, and it was on the results obtained that I based some of the remarks made in the article referred to by Mr. Ford. His experiments, therefore, confirm mine.—Carl Hering.)

Sweeping Up Molecules of Gas With a Broom.

Dr. Lodge recently stated in a contemporary that at the temperature of absolute zero the molecules of a perfect gas "would be lying all about the floor in an inert and stationary condition and could be swept up."

A Straight Line Proportion in the Law of the Electromagnet.

BY CARL HERING.



R. O. FROELICH, whose formula for the electromagnet, published many years ago, is so well known, recently read an interesting paper on the electromagnet before the Electrical Society of Germany, which is reprinted in full in the "Elektrotechnische Zeitschrift," Jan. 18, page 39. In it he deduces "a straight line proportion," which enables the law to be stated in the form of a formula, which apparently gives sufficiently accurate results for all practical purposes. The object of the present article is to give a brief abstract of the rather lengthy paper for the benefit of those to whom the original is not accessible. We will also endeavor to "Americanize" the formulas by reducing them to a practical form by using the symbols and names which are to be introduced in this country. Some of his statements are not as clear as might be desired, but we believe from deductions and comparisons made with his formulas, that we have interpreted him correctly. Furthermore, some of his fundamental formulas contain what appear to be typographical errors besides an arbitrary factor of 1,000; we have corrected the formulas and omitted the latter factor, as it is, we think, confusing, its only use being to increase the numerical values of certain constants. We have also changed the symbols to those recommended by the recent congress, except in the case of K , which, in this abstract, refers to constants.

In the first part he reconciles the two present theories of electromagnetism with each other; this, although interesting, we will here pass over. In the second part he deduces his new law. As is well known, the analogy between the law of the electric circuit and that of the magnetic circuit does not apply in the case of resistance and reluctance, as the reluctance is not a constant, but varies with the M. M. F.; that is, with the gilberts. As an independent variable, only the flux (webers) or flux density (gausses) can be used, similarly as in the electric circuit, in which the electric properties of a body, like the resistance and polarization of an electrolytic bath, can depend only on the current and not on the E. M. F. of the battery used. Among the dependent variables are the magnetic fall of potential (magnetische Gefälle) and the reluctance (oersteds).

He then proceeds to deduce his law, as a basis of which he uses the linear proportion first pointed out by Mr. Kennelly in his able paper read before the American Institute of Electrical Engineers on Oct. 27, 1891 (see the Transactions, or a reprint which was published in The Electrical World Nov. 7, 1891, page 350). Mr. Kennelly showed that with the exception of the unimportant first part of the curve, the magnetic reluctance is the linear function of the M. M. F. or ampere turns when the circuit consists only of that iron. Dr. Froelich here introduces a new quantity, which he calls "Saettigungsverhaeltniss," which might be translated literally as the saturation relation; this he defines as the relation between the existing number of lines, to the difference between the maximum number of lines and the existing number of lines. Or, to put it in the form of a formula, letting Z represent this saturation relation, then

$$Z = \frac{\Phi}{\Phi_m - \Phi}$$

in which Φ represents the existing flux (in webers or lines of force) and Φ_m the maximum flux. This quantity differs from what is usually called the saturation, as the latter is the relation of the existing flux to the maximum flux, that is,

$\frac{\Phi}{\Phi_m}$. The saturation relation has the property in common with M. M. F. and reluctance, that it may increase to infinity. The saturation relation is unity when the saturation is one-half, and it is infinity when the saturation is one.

By plotting the values of this saturation relation as abscissae and the reluctances as ordinates, both for wrought and cast iron, he obtains the curves shown in Fig. 1, which

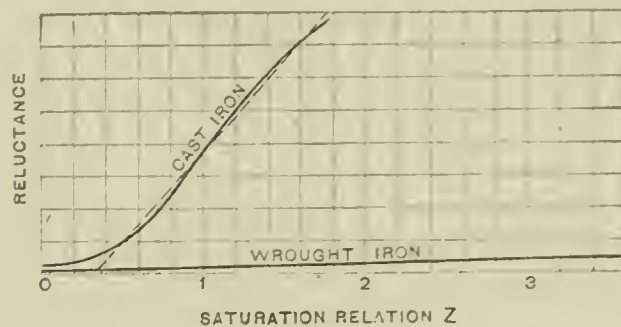


FIG. 1.

he states can be replaced by straight lines, the error for the range used in practice being no greater than what is allowable. Representing the saturation relation by Z , he states that for wrought iron the straight-line proportion may be assumed to begin at $Z = 0.2$, corresponding to a saturation of 0.17, while for cast iron it begins at $Z = 0.5$, corresponding to a saturation of 0.33. He therefore assumes that the reluctance of iron is a linear function of the saturation relation, and on the basis of this he deduces his law. The fundamental formula thus becomes

$$\nu = k + k' Z = k + k' \frac{\mathfrak{B}}{\mathfrak{B}_m - \mathfrak{B}}$$

in which ν is the specific reluctance or reluctivity (reluctance per unit length and cross-section), k and k' are constants and Z the saturation relation, which in this formula may be represented in terms of the flux per square centimetre; that is, by $\frac{\Phi}{S}$, S being the cross-section, which is usually termed the induction and is represented by $\mathfrak{B}$. This formula does not apply to low saturation when the circuit consists entirely of iron, but when it contains air also, the reluctance of which is much greater than that of the iron, it may be used even for low saturation. From the researches of Hopkinson he deduces the constants for wrought and cast iron, and obtains the following: For wrought iron $k = .000250$, $k' = .000250$, $\mathfrak{B}_m = 17,700$ (gausses); for cast iron $k = .00375$, $k' = .0112$, $\mathfrak{B}_m = 14,700$.

He then assumes an electromagnet of equal cross-sections throughout, and without leakage or spreading of the lines of force; the only form of magnet of this kind which we can conceive is a ring magnet with a short air space. For this the formula for the total reluctance will then be

$$\mathfrak{R} = \frac{4\pi}{10} \frac{AT}{\Phi} = \frac{l}{S} + \frac{L}{S} k + \frac{L}{S} k' \frac{\Phi}{\Phi_m - \Phi}$$

in which $\mathfrak{R}$ is the reluctance (in oersteds), AT the ampere turns, Φ and Φ_m the total and maximum flux (in webers) respectively, L and l the lengths of the iron and the air circuits respectively, in centimetres, S the cross-section in square centimetres, k and k' the above constants. By letting

$$\frac{l}{S} + \frac{L}{S} k = K$$

and

$$\frac{L}{S} k' = K'$$

this becomes

$$\mathfrak{R} = \frac{4\pi}{10} \frac{AT}{\Phi} = K + K' \frac{\Phi}{\Phi_m - \Phi}$$

which he calls his practical law of the electromagnet.

The constants have what he terms a natural meaning; K being the starting or dead reluctance of the magnet and K' the coefficient of increase (Wachsthums koeficient); the former depends almost entirely on the air space and the latter, as also Φ_m , depend only on the iron. The values of the constants K and K' are given for several machines, but as neither the dimensions nor even the output of the machines are stated, it would be of little use to give it here.

He then deduces a general formula for the magnetic circuit of a dynamo, taking into consideration all the various dimensions and magnetic qualities of the air space, the iron in the armature, magnets, cores, pole and yoke pieces, as also the coefficients of leakage; but this formula appears to us to be too cumbersome to be of use in practice, and it will therefore not be given here. A simpler approximate formula is also given, agreeing with the other in three points of the curve, but this also is hardly sufficiently simple for general practical applications. He also shows how the formula may be determined from the characteristic of a finished dynamo.

While we fully appreciate the value of some general practical formula for calculating field magnets, yet if it does not simplify the calculations as usually made, such a formula is merely interesting, but not very useful. We might suggest here that the first formula for calculating the specific reluctance, or possibly another deduced from it expressing the total reluctance, might be of real practical value, provided the constants for the various qualities of iron are known and can be depended upon, by which we refer more particularly to the maximum magnetism, which is not a very definite quantity. This would enable one to calculate the reluctances of the various different parts of the heterogeneous magnetic circuit of a dynamo for any desired flux, and the leakage coefficients can then readily be introduced; after having de-

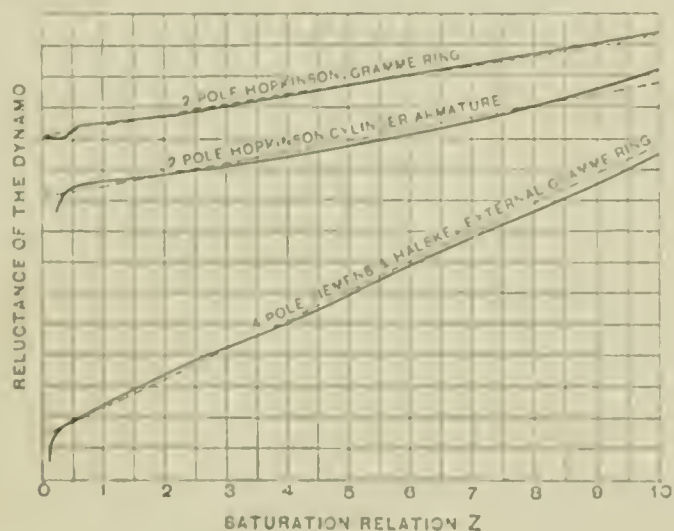


FIG. 2.

termined these reluctances the rest of the calculation to determine the ampere turns would be a very simple matter. Such a formula would have the advantage over the one usually used merely in that the calculations are algebraic, using numerical constants, instead of graphic, with the use of curves, but whether there are any real advantages gained is a question.

To show the correctness of his formula for the magnetic circuit of dynamos, he gives the calculated and observed results for three totally different machines, which are shown in Fig. 2 by dotted and full lines respectively; the results appear to be very satisfactory. It is of interest to note that by thus representing the characteristic of a dynamo, or more correctly speaking, of the magnetic field, it becomes a straight line.

Regarding the practical application of this law to the calculation of the field magnets of a dynamo, he admits that it offers no advantages over the methods now in use, as it is only another form of the Hopkinson method; the former

is an algebraic method and the latter a graphical one. The advantages of his method appear in the application of this law to the observations of a finished machine, as by means of it various factors, such as the air reluctance, the various constants, including those of the iron, the saturation, etc., are brought out separately, while in the graphical method they are all combined together. His law thus enables one to study a machine more thoroughly, as it reduces a heterogeneous magnet to an equivalent in the form of a simple magnet of uniform cross-section, and thereby affords a means of comparing machines of totally different types. The law is also claimed to be of use for studying the magnetic qualities of different samples of iron. In concluding, he shows how the law may be applied to the final calculations of the length of the core of the field magnet and the ampere turns encircling this core, after all the other dimensions have been decided upon. He also refers to a mathematical discussion of his magnetic deductions in a former paper published in that journal, June 30, 1893, page 365.

In concluding, we might add that while his new method is of interest and may be of use in special cases, it does not appear to be a sufficient advance to replace the methods at present in use. A general formula has some advantages, but so has also the less scientific but more practical method of making a few trial calculations.

Mr. Preece's Views of America.

In a recent address in London Mr. Preece made the following remarks regarding the Chicago Congress: "Perhaps the most useful result of the congress was the bringing together of such an international mixture of electricians, making friendships, allaying jealousies, and breaking down national prejudices. Electricity is the only branch of science which has but one language, and it is now quite cosmical in its character. Congresses do infinite good in promoting friendliness among nations." Regarding the World's Fair, he said: "Nothing grander in design or more beautiful in execution has ever been seen in this world than the group of buildings situated in Jackson Park, Chicago, and called the 'World's Fair.'" * * * "Every possible convenience and accommodation was provided for exhibitors, but the response was poor, and the internal management of the whole business, owing to inexperience and perhaps overweening confidence, was indifferent." * * * "The American public were surprised to find how much we had anticipated their work." * * * "The distinguishing feature of American engineering is the great scale on which it is carried out, and the rapidity of its adoption."

Patrick and the Telephone.

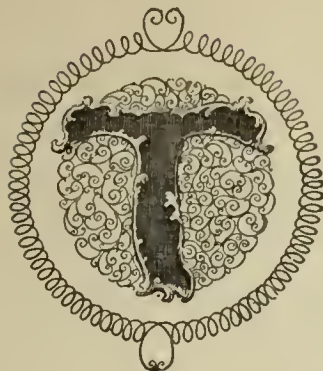
Our contemporary, London "Electricity," reprints a little anecdote by Mr. Stuart-Smith from his recent article in The Electrical World, intimating that it is a "chestnut," but adds another, which, though much older, may still be worth reprinting. When the telegraph was first introduced into Ireland, Patrick had a brother residing some distance away who was hard up and asked him to supply him with a pair of boots. The boots were secured, and Patrick hung them up on the telegraph wire, addressed to his fraternal relative. The next morning he went to see if they had gone. They had, and in place thereof he found a pair of soleless shoes. He said: "This is a wonderful invention. Dennis has not only got his new boots, but has sent me back his old shoes."

Storage Battery Cars.

During the recent snows the Waddell-Entz storage battery cars on Second avenue received high praise for the admirable manner in which they performed their work. While the horse cars required four horses and ran on double time, the electric cars did not have the least difficulty on their trips.

Formulae for Resistance Coils.

BY GUSTAV RENNERFELT.



THE formulae given below may be found useful for determining the dimensions of a bare conductor of a certain resistance, carrying a certain current, and having a certain proportion between the watts expended in the conductor and its surface.

The formulae are derived in the following manner:

Let R = Resistance in ohms.

C = Current in amperes.

f = Number of square units surface for each watt consumed in the conductor.

S = Surface of conductor (leaving out end surfaces).

x = Area of cross-section of conductor.

y = Length of conductor.

W = Weight of conductor.

k = Specific resistance of material in conductor.

s = Specific gravity of material in conductor.

Before any of the dimensions can be determined it is necessary to know the shape of the cross-section, whether it is a circle, a rectangle or some other figure. For any figure we have the relation $p = m \sqrt{x}$, where p denotes perimeter of the figure, x the area, and m is a quantity depending on the shape of the figure. For instance, for a square $m = 4$, and for a circle $m = 2 \sqrt{\pi}$, which, by the way, is smaller than for any other figure.

Knowing the shape of the cross-section, and consequently

The weight of the conductor is

$$W = s x y = s \sqrt[3]{\frac{f^2 k}{m^2}} C^2 R \sqrt[3]{C^2} \quad (5)$$

To make the formulae (3), (4) and (5) more convenient to use, some of the cube roots may be arranged in a table, and the formulae rewritten thus:

$$x = \alpha \beta \gamma^2 C \sqrt[3]{C} \quad (6)$$

$$y = \frac{\alpha \beta}{\gamma} C R \sqrt[3]{C} \quad (7)$$

$$W = s \alpha^2 \beta^2 \gamma C^2 R \sqrt[3]{C^2} \quad (8)$$

where the values of the constants are

$$\alpha = \sqrt[3]{f^2}, \beta = \sqrt[3]{\frac{1}{m^2}}, \gamma = \sqrt[3]{k}.$$

γ is thus depending on the material, β depends on the shape of the cross-section, and α on the ratio between surface and watts. Their values for some varying conditions are given in the following three tables:

Table No. 1 is figured for the English inch as unit, and with the assumption that the specific resistance varies according to the formula: $k = k' (1 + a t + b t^2)$, where t is a temperature in degrees C., k resistance at temperature t , and k' resistance at temperature 0° C. The constants k' , a and b are assumed as follows.

	k'	a	b
German silver.....	.000090	.00044	.00000152
Iron	.000040	.0048	.00000126
Aluminium	.000013	.0038	.00000126
Copper	.0000033	.0038	.00000126

The figures in column s of table No. 1 mean weight in pounds per cubic inch of the material.

Table No. 2 gives values of α and α^2 for values of f varying from $1/2$ to $2 1/2$ square units per watt.

TABLE NO. I.

	—60° C. = 140° F.—			—100° C. = 212° F.—			—150° C. = 302° F.—			s
	γ	$\frac{1}{\gamma}$	γ^2	γ	$\frac{1}{\gamma}$	γ^2	γ	$\frac{1}{\gamma}$	γ^2	
German silver.....	.0210	47.66	.000440	.0211	47.37	.000440	.0213	47.02	.000452	.306
Iron	.0173	57.83	.000299	.0181	55.12	.000329	.0191	52.29	.000363	.278
Aluminium	.0117	85.50	.000137	.0122	82.06	.000149	.0128	78.34	.000163	.293
Copper	.00930	106.8	.0000870	.00970	102.5	.0000953	.0102	97.77	.000105	.320

TABLE NO. II.

sq. ins. per watt.....	.50	.07	.75	1.00	1.33	1.50	1.60	2.00	2.50
$\frac{1}{f}$ watts per sq. inch.....	2.00	1.50	1.33	1.00	.75	.67	.60	.50	.40
α	.630	.703	.826	1.00	1.211	1.310	1.402	1.587	1.842
α^2	.397	.582	.681	1.00	1.468	1.717	1.960	2.520	3.393

TABLE NO. III.

	Circle.		Square.		Rectangular sections.									
	2:1	3:1	4:1	5:1	6:1	7:1	8:1	9:1	10:1	11:1	12:1	13:1	14:1	15:1
β	.430	.397	.382	.361	.342	.320	.313	.301	.291	.282	.274	.267	.261	.256
β^2	.185	.158	.146	.130	.117	.106	.098	.0908	.0848	.0797	.0753	.0714	.0681	.0651

the value of m , we can write the equations:

$$S = p y = y m \sqrt{x} \text{ and } S = f C^2 R$$

from which we have

$$y m \sqrt{x} = f C^2 R \quad (1)$$

We also know the resistance of the conductor to be

$$R = \frac{y}{x} k \quad (2)$$

Equations (1) and (2) give us:

$$m x \sqrt{x} = f C^2 k, \text{ or } x = \sqrt[3]{\frac{f^2 C^4 k^2}{m^2}}$$

We have thus the area of the cross-section:

$$x = \sqrt[3]{\frac{f^2 k^2}{m^2}} C \sqrt[3]{C} \quad (3)$$

In order to find the length y , we can put in equation (1)

$$x = \frac{k y}{R}, \text{ which gives } y m \sqrt{\frac{k y}{R}} = f C^2 R, \text{ or}$$

$$\text{length of conductor } y = \sqrt[3]{\frac{f^2}{k m^2}} C R \sqrt[3]{C} \quad (4)$$

Table No. 3 gives values of β and β^2 for some different cross-sections, circular, square and rectangular, with different proportion between the sides.

It is evident that the formulae in question are equally applicable if there are several conductors of the same size arranged in parallel, instead of a single conductor. The value of m will, however, in such a case be different, and consequently the value of β . It is easily seen that if the number of conductors in parallel is n , the value of m is $\sqrt{n}$ times as great as the value of m for a single conductor—cross-sections being similar.

If there are n conductors in parallel, the value of β as given in table No. 3 must therefore be multiplied by $\sqrt[3]{\frac{1}{n}}$

$$\text{and } \beta^2 \sqrt[3]{\frac{1}{n^2}}.$$

As the cross-section is proportional to β and the weight to β^2 , it is thus seen that, for instance, the using of two conductors in parallel instead of one will for the same

heat density or ratio of watts to surface admit of the cross-section being reduced to $\sqrt[3]{\frac{1}{2}} = .79$, and the weight to $\sqrt[3]{\frac{1}{4}} = .63$.

Using three conductors in parallel instead of a single one will for the same heat density reduce the cross-section to 69 per cent. and the weight to 48 per cent.

As a comparison between the four mentioned metals may be drawn the following conclusions:

A coil with fixed conditions in regard to resistance, strength of current, heat density and shape of cross-section has the least weight if made of.....Aluminium
has the least bulk if made of.....Copper
has the least price if made of.....Iron
has the least variation in resistance if made of.....German silver

An example will show how the formulae can be used. Suppose a coil of bare, round, pure copper is required to carry 350 amperes and to offer a resistance of .000943 ohm at 100° C. If the working conditions are such that 100° temperature will be reached, if there are .60 watts per square inch surface, what dimensions should be given to the coil?

From the tables are found the constants:

$$\alpha = 1.402, \alpha^2 = 1.966, \beta = .430, \beta^2 = .185, \gamma = .00976,$$

$$\gamma^2 = .000953, \frac{1}{\gamma} = 102.5, s = .32.$$

We thus have cross-section $x = 1.402 \times .430 \times .000953 \times 350^3 \div 350 = .142$ square inches, length $y = 1.402 \times .430 \times 102.5 \times 350 \times .000943 \div 350 = 143.7$ inches.

A wire 12 feet long and with $\frac{7}{16}$ inch diameter would thus be suitable. The weight of the wire is 6.53 pounds.

If other metals than copper were used, but we still kept a circular cross-section and .60 watts per square inch surface, the weights would be:

$$\text{For iron, } \frac{181 \times 278}{97.6 \times 320} \times 6.53 = 10.5 \text{ pounds.}$$

$$\text{For German silver, } \frac{211 \times 306}{97.6 \times 320} \times 6.53 = 13.5 \text{ pounds.}$$

$$\text{For aluminium, } \frac{122 \times 93}{97.6 \times 320} \times 6.53 = 2.37 \text{ pounds.}$$

The aluminium coil would thus be by far the lightest one, but would, however, require 25 per cent. more room than the copper coil. By using any other cross-section than the circle, the weight and dimensions can, of course, be reduced. If, for instance, rectangular section were used, with ratio 7:1

between sides, the weight would go down to $\frac{90.8}{185}$, or about one half.

The Chicagonian Outdone.

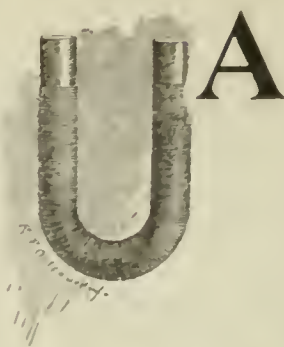
In speaking of the large German search light on the Manufacturers Building at the World's Fair, a native of Chicago stated as something wonderful that he had seen it when he was in Milwaukee, to which the attendant replied: "Dots notting; I seen him vemm I vos in Nuremberg, in Charn-cany."

Technical Review of the World's Fair.

Two French engineers, Messrs. Grille and Falconnet, are about to publish a technical review of the World's Fair, which is to form ten to twelve volumes in 8vo and several additional volumes, comprising 400 plates, in quarto. It will be published by Bernard et Cie., of Paris, and is to be completed at the end of this year at the latest.

On the Design of Electromagnets for Specific Duty.

BY CARY T. HUTCHINSON.



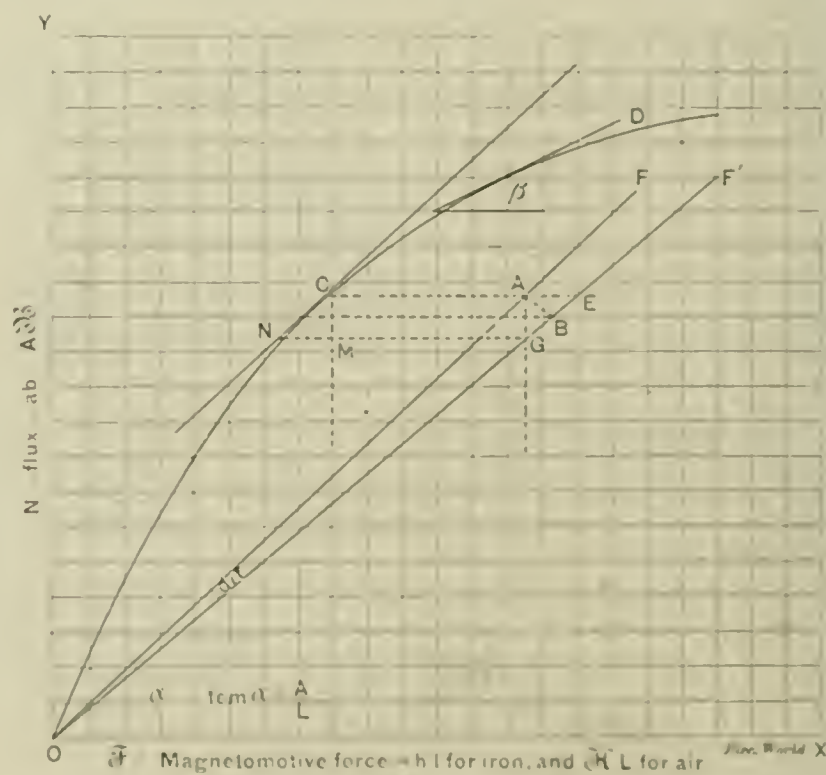
An article by Mr. E. R. Carichoff on this subject was published in The Electrical World of Jan. 27. The results brought out by the writer are valuable, and, I believe, new. The article is perfectly clear, when properly understood, and deserves the commendation it received in the editorial columns of the paper.

Mr. P. Mathews, however, publishes an article in the last number of The Electrical World which plainly shows that he does not entirely understand the article, and it seems worth while to present Mr. Carichoff's results in a slightly altered form, that may be more easily understood.

His problem is: Having given a magnet of definite length and cross-section, an air gap of given length, and any constant magnetomotive force, to find the polar area giving the maximum force.

Let $A, L, \mathfrak{B}, \mathfrak{H}$ and $\mathfrak{F}$ represent respectively the area, length, induction, magnetic force and magnetomotive force of the air gap; a, l, b, h and f the same quantities for the iron, N , the flux, which is the same in iron and air, since no leakage is assumed.

The curve $OC D$ is the characteristic of the iron: that is to say, the ordinates are flux, $N = a b$, and the abscissæ are magnetomotive force, $f = h l$; the air line OF is the same, ordinates being $N = A \mathfrak{B} = A \mathfrak{H}$, and abscissæ, $\mathfrak{H} L$;



DESIGN OF ELECTROMAGNETS FOR SPECIFIC DUTY

therefore the tangent of the angle $F O X = \frac{A}{L}$ represents the permanence of the gap. The tangent of the angle (β) that a tangent to curve $OC D$ makes with $O X$ is represented by

$$\frac{dN}{df} = \frac{a db}{l dh} = \tan \beta.$$

The curve $EC D$ in Mr. Carichoff's paper is the same curve, reduced to unit length and unit area of iron; the equivalent gap length then being $L' = \frac{L}{l}$.

The ordinates of his curve are then $\frac{N}{a} = b$, and the abscissæ, $\frac{f}{l} = h$; that is, the ordinary $\mathfrak{B} \mathfrak{H}$ curve for the iron; the ordinates of the line OF are $\frac{N}{a} = \frac{A \mathfrak{H}}{a}$, and the

abscissæ $\mathfrak{H} \frac{L}{l}$. Then tangent $\alpha = \frac{A l}{a L}$ and $\tan \beta =$

$$\frac{db}{dh}$$

In what follows I shall refer to the figure above, but it will readily be seen that everything said here applies to Mr. Carichoff's curves.

Then assuming the area A is the only variable, for maximum force I find

$$\text{Force} = P \sim A \mathfrak{H}^2 = A \mathfrak{H}^2 \quad (1)$$

$$\frac{dP}{dA} = 2 A \mathfrak{H} \frac{d\mathfrak{H}}{dA} + \mathfrak{H}^2 = 0 \text{ for maximum}$$

$$0 = 2 A \frac{d\mathfrak{H}}{dA} + \mathfrak{H} \quad (2)$$

$$\text{Total M. M. F.} = \text{constant} = \mathfrak{H} L + h l \quad (3)$$

$$0 = L \frac{d\mathfrak{H}}{dA} + l \frac{dh}{dA}$$

$$\frac{dh}{dA} = - \frac{L}{l} \frac{d\mathfrak{H}}{dA} \quad (4)$$

$$\frac{db}{dA} = \frac{db}{dh} \frac{dh}{dA} = - \frac{L}{l} \frac{db}{dh} \frac{d\mathfrak{H}}{dA} \text{ from (3)} \quad (5)$$

$$N = A \mathfrak{H} = a b \quad (6)$$

$$A \frac{d\mathfrak{H}}{dA} + \mathfrak{H} = a \frac{db}{dA} \quad (7)$$

therefore

$$A \frac{d\mathfrak{H}}{dA} + a \frac{db}{dA} = 0, (7) \text{ in } (2) \quad (8)$$

and

$$A - L \frac{a db}{l dh} = 0, (5) \text{ in } (8). \quad (9)$$

or

$$\frac{a db}{l dh} = \frac{A}{L} \quad (10)$$

that is,

$$\tan \beta = \tan \alpha \quad (10)^1$$

That is, for maximum force, the line OF is parallel to the tangent. It is obvious that if work be defined as "force and length of gap" the same condition holds for maximum work, the area being the variable.

When the magnetizing force is small and may be taken constant, then (10) means

Reluctance of iron = Reluctance of air gap.

Mr. Mathews has clearly misunderstood Mr. Carichoff's figures; the statement at the end of his article that the reluctances are in inverse ratio of the sections is not a consequence deducible from Mr. Carichoff's article; moreover, it is wrong.

Mr. Mathews works out correctly the other problem of the best length for the gap, with constant area, to give maximum work, work being defined as above. The result is, as one would expect, that the reluctances (for constant μ) of the two parts should be equal. He works it out only in the case of constant permeability. For the general case the deduction is as follows:

The equations are—

$$N = A \mathfrak{H}^2 L \quad (11)$$

$$\frac{dN}{dL} = 0 = 2 A L \mathfrak{H} \frac{d\mathfrak{H}}{dL} + A \mathfrak{H}^2 \quad (12)$$

$$F + f = \mathfrak{H} L + h l \quad (13)$$

$$\frac{dh}{dL} = \frac{dh}{db} \cdot \frac{db}{dL} \quad (14)$$

Differentiate (13); substitute from this and from (14) in (12) the result is

$$\frac{a db}{l dh} = \frac{A}{L} \quad (15)$$

and for constant μ this is,

Reluctance of iron = Reluctance of air gap, as Mr. Mathews finds.

There is, of course, no condition for maximum force when the gap length is the variable.

These results are similar to the conditions for maximum work of a battery, and, like them, are independent of the magnetomotive force; they apply to all values of the magnetomotive force. This is the meaning of the locus curve in Mr. Carichoff's article.

Cost of Operating a Municipal Plant.

The city authorities of Topeka, Kan., have issued a financial account of the municipal electric street lighting plant from its institution in November, 1889, to December, 1892, from which we abstract the following:

The plant consists of a lot and building by a railroad switch. There are three boilers and three engines (worked to 235 h. p.); six Jenney (Indianapolis) arc dynamos of 30-lamp capacity each; six circuits, with 24 72-100 miles of pole line and 33 5-10 miles of wire, supported on 943 30-foot poles. The lamps are suspended between 40-foot poles at the centre of each intersection on the principal streets, and at each alternate intersection on the residence streets. The greater portion of the lamps are 1,100 feet apart one way and 800 feet the other, making in all 184 lamps, rated at 2,000 c. p. A test of seventeen lamps showed an average voltage of 2315-100 and a current of 19 amperes, or 43985-100 watts, equivalent to 1,953 nominal candle power. The cost of the lot and building was \$8,559.33; of the plant, poles and wires, \$46,888.65, making a total cost of \$55,447.98.

The average cost of each arc light during the time that the plant has been in operation has been \$93 per year, or \$7.75 per month, or \$3.86 per 100 hours, divided as follows:

	Per centum.
Fuel (at \$2.75 per ton).....	25.67
Carbons	5.51
Globes	.43
Oil and waste.....	1.18
Repairs	8.93
Insurance and telephone.....	2.45
Superintendence and labor.....	36.40
Interest at 6 per cent.....	19.43
	100.00

The Azores Cable.

The following letter, written by a cable man in the Azores and published in the London "Electrician," is rather amusing: "The people at Pico said that the cable was the cause of the cyclone, but as it saved them from starving, by bringing the milho at once, they don't consider it such witchcraft as they did at first. It is a fact, though, that the fishermen have said that the 'talking' in the cables has frightened the fish away! People in Pico would not have the land line insulators on their houses because of this same 'talking.' I have been told that if I had been here a quarter of a century earlier I should have stood a chance of being burnt, and should have figured in the annals of electricity as a martyr to the science."

Effects of Temperature on the Breaking Strain of Metals.

Prof. Dewar, in his recent lecture on "The Scientific Uses of Liquid Air," showed that the breaking strain of metals at 180° C. below zero was greatly increased; in the case of iron and German silver it was nearly doubled; in certain metals an equally remarkable increase occurs in the percentage of elongation before rupture.

Rope Driving.—IX.

BY J. J. FLATHER.



THE ropes most commonly found in use are from 5-8 inch to 1 3-4 inches in diameter, although other sizes are frequently employed; in one case, cited by Mr. T. S. Miller,* a rope no larger than 5-16 inch diameter is used very satisfactorily to transmit 20 h. p.

The largest rope in use for this purpose, as far as the writer is aware, is 3 1-2 inches in diameter; it is of cotton (Lambeth), and is used to

drive the cable drums in the Washington street power station of the North Chicago Street Railway Company.

In England and Germany ropes smaller than 1 inch in diameter are seldom employed; in ordinary cases the sizes most frequently adopted vary from 1 1-2 to 2 1-2 inches in diameter.

With a given velocity the weight of rope required for transmitting a given horse power will be the same, irrespective of the diameter of rope; the smaller rope will require more parts, but the weight will be the same. As we have stated, many engineers prefer to use a greater number of ropes over wide-faced pulleys, but in order to reduce the expense incident to a large number of grooves in the pulleys a closer margin is allowed on the smaller ropes, and in consequence the normal working strain on each rope is usually increased far in excess of that which would be necessary if the same weight of rope were employed as for the larger diameter. As a result of this, the small ropes are rapidly worn out and frequent renewals are necessary.

We are aware that small ropes are advocated and installed by many engineers, but we believe this to be wrong both in principle and practice. In rope driving the first cost and erection of small driving pulleys may influence a designer to use small ropes, but as ropes are sold by the pound, and as the weight necessary to transmit a given power should be the same, irrespective of the diameter, it is evident that the first cost of the rope itself will be the same, whether large or small ropes are employed. Moreover, if the pulley is suitably proportioned to the size of rope in each case, the smaller rope will last only about one-third as long as a rope twice its size, under similar conditions.

The wear of a rope is both internal and external; as we have previously noted, the internal wear is due to the bending of the fibres and their sliding upon one another, which produces a grinding action, very much increased when the strands are not lubricated or when a hard twist is given to the rope, thus preventing by the greater compression of the fibres upon one another that freedom of action which is so essential to the life of the rope. It is evident that a similar compression of the fibres will occur when a rope under tension is wrapped around a pulley; the greater this tension the greater also will be the compression and distortion of the fibres.

The external wear is due to the contact between the rope and the sides of the groove in which it runs, and is greatly increased when slip occurs; roughness in the groove also increases the wear, and for this reason the rim should be turned smooth and polished, as the outer fibres, rubbing on a rough-turned or cast surface, will gradually break, fibre by fibre, and thus give the rope a short life.

Contact between different ropes, or between a rope and some obstructing surface, such as a partition wall, post, or floor beam, is frequently the cause of a large portion of the external wear of a rope; this may be due to faulty construc-

tion or erection; pulleys designed with too small a pitch between the grooves, or running out of true, causing the ropes to vibrate and flop; or, as in outside work, a swaying, producing contact, may be set up in the ropes, due to the action of the wind.

With the same total stress in a rope, it may be assumed that the wear, both internal and external, increases directly with the number of flexures, the slip, and the surface in contact; and also that a reverse bending is more injurious to the rope than single bends in a constant direction. For a given speed the number of flexures and the actual surface in contact with the pulleys will decrease as the distance between centres increases, and hence the wear will vary inversely with the distance between centres of pulleys, but it must be noted that with imperfect construction an increased distance between shafts will favor swaying and rubbing of the ropes against each other and the edges of the grooves.

The number of flexures and the surface in contact will evidently increase directly as the velocity, and therefore the wear may be assumed to vary directly as the velocity of the rope. If we assume that two 1 1-4-inch ropes are necessary to transmit a given horse power, it will require eight 5-8-inch ropes to transmit the same power at the same speed and tension per square inch of section. If suitable pulleys are used in each case, the wear will be considerably greater with the smaller ropes. For the total external surface of the eight ropes in contact with the pulley each revolution is twice as great as that obtained with the 1 1-4-inch rope; moreover, the distance between centres of shafts will generally be considerably less with the smaller ropes, and as the number of revolutions of the smaller pulleys should be more than twice as great for the same speed of rope (since the pulleys are less than half the size of those used for the larger rope), the number of flexures and the wear of the rope on the pulleys will be greater with the 5-8-inch rope—for not only is each rope bent more than twice as many times per minute, thus producing eight times the bending in the smaller ropes, but, as the slip is independent of the diameter of the rope, it will be evident for the same proportional stress and arc of contact that the slip will be four times greater in the case of the smaller ropes, even if we neglect the differential driving effect which may be assumed to increase with the number of ropes.

Thus, it will be seen that under similar conditions and proportional stress, we should expect the smaller rope to wear out more than twice as fast as one double its size; and when the stress is proportionally greater in the smaller rope, as we ordinarily find it, the wear will be still greater.

These conclusions are borne out in practice, for in transmissions using small ropes 3-4 inch in diameter and under the life of the rope is usually only from six to twelve months; in many cases such ropes will last only three months, although others have been in active use for periods varying from one to two years.

On the other hand, the larger sized ropes, one inch to two inches in diameter, will last from two to six years, and under favorable conditions large ropes have lasted eight and even ten years.

From an investigation of numerous examples of rope driving under a variety of existing conditions, the writer is led to believe that ropes less than 3-4-inch diameter should not be used if it is at all practicable to employ the larger sizes, and that ropes one inch in diameter and over are to be preferred where it is possible to use the larger pulleys which are necessary for such ropes.

With larger ropes the wear is not only much less, but, where the usual multiple wrap system is used, when a number of yarns give way the rope does not part at once if subjected to a greater or sudden tension, but may run until a convenient opportunity offers to shut down; whereas, with the small rope, having a greater number of wraps, when a

*Trans. A. S. M. E., 1891.

strand or a number of yarns give way, any increased stress due to imperfections in the system is liable to still further rupture the yarns in the weaker rope, and a sudden break or pulling out occurs.

Besides the greater life of the rope, and consequent less cost, the saving of time on account of fewer breakdowns and stoppages is a factor worth considering; and although this feature does not cut as much of a figure with rope driving as it does with factory belting, yet it is of such importance that many men would rather use some other form of transmission than suffer the annoyance incident to resplicing a broken rope every few months. While the time lost in repairing the rope or in laying down a new one may not be great in itself, the stoppage of a department in a busy season may prove to be a serious loss. Where foundries and isolated shops have been driven by small ropes, this has happened so frequently that the ropes have been taken out and replaced with shafting, or other more expensive method of transmission.

In order to avoid any serious loss of time or inconvenience due to a sudden rupture two independent ropes should be used, each having its own tension sheave and weight. This does not involve any more wraps than would otherwise be used for a single wind, for the normal working stress is in any case so much less than the actual strength that for a temporary run of a few hours, or even days, one rope could readily carry double its working load, in case the other should give out. When two independent ropes are thus used they may be wound separately, each wrap occupying successive grooves on the pulleys; or, which is more frequently the case, the ropes may be wound in parallel, thus bringing each rope in alternate grooves; in either case it is preferable to use an independent tightener, although a single-tension carriage, provided with two sheaves, may be used, but with this latter, owing to local causes and the difficulty of splicing both ropes of an equal length, the load is not as well distributed between the two ropes.

In subsequent considerations of the driving power of ropes, the relation between the ultimate strength, weight per foot of length, normal working strain, and the diameter of rope will be represented by the following equations, which have been determined for manilla transmission rope:

Let d = diameter of rope in inches.

w = weight of rope in pounds per foot.

S_1 = breaking strain.

t = normal working strain.

x = an empirical coefficient.

Then $w = 0.3216 d^2$.

$S_1 = 100 d^2 x$.

$t^* = 200 d^2 = b$.

$x = 81 - 9 d$.

In determining the horse power which a rope will transmit under given conditions the centrifugal force due to the velocity and weight of rope is an important factor and its influence should be considered in all cases, for at high velocities this force diminishes the pressure exerted between the rope and the circumference of the pulley, thus reducing the friction between rope and pulley. When, therefore, a rope has to transmit a given force, P , it must be subjected to a greater tension the greater the centrifugal force, F_c . At a speed of about 90 feet per second the centrifugal force increases faster than the power from increased velocity of the rope, and at 140 feet per second this force equals the assumed allowable back tension in the rope; and since the

*On account of the relatively great difference between S_1 and t , it is not thought advisable to consider the increase in strength of the smaller ropes, as in any case the difference would be very slight, and, moreover, it must be noted that t is the normal estimated strain, and may vary considerably from the actual strain.

transmitting force is equal to the difference in tension in the two parts of the rope, it will be seen that no power will be transmitted at this speed unless the assumed allowable tension be exceeded.

It is evident that for a given total tension the less back tension required to prevent the slip of the rope on the pulley the greater will be the power transmitted at a given speed.

The determination of this back tension is, however, attended with a degree of uncertainty, as there are no conclusive experiments which give reliable data for its calculation; the coefficient of friction, Φ , as stated by various authorities, varying all the way from 0.075 up to 0.88.

Reuleaux quotes the experiments of Leloutre and others as indicating a value of 0.075 for cylindrical pulleys with new hemp rope, 0.088 for semi-circular grooves and 0.15 for a wedge groove of 60°.

Experiments by the Messrs. Pearce Brothers, of Dundee, give a value of Φ equal to 0.57 to 0.88 for ropes on ungreased pulleys, and $\Phi = 0.38$ to 0.41 when the pulleys are greased.

Unwin states that the coefficient of friction for ropes on a flat metal pulley is equal to 0.28, from which the actual coefficient for a grooved pulley is obtained by multiplying 0.28 by the cosec. of half the angle of the groove. For an angle of 45° this would give $\Phi = 0.72$. These latter values are probably very much higher than is ordinarily found in actual practice with well lubricated ropes and moderate slip. From a consideration of various experiments and the conditions under which they were carried out, it would appear that for ropes which are partly worn and sufficiently greased to wear well with a low percentage of slip a value of 0.12 for a flat-surfaced, smooth-metal pulley will approach very closely to those conditions which obtain in average practice, from which the following working coefficients are obtained:

For a groove of 30° this would give

$$\Phi = 0.12 \operatorname{cosec} \frac{30^\circ}{2} = .46.$$

For a groove of 45° this would give

$$\Phi = .12 \operatorname{cosec} \frac{45^\circ}{2} = .31.$$

For a groove of 60° this would give

$$\Phi = .12 \operatorname{cosec} \frac{60^\circ}{2} = .24.$$

Besides varying with the angle of groove, as shown, the coefficient of friction is affected by the condition of the rope, and for dry ropes Φ may be taken somewhat greater than the above value; Φ will also be increased with an increased percentage of slip.

If the arc of contact on smaller pulley, the coefficient of friction between rope and sheave and the total tension in the rope be known, the tension on slack side of the pulley, and hence the horse power transmitted, can be readily determined from the following considerations:*

Assuming, as before, that the driving force, P , is equal to the difference in tension T_1 on the driving side of the rope and T_2 on the driven side, and noting that the driving force must equal the friction F between the surfaces, we obtain

$$T_1 - T_2 = P = F.$$

The friction, F , depends upon the arc of contact α between the rope and its sheave, the coefficient of friction Φ and upon the centrifugal force F_c , set up in the rope, due to its velocity and weight; it is, however, independent of the diameter of pulley. To determine the values of F , T_1 and T_2 , it will be necessary to assume a given tension in the rope; also its speed and weight, coefficient of friction and arc of contact.

*Weisbach, volume III., page 254. See also Reuleaux.

Let f = friction between element of rope and pulley.

g = acceleration due to gravity = 32.16.

p = normal pressure on pulley.

t = allowable working tension = 200 d^2 pounds.

v = velocity of rope in feet per second.

w = weight of rope per unit length and area = 0.3216 d^3 pounds per foot.

z = abbreviation for $\frac{w v^2}{g t}$.

A = area of cross-section of rope.

F_c = centrifugal force.

P = driving force = $T_1 - T_2$.

R = radius of pulley.

T = tension in rope at any point.

T_1 = tension in rope on tight side.

T_2 = tension in rope on slack side.

α = least arc of contact between rope and pulley—circular measure.

ϕ = coefficient of friction.

If in Fig. 29 T is the tension in the rope at any point, D .

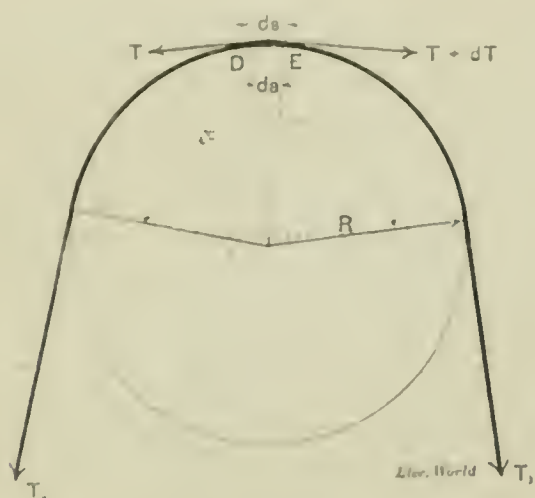


FIG. 29.

then the tension in the point E , whose distance from D is ds , will be $T + dT$. Assuming f to represent the friction on the element DE , we shall have $f = dT$ when the several forces are in equilibrium. Since the friction is dependent upon the normal pressure p exerted by the element upon the rim of the pulley, and since this normal pressure is diminished by the centrifugal force due to the weight and velocity of the element, we shall have $dT = \phi (p - F_c)$.

Now p is the resultant of the two forces T and $T + dT$; hence

$$p = T \sin \frac{d\alpha}{2} + (T + dT) \sin \frac{d\alpha}{2},$$

which may be assumed equal to $T d\alpha$ on account of the smallness of $d\alpha$ and dT .

The centrifugal force of the element of the rope is

$$F_c = w A \frac{v^2}{R g} ds = w \frac{t}{R g} \frac{v^2}{t} ds;$$

and since $ds = R d\alpha$, we have

$$F_c = w \frac{t}{R g} \frac{v^2}{t} R d\alpha = w \frac{v^2}{g} d\alpha,$$

substituting these values of p and F_c in $dT = \phi (p - F_c)$, we obtain

$$dT = \phi \left(T d\alpha - w \frac{v^2}{g} \frac{t}{t} d\alpha \right).$$

For convenience let $z = \frac{w v^2}{g t}$, then

$$dT = \phi T (1 - z) d\alpha, \text{ or } \frac{dT}{T} = \phi (1 - z) d\alpha.$$

Integrating,

$$\int_{T_2}^{T_1} \frac{dT}{T} = \int_0^\alpha \phi (1 - z) d\alpha,$$

hyp. logarithm

$$\frac{T_1}{T_2} = \phi (1 - z)^\alpha,$$

hence

$$\frac{T_1}{T_2} = \epsilon^{\phi \alpha (1 - z)} \text{ or } T_1 = T_2 \left[\epsilon^{\phi \alpha (1 - z)} \right],$$

in which ϵ is the base of the hyp. log. = 2.7183, therefore,

$$T_1 - T_2 = P = T_2 \left[\epsilon^{\phi \alpha (1 - z)} - 1 \right] = T_2 \left[\epsilon^{\phi \alpha (1 - z)} - 1 \right].$$

If we assume $\frac{T_1}{T_2} = r$, there is obtained

$$\frac{r}{r - 1} = \frac{T_1}{T_1 - T_2} = \frac{T_1}{P}.$$

These ratios, r and $\frac{r}{r - 1}$, Reuleaux calls the friction modulus and the stress modulus respectively.

As the common logarithm of ϵ is 0.43430, the value of r may be more readily obtained from common log. $r = 0.4343 \phi \alpha (1 - z)$; if the arc of contact is given in degrees, $\alpha = 0.0175 \alpha^\circ$, which gives the common log. $r = 0.4343 \times 0.0175 \alpha^\circ \phi (1 - z) = 0.007578 \phi \alpha^\circ (1 - z)$. As the weight of a manilla rope one foot long = 0.32 d^3 pounds, the value of z for varying speeds can be determined from

$$z = \frac{w v^2}{g t} = \frac{0.01 d^3 v^2}{t};$$

if now we assume a constant working stress $t = 200 d^2$ pounds, then

$$z = \frac{0.01 d^3 v^2}{200 d^2} = 0.00005 v^2.$$

(To be continued.)

Patent Office Abuses.

The Patent Commissioner recently said that the public has a very slight appreciation of the number of attempts that are made to get patents not based on valuable inventions, but which offset under cover of a slight change a meritorious invention made by another and already patented. It is the constant experience of the office that when a really valuable invention is made and the patent therefor issued and published, a score of applicants will come in for patents on trivial and unmeritorious details with the purpose of meeting the true invention with another patent on substantially the same thing.

Commenting on the same subject, a patent attorney said that a patent was granted some time ago for a paper band to secure a package of money, having the amount of the contents printed on it in different directions, so that the amount might be read, no matter in which position the package was held. This patent was sought to be withdrawn by the Commissioner of Patents. "The majority of the examiners are only fairly liberal, and some are not liberal enough, and the result of such instructions as have been given them by the Commissioner has been, and will be, till modified, to cause the least liberal examiners to be less so, and those who have pursued a fair and just course, too, feel that they must submit their judgment to the views they understand the Commissioner as holding. That there shall be a modification of the order that has been given to the examiners there can be no doubt, and the sooner it is made the better, for no inventor can now know what ground he has to stand on."

Berlin-Cologne Telephone Trunk Wire.

According to the London "Electrician" the telephone trunk wire between Berlin and Cologne (300 miles) is now open to the public. Three minutes' conversation costs one mark (24 cents). Urgent messages, which are to take precedence of ordinary ones, are charged for at treble rates.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE
PRINCIPAL FOREIGN
ELECTRO-PHYSICS.

ELECTRICAL JOURNALS.
BY CARL HERING.

Relation of Electrostatic Capacity and the Coefficient of Self-Induction.—"Electricite," Jan. 25, reports an Academy paper by Mr. Potier, in which he demonstrates a theorem, the conclusion of which is that the electrostatic capacity and the coefficient of self-induction are inverse functions, or, in other words, in absolute units their product is equal to unity in a conducting system in which one part envelops the other and which constitutes a complete circuit.

Electrical Heating in Physical Researches.—The Lond. "Elec. Rev.," Feb. 2, in calling attention to Prof. Nichols' recommendation to adopt electric heating for obtaining steady temperatures, suggests that there is nothing better than an incandescent lamp for this purpose, it being much better than a wire; it also suggests that hot, thin filaments may come into use for obtaining spectra, in which case no slit would be required and great brilliancy ought to be obtained.

Oscillographic Methods.—In "La Lum. Elec.," Jan. 27, Mr. Blondel refers to a recent paper by Prof. Nichols on "Phenomena of the Time-Infinitesimal" (an abstract of which is published in the London "Electrician," Jan. 5), and states that the oscillograph was described and invented by him, Blondel, a year ago; he gives a short description and adds a few new details.

Luminous Discharges in Electrodeless Tubes.—The Lond. "Elec. Rev.," Feb. 2, calls attention to a Physical Society paper by Mr. Rimington in the October number of the "Proceedings," in which he treats the subject mathematically and experimentally, arriving at the same conclusions that he did a year ago.

Effects of Light on the Electrical Discharge.—The Lond. "Elec.," Feb. 2, reprints from "Nature" a short but apparently complete summary of the work done in this direction.

A Fundamental Error in Laplace's Formula.—The "Elek. Anz.," Jan. 21, contains an article by Mr. Schwartz, in which he describes what he believes to be an error. Among other things he calls attention to the confusion caused by the so-called electrostatic and electromagnetic systems of absolute units; he states that a definite proof of the correctness of Laplace's formula is needed; magnetism and electricity, he claims, depend on surface actions; the former represents the statics and the latter the dynamics of the "gravimotoric" field of force; Laplace's error is claimed to lie in the fact that he defines the conception of force by MLT^{-2} without considering the true nature of the force; but this formula, however, he claims is wrong, as it contains the factor acceleration; it is also wrong, as Biot and Savart have shown experimentally that the surface action between the magnet pole and a conductor of electricity is proportional simply to the first power of the distance; in conclusion, he adds that the correct formula leads to the same results as the incorrect Laplace formula, and that the use of the latter is therefore not incorrect; the difference lies in the more simple expression for current, namely MLT^{-1} .

Force and Work.—The "Elek. Anz.," Jan. 28, contains

an article by Mr. Schwartz on this subject, in which he discusses the coefficient k in the formulas of Coulomb and Laplace.

Electromotive Forces of Polarization.—An article from "Zeit. Phys. Chem.," by Mr. Leblanc, is abstracted briefly in the Lond. "Elec. Eng.," Feb. 2.

Electromotive Forces of Insoluble and Complex Salts.—The Lond. "Elec. Eng.," Feb. 2, abstracts briefly from the "Zeit. Phys. Chem." an article by Mr. Zengelis on this subject.

Dielectric Constants of Biaxial Crystals.—Mr. Borel's article on this subject is concluded in "La Lum. Elec.," Jan. 27; the results of his measurements are summarized in a table.

Stationary Electric Waves.—An article by Mr. Salvioni is published in "La Lum. Elec.," Jan. 27.

MAGNETISM.

Law of the Magnetization of Soft Iron.—"L'Elec.," Jan. 27, abstracts an Academy paper by Mr. Joubin; if I is the intensity of magnetization, H the field, K the susceptibility, such that $I = KH$, and a curve is drawn with I as ordinates and K or $4\pi K$ as abscissas, he states that the curve is an exact parabola, except in the neighborhood of the origin. This curve has a striking resemblance to that for the density of saturated fluids, as a function of temperature, the latter being analogous to the susceptibility; the same relation is said to exist between the superficial density I and the susceptibility K as between the density and the temperature of the fluid; the same formula may therefore be used with both.

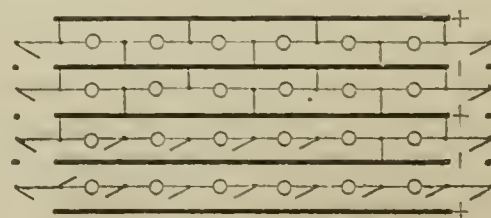
Magnetic Permeability of Oxygen.—A paper from "Wied. Ann.," by Mr. Hennig, is abstracted in the Lond. "Elec.," Feb. 2; the results for various pressures and temperatures, as also a comparison with the other determinations, are given; the paper is discussed editorially.

Earth's Magnetism.—"L'Ind. Elec.," Jan. 25, and "L'Elec.," Jan. 27, publish the constants as measured at the Observatory, near Paris. The author endeavors to determine the relation which exists between the number of storms and the declination of the moon.

Compass Regulations by Observations of the Horizontal Component.—"L'Ind. Elec.," Jan. 25, abstracts briefly an Academy paper by Mr. Cornu, in which is described how the necessary coefficients are determined.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Rheostats of Lamps.—A paper by Mr. Heim is reprinted in the "Elek. Zeit.," Jan. 25, in which he describes rheo-



RHEOSTATS OF LAMPS.

stats made of lamps, chiefly for laboratory purposes; as will be seen from the adjoining cut, which is one of seven,

the lamps, represented by circles, are connected in four groups of six in each series; at each junction between two lamps and also at each end there is a lever switch; between each row are strips of metal, shown in heavy lines, which are alternately connected to the positive and negative ends of the circuit; any of these may also be disconnected from that circuit; as will readily be seen, an almost innumerable number of combinations can thus be made from all in parallel to all in series, the one shown in the figure being a combination of some in series with some in multiple arc. A detailed description for a battery of 56 lamps in eight rows of seven each is also given. (The arrangement is ingenious and simple, but appears to have this objection, that a single incorrectly placed switch may make very great differences and may even cause the immediate destruction of a number of lamps.)

Kruppin, a New Resistance Material.—The article abstracted in the Digest Jan. 6 (see also Feb. 3) is abstracted very briefly in the Lond. "Elec.," Feb. 2, in which a table is given for the specific resistance and the current capacity of spirals, for various sizes of wire.

Electrostatic Voltmeters.—Swinburne's new voltmeter is illustrated and briefly described in the Lond. "Elec.," Feb. 2; it consists essentially of a quadrant electrometer.

Determining the Conductivity of Dielectric Liquids.—The article mentioned in the Digest Jan. 30 is reprinted in "La Lum. Elec.," Jan. 27.

DYNAMOS AND MOTORS.

Multiphase Motors.—In the "Elek. Zeitft.," Jan. 25, Mr. Steinmetz discusses briefly the history, the theory and the construction of induction multiphase motors. An abstract, which is too lengthy to be given here, will be found in another column of this issue.

Experiments with Brown Non-Synchronous Motors.—The tests of Mr. Banti are concluded in the Lond. "Elec. Rev.," Feb. 2; this description seems to be more complete than that from which our first abstract was made.

Irregularities in the Action of Dynamos.—Mr. Montpelier's serial is concluded in "L'Elec.," Jan. 27. The reprint in the Lond. "Elec. Eng." is continued in the issue of Feb. 2.

Dynamo Attendants and Their Dynamos.—The serial under this heading is continued in London "Electricity," Jan. 19 and 26.

Iron in Armatures.—Our attention has been called by Mr. Wiener to a typographical error in the abstract under this heading in the Digest, Jan. 20; the last figure should read 28 degrees instead of 48. From the rest of the abstract it will have been noticed that this must be a typographical error, the article itself showing that the rise of temperature is less for thin than for thick plates.

ARC AND INCANDESCENT LIGHTS.

Candle Power of Search Lights.—Under the heading of "A Reform in Photometry" Mr. Guilbert publishes an article in "La Lumiere Electrique," January 27, in which he discusses a recent article in which it was claimed that the intensity remained constant up to a certain distance, after which it varied according to the law of the inverse squares; he claims that this is an error, and that the intensity diminishes continuously; there is no interest attached to the intensity at small distances, as such apparatus are used only for great distances; he defines the term luminous power as the intensity of a naked light, which, when placed at the same point, produces at great distances an intensity equal to that measured on the axis of the beam of the search light; this definition, he claims, is correct, because such lights are used only at great distances; he states that all the experimental determinations which have been made in France and elsewhere were made at distances which were greater than the (minimum) limit of the application of the law of inverse

squares, and consequently are in perfect accord with the definition; in conclusion, he states that there is really no ground for discussion nor for the proposed reform.

The Goebel Lamp Story.—The Lond. "Elec. Rev.," Feb. 2, contains an article by Mr. Tanner, in which he quotes from the New York "Electrical Engineer" regarding the history and work of Goebel. In order to establish the truth or falsity of this story he visited the Hanover school, where Goebel's friend, Prof. Moenighausen, was supposed to have been, and was told by Prof. Ruehlmann, who has been a professor in that school since 1840, that no such professor was ever known in the kingdom of Hanover, nor had anything ever been heard regarding the experiments with electric light at Hanover in the early forties; he did not think it probable that they would have escaped his notice if they had ever been made. Prof. Ruehlmann thinks it probable that Goebel evolved all his alleged experiments out of his inner consciousness, and that they have no foundation in fact. Mr. Tanner next visited Goebel's home at Springe, where he met some friends of Goebel, who stated that he was no watchmaker nor optician, but was chiefly engaged in selling and repairing clocks; they also said that they had never heard of a Prof. Moenighausen; a visit to his cottage showed that it was unlikely that he ever built any machines there; his father never served as consul of the Netherlands at New York, being a gardener by profession. (Mr. Tanner also refers to Prof. Moenighausen as "Muenchhausen," a character of fiction, who, in German literature, is always credited with doing the most impossible things.)

Maximum Efficiency of Arc Lamps with Constant Number of Watts.—Referring to the question which arose at the Chicago Congress, a note in "L'Elec.," Jan. 20, describes briefly a method, and states that a maximum was obtained in the neighborhood of 900 c. p. for 54 to 55 volts and 8.4 amperes; for 10 amperes and 45 volts it was 450 c. p.; for 500 watts at 9 amperes and 55 volts the intensity was 1,200 c. p. It suggests that a similar series of experiments should be made with alternating arc lamps.

Auer-Welsbach Incandescent Gas Light.—According to a report from Athens in the "Elek. Zeitft.," Jan. 25, it was found that the introduction of this burner first diminished the number of lamps connected to the electric central station, but that after a short time these were again replaced with electric lights; the journal adds that the same experience was had in the city of Cologne.

Automatic Railroad Lamps.—The Lond. "Elec. Eng.," Feb. 2, gives a description, with illustrations, principally of the architectural features, of the charging station of the company providing such lamps in London.

Arc Lamps.—"L'Elec.," Jan. 20, gives an illustrated description of the Church lamp, in which the arc is fixed in position and the mechanism is operated by a vibrator; the lamp of Stekelorum and Mangin is operated by a brake acting on a train of gears.

Manufacture of Incandescent Lamps.—The illustrated serial in the "Elek. Anz." is continued in the issue of Jan. 28.

Cored Carbon Ligation.—The "Elek. Echo," Jan. 27, reprints at some length a communication on this subject.

TRANSMISSION OF POWER.

Mechanical and Electrical Transmission.—In the article in "Rev. de L'Elec.," Jan. 31, on "Central Stations in Belgium," it is shown that the cost of transporting electrical energy is 36 times as great as the cost of its production, from which it is concluded that it would be more economical to produce mechanical energy at a single point outside of the city, to transmit it as such, and to transform it into electricity in a large number of places near the points of consumption; calculations substantiating this are promised in a subsequent

article. (This system appears to be that proposed by Van Rysselberghe, mentioned in the Digest Oct. 7.)

Transmission of Power at Chambéry.—A note in "L'Ind. Elec.," Jan. 25, states that the waterfall for this plant is 2,040 feet high, furnishing about 2,000 h. p., and is situated about 11 miles from the city; there will be seven alternators, each of 120 kilowatts at 5,000 volts, two of which act as reserves; the loss in the line will be less than 10 per cent., and the transformation down to 110 volts takes place through transformers of 10 kilowatts each; it is to be started next May. No mention is made of the kind of hydraulic machinery which is to be used for such an enormous pressure.

Transmission of Power at Lyons.—A short description of this installation is given in "La Lum. Elec.," Jan. 27.

ELECTRIC RAILWAYS.

High-Speed Railroads.—"L'Ind. Elec.," Jan. 25, abstracts an address before the French Society of Civil Engineers by its president, Bousquet, in which high speeds are discussed and some figures calculated for ideal steam locomotives, a deduction from which is that at 200 kilowatts (about 160 miles) per hour, the weight of the locomotive and the power would become infinite. The paper refers to steam locomotives only.

Application of Electricity to Public Works.—"La Lum. Elec.," Jan. 27, gives an illustrated description of the application of electricity in the construction of the new harbor works at Bilbao, Spain, in which huge blocks of stone, weighing 100 tons, were transported by a specially constructed crane, traveling on rails and operated electrically.

Regulations.—The Lond. "Elec.," Feb. 2, discusses editorially the meeting of the Traction Committee, at which the proposed regulations of the Board of Trade were discussed. The Lond. "Elec. Eng.," Feb. 2, also discusses this subject at some length.

Blackpool Railway.—A summary of the reports on the Blackpool Railway, in which a slotted conduit is used, is given in the Lond. "Elec.," Feb. 2. The report is contained also in the Lond. "Elec. Eng.," Feb. 2, where it is also discussed editorially.

Generators for the Saleve Railway.—The "Elek. Anz.," Jan. 21, publishes a good illustration of the large horizontal dynamos with external fields.

Bordeaux-Vigean.—"L'Elec.," Jan. 20, gives an illustrated description of this railway, installed by the Thomson-Houston company.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Central Stations in France.—"L'Ind. Elec.," Jan. 25, publishes as a supplement a long list of all the central stations for the distribution of electric energy in France on the 1st of January, 1894; tabulated information is given in each case, the table being more complete in this respect than such tables usually are; the city of Paris is not included. A map of France accompanies it, on which are marked the locations of all the stations, different marks being used for distinguishing between alternating and direct current plants. Six months ago, when a similar table was published, the number of stations was 255, while at present it is 301; the total horse power is 38,200, of which 9,259 is furnished by water power alone, 6,000 by water and steam power combined, 21,820 by steam power and the rest by gas. Of all the stations 136 are operated by hydraulic power, 113 by steam power, 36 by steam and hydraulic power, 3 by power gas and 13 by municipal gas; 248 are continuous-current stations, 47 alternating and 6 continuous and alternating combined. A number of important stations are to be started in which power gas and polyphase currents are to be used; 115 stations are projected and in course of construction.

Polyphase Installation in 1893.—"L'Ind. Elec.," Jan. 25, gives the following summary of installations at present in

operation: France, 3 installations of triphase currents; St. Etienne, Pont-Lignon and Florensac, all like the installation at Lautten-Heilbron; Germany, 4 installations, also with triphase currents, Lautten-Heilbron, Bockenheim-Frankfort, Erding and Wangen; Austria, 2, Pergine with three-phase and Budapest with two-phase currents; America, one at Redlands, Cal.

High vs. Low Voltage.—An editorial in the Lond. "Elec. Rev.," Feb. 2, discusses this subject, but without apparently giving anything new; it quotes Mr. Ferranti as saying "the electric light industry would be benefited if pressure were higher and the cost lower"; regarding accumulators, it states that although most continuous-current stations have a battery, few of them seem to make use of it, spare steam power seeming to be preferred for meeting extra demands. "The benefits of storage, when carried out on a large enough scale, are evidently very great, but it must be on a scale to enable the supply to be made almost wholly from the batteries, using the machinery and running it continuously for charging only." If the voltage of the lamps could be doubled and the current halved, the mains would carry current for twice the supply; (this statement seems to us to require some modification; unless the mains are used near to their heating limit, which they generally are not, except in the case of short mains, double the voltage would increase the carrying capacity fourfold, assuming, as is generally done, the same percentage loss.)

Direct vs. Rope Driving.—In a communication to the Lond. "Elec. Rev.," Feb. 2, Messrs. Willans & Robinson show that a recent statement made by Mr. Ruddle, that there was about as much rope or belt driving as direct driving in England, is not correct; they claim that the proportion is far greater in favor of direct driving. The subject is also discussed editorially in the Lond. "Elec.," Feb. 2.

Accepting the Lowest Bids.—An editorial in the Lond. "Elec. Rev.," Feb. 2, on "A Main Consideration," discusses the bad policy of accepting the lowest bids, calling attention to the importance of the insulation of the mains and the absorbent action of poor insulating material, which causes trouble at the joints.

Luminous Fountains.—The "Elek. Anz.," Jan. , gives an illustrated description of the Engelsmann system, in which no expensive underground construction is required; a system is illustrated in which 12 radial jets are illuminated internally by the use of only three lamps.

Liverpool Stations.—The Lond. "Elec.," Feb. 2, abstracts a paper by Mr. Holmes on the distribution from a commercial standpoint.

London.—The station of the Metropolitan Company is described in "L'Elec.," Jan. 27.

Motive Power and Gearing.—In Mr. Carter's serial in the Lond. "Elec.," Feb. 2, he discusses the subject of fuels.

WIRES, WIRING AND CONDUITS.

Gutta-percha and Rubber Cables.—The Lond. "Elec. Rev.," Feb. 2, quotes from the "India Rubber World," in which a writer states that gutta-percha is best for deep-sea cables, while rubber is best for rivers and harbors; the best cable should be made with gutta-percha inside and rubber outside, so as to protect the wire from the sulphur and the gutta-percha from the atmosphere.

Wiring Light on Shipboard.—The Lond. "Elec. Rev.," Feb. 2, comments on fires caused by bad wiring, especially by bad joints, and states that nothing but armored cables are good enough for ship work, jointed by properly designed cast-iron boxes, made water tight, in which case the wires cannot possibly cause a fire. The Lond. "Elec. Eng.," Feb. 2, also discusses this subject.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telegraphy and Telephony of the World.—The Lond.

"Elec. Rev.," Feb. 2, quotes from the "Jour. Teleg.," giving the statistics for 1892 and 1893; for the latter they were as follows for telegraphs: Total length of line, 1,661,300 kilometres; submarine cables, 250,000; total length of wire, 4,910,070; total number of messages, 336,052,000, providing a revenue of about \$100,000,000; in 1892 the telephone systems had a total length of wire of 972,113 kilometres, over which 982,387,416 conversations took place; Great Britain is not included in this summary; the number of conversations in America is about two-thirds of the total; Switzerland and Sweden are best in the number of subscribers per population, which are 5 and 5.82 per thousand respectively, the general average for the world being 1 per 800.

French Cable Enterprise.—The Lond. "Elec.," Feb. 2, discusses recent French cable enterprises, giving maps of the proposed cables joining the West Indies with South America; also of the cables on the east coast of Africa.

Pacific Cables.—Lond. "Elec.," Jan. 19, contains a short article by Mr. Hancock.

Railroad Signals.—Mr. Teirich in the "Elek. Zeitft.," Jan. 25, describes a system with an automatic danger signal in case of breakage of the wires.

Telephone Receivers.—An illustrated description of an improved receiver is given in the Lond. "Elec. Eng.," Feb. 2.

Interchangeable Telephone Switch.—Lond. "Elec.," Jan. 19, describes and illustrates the Sloper switch.

ELECTRO-CHEMISTRY.

Electro-Zincing Process.—In the Lond. "Elec. Rev.," Feb. 2, the Cowper-Coles process of plating or galvanizing large steel plates by a cold process is described and illustrated; the installation is capable of coating plates 18 feet long; it is claimed that the cost is very much cheaper than the usual hot galvanizing, being about half in the case of plates, and as the process is a cold one, there is no distorting or warping, nor diminution in the strength of the steel; the current density used is 50 amperes per square foot; a table gives the results of tests of the tensile strength of various pieces before galvanizing, after hot galvanizing and after being zinc plated, the tensile strength in the latter case being in all of the three specimens appreciably greater than that for the hot galvanized steel; while the zinc on galvanized steel peeled off on stretching, that on the plated steel remained intact; no further information is given.

Electric Production of Varnish.—According to "La Lum. Elec.," Jan. 27, the Pfanne process is as follows: An electric current is passed for two or three hours through an intimate mixture of pure linseed oil, water and sulphuric acid; it is necessary to agitate the mixture continually, which is done by an agitator turning alternately in different directions; the agitator is connected to one pole and the vessel to the other; no further information is given.

Copper Baths.—The note under this heading in the Digest, Feb. 10, appears to have been based on an incorrect report. According to the "Elek. Zeitft.," Jan. 25, Dr. Langbein's improvement consists in the use of cuprocupriesulphite in place of the usual salts, and it is with this that he obtained the result that not even a trace of cyanogen is given off; the salt is soluble in cyanide of potassium, but not in water.

Electro-Chemical Cementation.—The Lond. "Elec. Rev.," Feb. 2, mentions briefly a method of Mr. Conedara, whereby the copper may be separated from solutions by means of iron electro-chemical cementation.

Dry Cells.—The serial of Mr. Zacharias is continued in the "Elek. Anz.," Jan. 21; a reply is published in the issue of Jan. 28.

MISCELLANEOUS

Lightning Rods.—An article in the "Rev. de l'Elec.," Jan. 31, calls attention to the difficulty of proving by statis-

tics whether or not lightning rods should be used; belief is expressed that lightning rods do protect and that a bad one is better than none, the protection being better the better the rod is constructed; a number of cases are cited; in one there was a very bad lightning rod, and yet it protected a building during a certain storm; it is argued that if it had been good there would have been no bolt of lightning; in some cases buildings with rods were protected while those without and in the neighborhood were destroyed; in the case of a certain church one spire was protected, while some of those having no rods were destroyed; in the case of vessels, those in which the masts are metallically connected with the iron hull have never been struck, while wooden ones have; the damage done by lightning in Germany amounts to from two to two and one-half million dollars per year. It quotes Lord Kelvin as having said that in Scotland it is cheaper to insure a building than to furnish it with lightning rods.

Starch.—According to "La Lum. Elec.," Jan. 27, Mr. Schaeffer has issued a report on different samples of fecules purified by the Siemens & Halske process of transforming the ordinary fecule of commerce into more soluble products, which are whiter and have no odor; the process, according to "La Nature," consists chiefly in a treatment by electrically generated ozone; all the samples were perfectly white and had greater thickening power than the finest fecule of commerce, and the starches made with these do not change in five days, while those made by the ordinary process liquefy in 24 hours; no information is given regarding the cost of the process.

Electricity in Plant Growth.—The Lond. "Elec. Eng.," Feb. 2, gives a brief account of a long series of experiments by Dr. Romanes on mustard seedlings exposed to constant electric light and to interrupted flashes, respectively, and he finds that the heliotropic influences of sparks or flashes is greater than can be produced by any other light; a strange feature was that his remarkable results were not accompanied by the formation of any particle of chlorophyl.

Flying Machines.—The "Elek. Tech.," Jan. 15, mentions that the Austrian Society of Engineers and Architects is about to undertake to construct the machine proposed by Prof. Wellmer. The wheel is to be 5 metres in diameter and 2 metres wide, and to have the required speed (peripheral?) of 45 metres per second; it is to be driven electrically or by steam; either the direct force will be measured or it will be so arranged that it will propel itself up into the air.

Healing Frozen Noses.—In an abstract in the "Elek. Echo," Jan. 27, Dr. Helbing has been successful in twenty cases, the treatment being to apply both poles to opposite sides of the nose and to pass a moderately strong current for five or ten minutes, moving the electrodes about; the immediate result is a reddening of the tissues, which may last several days; in some cases ten to fifteen applications are necessary.

Central Station Currents in Therapeutics.—An abstract of Mr. Gaiffe's paper, mentioned in the Digest last week, is given in the Lond. "Elec. Rev.," Feb. 2.

Corrugated Coverings.—The "Elek. Zeitft.," Jan. 25, gives an illustrated description of a new form of corrugated paste-board, resembling the outline of a dove-tail joint, which is used as an insulating material and for the protection of telegraph poles where they are inserted in the ground.

Mechanical Applications.—Mr. Richard's well-illustrated serial is continued in "La Lum. Elec.," Jan. 27, in which a number of applications are described.

Biographical.—"L'Ind. Elec.," Jan. 25, publishes a biography of Heinrich Hertz by Mr. Guillaume, in which he gives chiefly a short resume of the work done by this physicist. The "Rev. de l'Elec.," Jan. 31, reprints from the

"Jour. de Geneve" a brief description of his important work in electrical researches; among all those published recently this is the best brief description of the researches which made him famous.

Educational.—The "Elek. Zeitft.," Jan. 25, gives a report of a course of instruction in electricity in a trade school for mechanics.

From the Convention City.

I CONSIDER THE ELECTRICAL WORLD almost indispensable to any one who wishes to be well informed. I hope I may never be deprived of reading its very interesting and instructive pages.

Washington, D. C.

F. D. NEALE,
R. and P. Division, War Dep't.

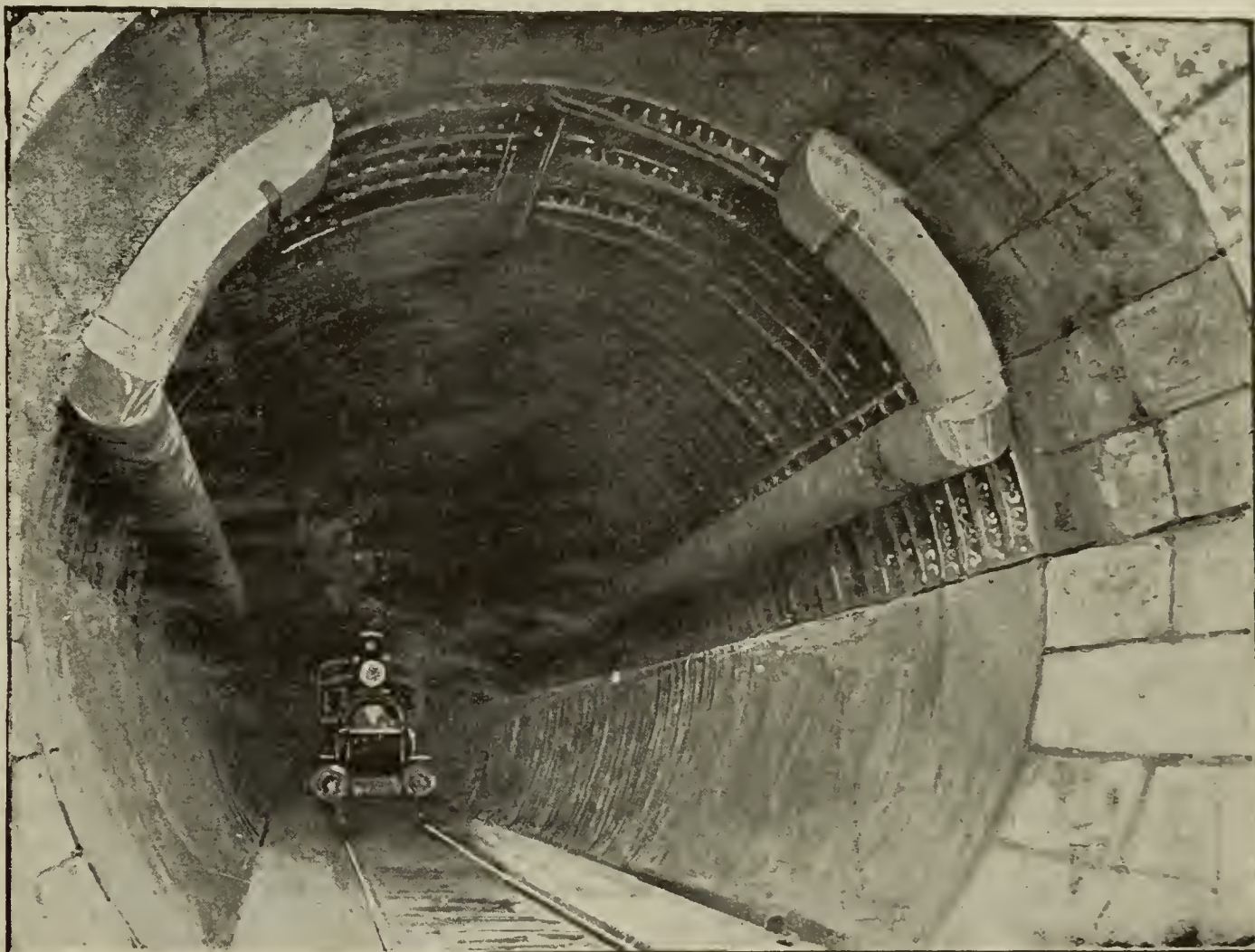
Praise from the Dominion.

The existence of such a remarkable journal as The Electrical World is significant of the enormous development of electrical interests in the United States within the last dozen

terminated by experiment had been taken from a report by Mr. Charles Hewitt. It should have been more clearly specified that the items referred to were deduced from information in Mr. Hewitt's report, and are those relating to the cost of power, repairs to motors, oil, waste and packing. Mr. McDougall merely availed himself of valuable general data contained in the report relating to these points, and for any other implication unintentionally conveyed the writer of the article, and not Mr. McDougall, is responsible. We have thought that this explanation is due both to Mr. Hewitt and to Mr. McDougall.

The St. Clair Tunnel.

The Grand Trunk Railway, in order to establish communication between Sarnia and Port Huron, constructed an immense tunnel under the St. Clair River, which is one of the finest examples of engineering work in this country at the present day. The length of the tunnel proper is 6,025 feet, and of the portals that form the approaches 5,605 feet additional, or more than two miles in all, being the longest



INTERIOR OF THE ST. CLAIR TUNNEL.

years. The contents of the present issue are of such variety and scope as to lead to the belief that all departments of electrical work, whether power, light, heat or communication, are within its grasp. And not only this, but the various subjects are treated in a manner and with an ability which merits high praise. Besides the editorials there are papers by Prof. Elihu Thomson, W. A. Rosenbaum, W. Stuart-Smith, Townsend Wolcott, and the "Digest of Current Technical Literature" is a valuable resume of European thought and experiment. The paper has correspondents in London, England, and in Canada.—Monetary Times, Toronto, Can.

Storage Battery Traction.

In an article under the above caption in our issue of Feb. 3, it is stated, explanatory of an estimate of cost of operation, that the data there given which were not directly de-

submarine tunnel in the world. It is a continuous iron tube 19 feet 10 inches in diameter, put together in sections as the work of boring proceeded and firmly bolted together, the total weight of iron aggregating 56,000 pounds. The tunnel commenced in September, 1888, was opened for freight traffic in October, 1891, and passenger trains began running Dec. 7, 1891. Work was commenced at both ends, the two sections meeting in mid river with perfect accuracy. The tunnel passes through blue clay, except an occasional pocket of quicksand and water and a few boulders. Borings were made by cylindrical steel shells, with cutting edges driven forward by hydraulic rams.

One of the accompanying illustrations gives some idea of the course of the tunnel and the steep grades on either end.

The rails of the track rest on a bed of brick and concrete, filling the bottom of the tubing. The engines, built by the Baldwin Locomotive Works, used to pull trains

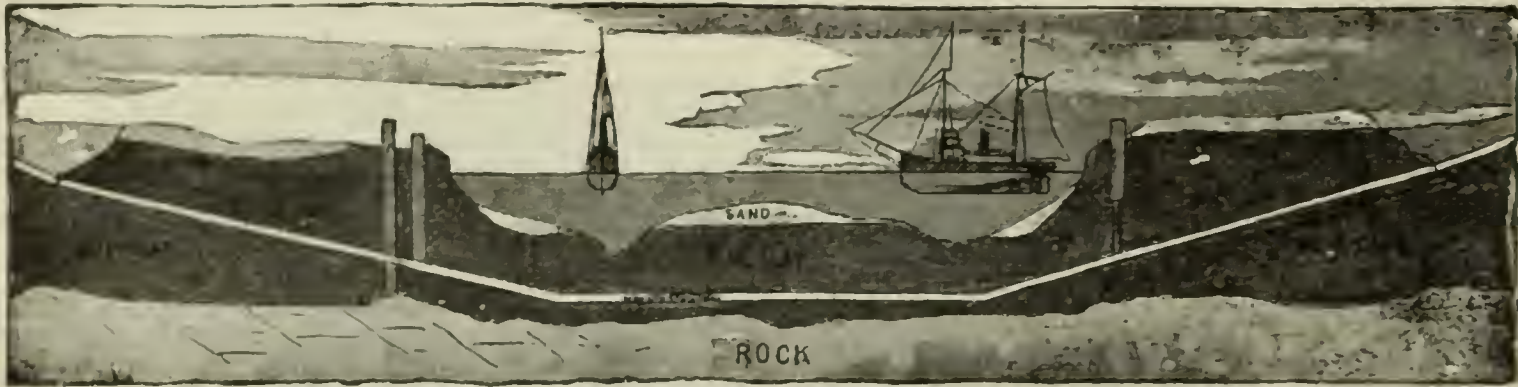
through the tunnel and up the steep grade, are the largest in the world, having ten driving wheels and weighing nearly 200,000 pounds, with cylinders 22 inches in diameter, with a 28-inch stroke.

The cost of the tunnel was \$2,700,000. Four thousand cars can be daily moved through it, which shows its immense superiority over the old ferry. The enterprise was promoted by Sir Henry Tyler, of England, president of the Grand Trunk Railway, assisted by Sir Joseph Hickson, late general manager. The engineers were Joseph Hobson, chief; T. E. Hillman, first assistant, and M. S. Blakelock, second assistant. Electric lights were employed for illumination during the construction, the plant being furnished by the Edison Company on the American side and the Ball Electric Light Company on the Canadian side.

The Great Northwestern Telegraph Company of Canada was obliged to carry its lines through this tunnel, and this

simultaneously. To obviate the necessity of charging the heater with steam at intervals, a stove enclosing a coil is placed underneath the platform of the car and this enclosed coil is connected with the steam chamber of the heater. When the steam with which the heater has been charged condenses, the condensed water flows into the coil by gravity, in consequence of one end of the storage heater declining toward the stove, and is again made into a steam and returned to the steam chamber of the heater. In this manner the car can be heated for an indefinite period. Should the fire in the stove, through some unforeseen cause, become extinguished, there is at all times sufficient heat retained by the storage heater to keep the car warm from five to seven hours.

It is a perfectly simple matter to equip any construction of horse, cable or electric cars with these heaters. As they take up no valuable space in the cars, the cost of the ap-



SECTION OF ST. CLAIR TUNNEL.

large contract for cables was secured by the enterprising American firm of W. R. Brixey, New York City. Six thousand feet of 18-conductor aerial kerite cable was required for this purpose, and it is stated by the Great Northwestern company that in spite of the severe test to which it has been subjected during the past two years it has given perfect satisfaction.

Street Car Storage Heating System.

The accompanying illustrations represent the details of a storage heater manufactured by the Gold Car Heating Company, Franklin and Cliff streets, New York, which possesses several features of interest, and whose value has been demonstrated by the best of tests—long practical use.

The storage heater shown is of sufficient length to be

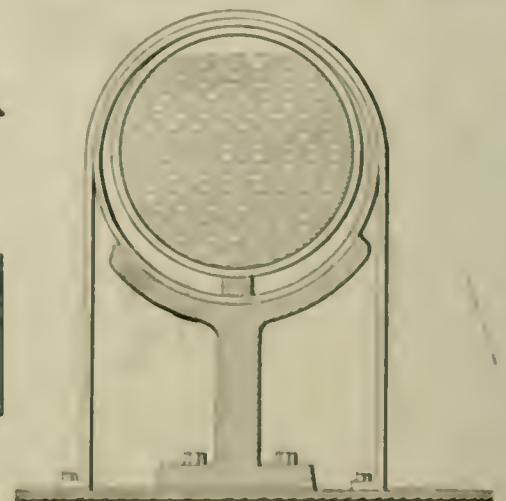
paratus is saved in a very short time by the seating capacity otherwise taken up by a car stove. A pleasant hot water heat is radiated uniformly through the car, and in damp or wet weather the floor is always kept perfectly dry.

All the fittings and parts of the apparatus are of the best quality, and will therefore last as long as the car remains intact. No repairs are needed, and as past achievements are the best promise of the future, the makers cite the fact that over 15,000 of these heaters have been in use on the largest railroads of this country and Europe for from two to ten years, and yet not one of them has required any repairs whatever.

A very thorough test of this system was recently made by the Third Avenue Railroad Company of New York, and for two weeks, during which the thermometer continually registered below 25 degrees, the car in which the Gold heater



SECTION OF CAR, SHOWING STORAGE HEATER.



SECTION OF HEATER.

placed longitudinally under the seats of a car, and consists of a five-inch boiler tube, enclosing a cylinder four and one-fourth inches in diameter, hermetically sealed at both ends and filled seven-eighths full with a strong solution of non-freezing liquid. When steam is turned on it passes between the outer tube and the interior cylinder, and consequently the warming of the car and the storage of heat commences

had been installed was thoroughly heated, to the expressed satisfaction of both the railroad officials and the traveling public, the temperature being maintained at over 70 degrees under every possible condition.

In a test made on Saturday, Jan. 13, 1894, on car No. 424 of the Third avenue cable road, running between Fort George and the East River at 125th street, during ten hours

between 1:30 and 11:30 P. M., the temperature inside of the car was continually above 70 degrees, while the temperature outside ranged from 32 to 27 degrees. Thirty-eight pounds steam pressure was on the heater from 12 to 12:45, at which time the fire in the stove was started. The temperature of the car when the steam was turned on was 32 degrees, and when the fire was started the temperature was 65 degrees. The amount of condensation when steam was shut off, at 12:45, was 37 pounds, and when the car was laid up 19 pounds. Thirty-five pounds of coal was used in the stove during the test, but there was sufficient coal in the stove when the trial was completed to last for nearly two more trips, or nearly three hours.

The total condensation during the test was 56 pounds, to produce which, under the conditions existing at the time of the trial, would require the use of seven pounds of coal. This, added to the 35 pounds of coal put in the stove, would amount to 42 pounds and would cost 82-5 cents for heating the car for fourteen hours.

Independent Air Pump and Jet Condenser for Power and Central Stations.

The apparatus illustrated consists of an independent air pump and jet condenser of large capacity. The exhaust steam from the main engines, pumps, etc., is admitted into the top of the condenser and on its descent is met by a fine spray of cold water coming in the opposite direction through a copper spray pipe, thereby producing a complete mechanical mixture of the steam and injection water. The steam is thus condensed, a vacuum formed and the air pump removes the condensed steam and injection water from the condenser, the action being continuous. The condenser is provided with the Davidson "automatic vacuum breaking device," consisting of a copper float and valve opening to the atmosphere. Should the water in the condenser rise above a safe level, the ball float, acting on the valve, secures an immediate connection with the atmosphere, which destroys the vacuum in the condenser and stops the flow of injection water. It is consequently impossible for the water to back up, prime the engine cylinders and cause the serious damage resulting from the use of some forms of condensers.

With a condensing apparatus a considerable saving in fuel or an increase of power can be had at small cost where water is available, and the manufacturer of the apparatus described, M. T. Davidson, 43 Keap street, Brooklyn, guarantees an increase of 25 to 30 per cent. in power through its use. Where additional power is not required, a saving in fuel of

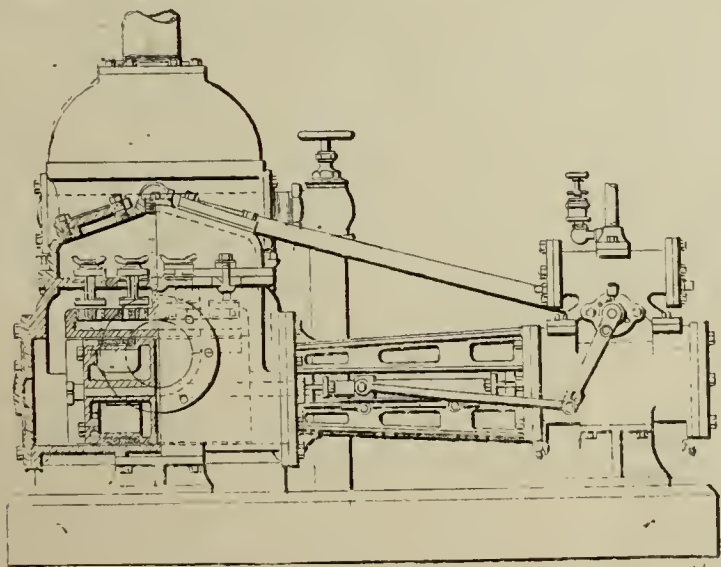
engines which it serves, against 5 to 7 per cent. in the ordinary condensing apparatus, with its air pump a component part, and this power is not taken from the engine, where it is most expensive, but direct from the boiler. The quantity of injection water required in this latitude will be about 20 to 25 times the amount required for the boiler. The condensing water, after leaving the condenser for the hot well, should have a temperature of about 100, and can be used for boiler feeding. When a closed feed water heater of any pattern is already in use, it need not be laid aside, as it will act as a surface condenser between the engine and the independent condenser, and increase the temperature of the feed water so that it can be returned to the boiler at a temperature of about 150.

A single condenser can be used for two or more engines, for pumps, etc., any or all of which may be stopped without interfering in the least with its action. Being wholly independent of the engine, it can be started to free the cylinder from water and form a vacuum before starting the engine. In its operation it assists in regulating the running of the engine, particularly when the load is variable.

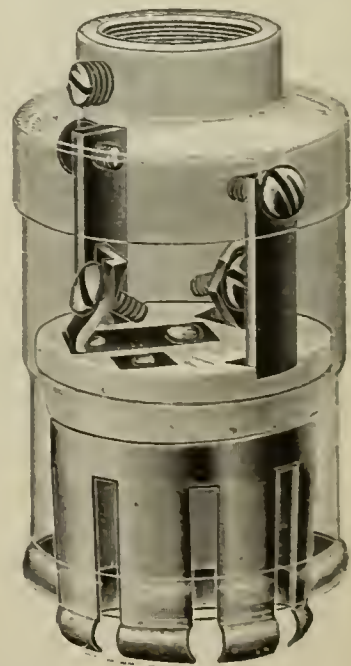
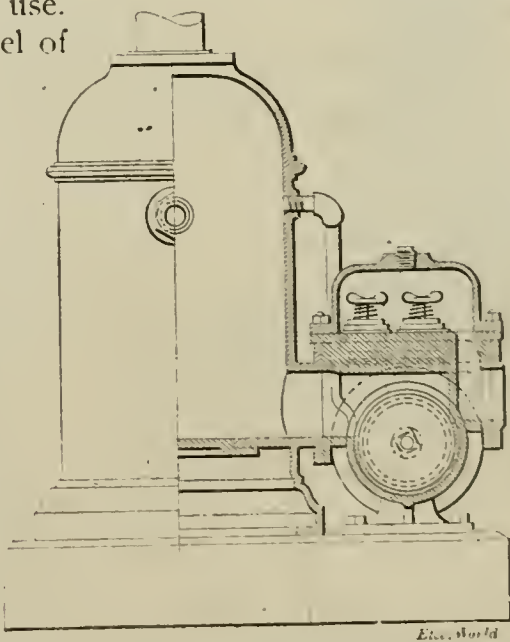
This condenser requires no steam pump (which is necessary with some forms of condensers) to lift its injection water, as it will lift from any point that can be reached by pumps in general use, and requires no attention whatever beyond starting and stopping; once started, and the steam and injection water adjusted, the apparatus is automatic. It can be set up by any mechanic, it being only necessary to select the most convenient place for water connection and lead the exhaust from the engine to the apparatus. In most cases no masonry foundation is required, and but little more floor space than is occupied by a common steam pump. It is noiseless in its operation, and its location in the engine room is entirely unobjectionable. By the use of two-gate valves or a three-way cock the condenser can be shut off at will, leaving the engine simply non-condensing, and by the use of the Davidson automatic exhaust relief valve this change can be made automatically.

New Keyless Socket.

The accompanying cut shows a new style of keyless socket designed especially for street fixtures, brackets, etc., where a socket is required to screw on a pipe through which wires are led to the socket. The nipple is threaded for 3-8 gas pipe, and by reference to the cut it will be seen that



INDEPENDENT AIR PUMP AND JET CONDENSER.



KEYLESS SOCKET.

20 to 25 per cent., or a reduction in boiler pressure, which in many cases is desirable, may be obtained. The power required to operate this condenser and air pump is claimed to be not more than 2 or perhaps 2 1-2 per cent. of that of the

there is ample room within the socket for disposing of the leading-in wires. The sockets are made to fit S. M., T. H. and Edison lamps, and are manufactured by the Iona Manufacturing Company, 336 Congress street, Boston, Mass.

Imperial Dry Battery.

While the Imperial battery we illustrate has been on the market for more than three years, it has only been within the past year, since Mr. Burnley has connected himself with the Miamisburg Electric Company, Miamisburg, Ohio, that they have been manufactured in sufficient quantities to supply the demand. Advantages of this battery are that the depolarizer used does not become a dead weight or resistance, and it is not possible for the battery to deplete itself by used-up depolarizing matter, and, therefore, the possibility of internal short-circuiting is eliminated. It consumes material only when the circuit is closed, and will not, therefore, deteriorate when not doing work; thus giving back in actual service rendered an equivalent for money expended and possessing the superior merit of holding its initial force over long periods of time, enabling dealers to place them on their shelves without an appreciable deterioration. They are slow to polarize and quick to recuperate and not liable to rapid failure, and it is almost impossible to deplete the cell by exhaustive work so that it will not do good service; hence, its efficiency is all that could be desired. They are hermetically sealed and remain so, and will not boil over or burst the seal, and oozing of the salts from the top is entirely eliminated. Its internal resistance is small and possesses a high and quite constant E. M. F. The Imperial is not a closed-circuit battery, and should not be so used, but it is intended for all purposes for which an open circuit battery is used, and is constructed to meet all the conditions



IMPERIAL DRY BATTERY.

required for such a battery by the general trade. Its voltage is 1.5 and amperage from 7 to 10. Where higher amperage is wanted special batteries are made.

The Empire State Radial Truck.

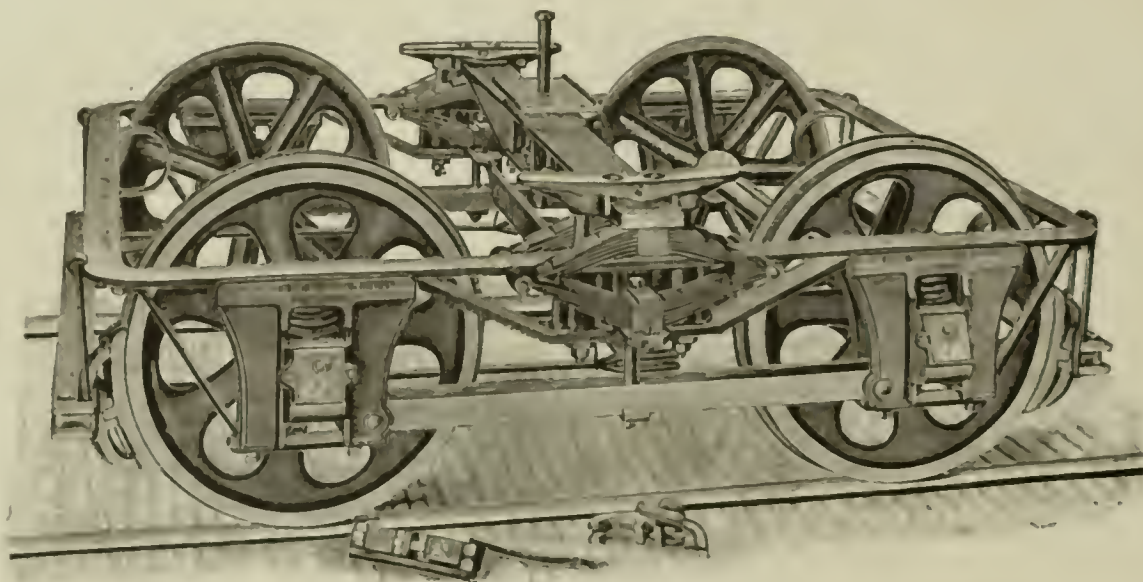
The truck we illustrate, manufactured by the Taylor Electric Truck Company, Troy, N. Y., is designed on the radial principle; that is, the traction is applied from a point central to the four wheels and not from plates on the side of the frame, and is claimed to be the only radial truck designed for electric motors in which the car body is supported by elliptic springs, and the only one that can be run safely around curves at a high speed.

The sides are composed of two steel bars placed edgewise, firmly bolted together, and secured at each end by trussed end bars, and in the centre by two heavy wrought iron bars placed edgewise, which also afford a place for the attachment of the motor or cable grip. The independent rectangular frame thus made forms a rigid and substantial base for the construction of the truck. To the side bars are firmly bolted the pedestals or jaws that receive the axle boxes,

which slide freely between the vertical guides of the pedestal, thus keeping the axles parallel with each other, and resisting the pressure of the brake when applied to the wheels. On each side of the bottom of the pedestal are sockets which receive the adjustable angular braces supporting the ends and centres of the frame. Connecting the two arms of the pedestals is a strong steel stay, fitting tightly between shoulders. Entering the sockets of these stays are adjustable tubular braces, extending from pedestal to pedestal, and with the side bars and angular braces forming a simple, and at the same time a substantial truss, distributing the weight of car and the strains from motor and all other causes over the entire frame of the truck.

Above and resting on the axle boxes, and between the side bars, are half elliptic springs, engaging in yokes at their ends and giving a perfectly free and elastic action, which enables them to receive and reduce the shock and jolting so commonly experienced in electric cars. These springs also reduce the shock and strain on motors caused by obstructions on the rails or irregularities in the road bed. To further secure easy riding, at each end of the truck frame is placed a pair of elliptic springs, securely fastened to the trussed end bar. Upon these springs, but not fastened to them, is placed the body bolster, extending across the car and engaging the side sills by angle irons at each end.

The car body is fastened to the truck by king bolts placed in the centre at each end, and passing through the bolster and end bar. These king bolts are arranged with a coiled spring that bears against the centre of trussed end bar



IMPROVED RADIAL TRUCK.

upon the under side, and assists the full elliptic springs in preventing the end teetering of the car body.

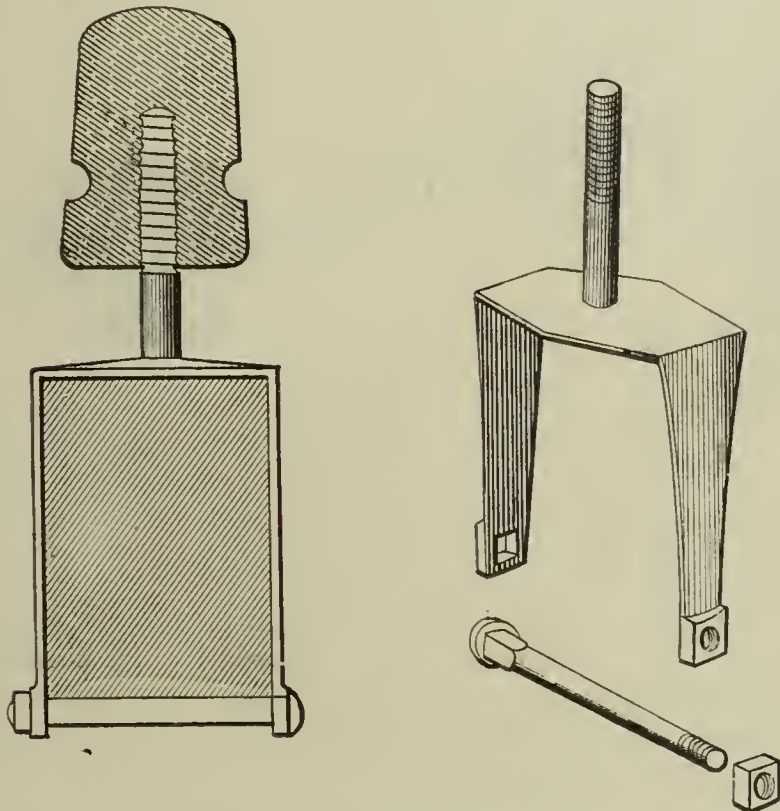
The truck is equipped with a compound lever brake, by which the power is applied centrally, and by which an even and direct pressure of the brake shoes is put upon all the wheels at the same instant, thereby stopping the car gradually and quickly. These brakes are so hung that the shoe adjusts itself to the periphery of the wheel whether the car is light or loaded, thereby securing a uniform wear of the brake shoe. The brake shoe is entirely independent of the brake head, and is held to it by a key, which can be readily removed, allowing the worn-out shoe to be replaced by another, without unscrewing a single bolt, thus saving time and expense. The brakes are also supplied with an adjustable releasing spring, which can be so nicely adjusted that each shoe can be set at an equal distance from the wheels. The brake rods are provided with quick-acting turnbuckles to take up the slack caused by wear, and all adjustments can be made from the sides, without the necessity of running the truck over a pit. When a motor car is used with a trailer, and both cars mounted upon this truck, an additional device can be attached to the brake by which both

cars can be controlled by the motorman, and the services of a brakeman on the trailer dispensed with.

From the above description it will be seen that solidity of construction is assured, and that any width of car frame can be used without change of construction. The durability is great, and little or no wear comes on the car body, and no uneven wear on the journals and bearings. All working parts of the motor are accessible without disturbing any part of the truck, and the truck can be quickly removed from the car body. By the peculiar combination of the elliptic springs there is no end teetering, even when running at a high rate of speed, and an easy and elastic movement is given to the car body, thereby obviating the shocks and unpleasant jolts so commonly experienced in electric cars.

Insulator Support.

The insulator support we illustrate, manufactured by Henley & Lauder milk, Paris, Tenn., obviates the employment of holes in the cross arm of the pole. It can be adjusted to any desired point on the arm and there rigidly clamped in position. It will protect the cross arm from weather cracks, and in a measure avoid inside decay, as the device is entirely external of the arm, and no holes are necessary which would



INSULATOR SUPPORT.

admit water. The employment of the improved support renders the cross arm stronger and more durable, as it does not require to be perforated for the passage of the ordinary insulator pin, and for the same reason the size of the cross arm can be reduced. The support can be quickly and conveniently applied or removed, and where there are more wires on one side of the pole than the other side an efficient balance can be obtained by adjusting the supports on the side carrying the least number of wires furthest from the pole.

A Telephone Exchange System.

An improved telephone switchboard exchange has been placed on the market by the Lockwood Electric Telephone Construction Company, 18 Columbia Heights, Brooklyn, N. Y., which claims unusual simplicity of construction and ease of operation. The main feature of the switchboard is a plug which takes the place of a spring jack, and which has a push button in the back end for the purpose of cutting in a local battery for signal purposes at the magneto bell, if desired. When the plug is placed in the hole in the switch-

board by the operator the metallic circuit is completed, and then by pushing the button it calls up both ends of the line. The switchboard and telephone connections are diagrammatically shown in Fig. 1, which also gives a detail of the plug. Each subscriber has a switchboard constructed upon this plan, with as many connections or holes for the plug as there are connections, and by placing the plug in the different holes, and pressing the button at the end he can



FIG. 1.—TELEPHONE EXCHANGE SYSTEM.

place himself in connection with any of the subscribers he may desire. When not in use the plug is placed in a ground hole.

Mr. William C. Lockwood was among the first in the telephone field, one of his patents on a magnetic transmitter, No. 233,360, bearing date Oct. 19, 1880, and the same year the Lockwood Telephone Company, of Chicago, was started. He has been actively engaged in the telephone field since then, producing a number of improvements, of which one was a practical system of direct-current telephony, patented in March, 1892.

The transmitter shown in Fig. 2 is an improvement on that of the patent of 1880. Its chief feature is an iron ring

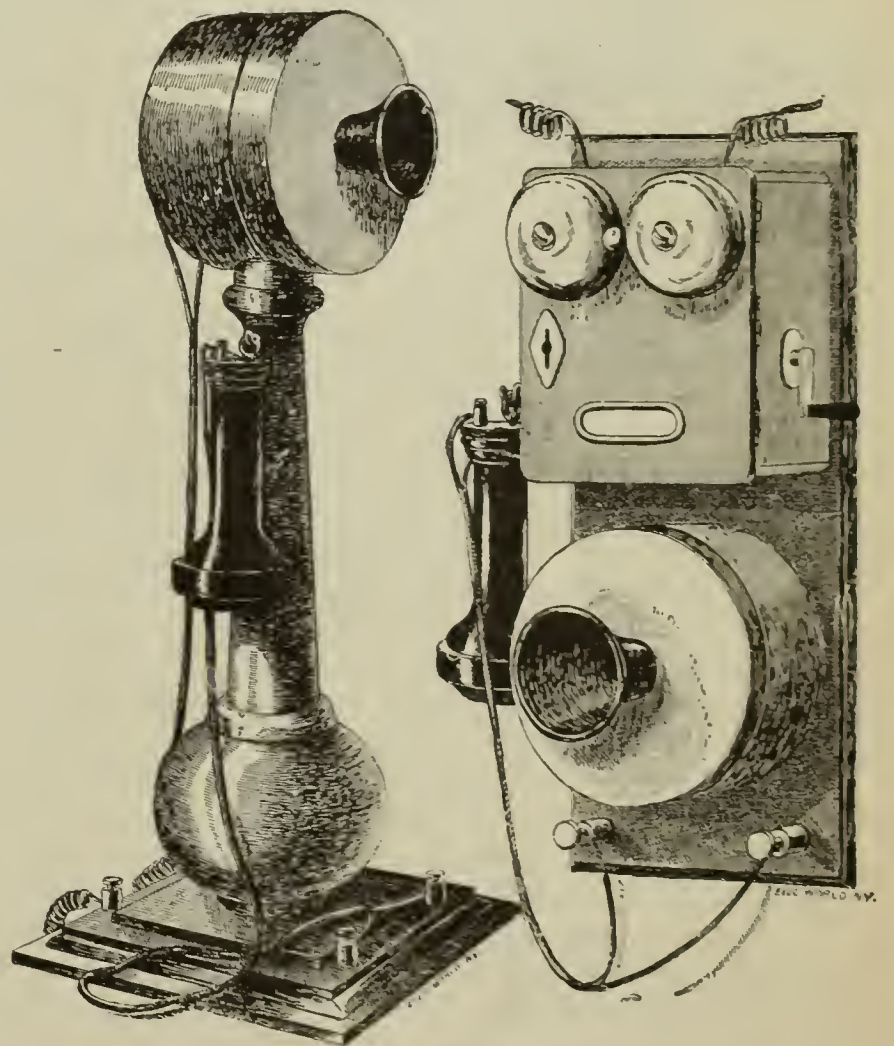


FIG. 2.—TELEPHONE EXCHANGE SYSTEM.

upon which the metal diaphragm rests, this iron ring in turn resting upon a mica ring, and it is claimed that this renders the instrument exceedingly sensitive. The illustration shows two styles, one being a complete set with magneto bells, etc., and the other a desk transmitter and receiver. It is claimed that this transmitter and receiver will work effectively 25 miles, and has been tested for a distance of 170 miles.

An Automatic Telephone Service.

The system of telephonic intercommunication which we illustrate, the invention of Mr. T. McCoubray, P. O. Box 34, New York, and formerly secretary of the National Electric Light Association, is designed for use in warehouses, stores, mills, factories, ships and large plants of every description. It is also especially adapted for use in small centres or villages where a limited number of subscribers would not justify the installation of an expensive exchange or central station and attendant operators.

The auto-service is designed so that when the operator at any one station is in communication with any other, the circuit is kept closed and the hand left free for use in writing, etc. When the hand-phone is restored to its normal position, however, a warning bell will ring continually until the calling key is released, thus opening the circuit and leaving the station ready to be called. In this system it is not necessary to place the hand-phone in any fixed relation to any other part of the apparatus; it is simply laid down any-



AUTOMATIC TELEPHONE SYSTEM.

where within the limit allowed by the flexible connections, and the station is always in such relation to the outlying stations as to admit calling up or being signalled to by any of them.

Another advantage is that when any station signals to any other a bell rings at both stations, and the picking up of the hand-phone by the operator at the outlying station changes the character of the signal at the station calling, thus giving instantaneous notice that the call has been heard and conversation may begin. This "return" ring thus demonstrates that the outlying station is being signalled, and insures the certainty of the circuit being in order. There is but one battery source required, and this is placed in some convenient place, where it may be inspected at any time, should the necessity arise, by the person in whose care it would be. The advantage of this single battery source is apparent, as, for example, where a system of 50 stations is employed, with this system but six cells of battery, all located at one place, would be required. In other systems there would be needed several hundred cells of battery to perform the same service, scattered in various parts of the territory, necessitating great expense and constant care. The signalling box—unlike other systems—has but a single key, which is used to place it in connection with any of the outlying stations. The signal operates only at the selected station, and does not ring up any other, except as desired. In this system there is no necessity of employing both hands—one to hold the telephone to the ear and the other to hold down the key or but-

ton; a very grave objection when the user has occasion to make memoranda. Where the necessity of using both hands in other systems does not exist, they involve the closing of a switch or the insertion of a plug; in either case, a neglect, through forgetfulness, to restore the line to its normal condition would render useless the signalling apparatus, which objection does not apply to this system, nor the objection of always hanging the telephone on a hook or placing it in some certain relation to the line to keep it in circuit. The apparatus illustrated is designed for eight stations, but the system may be applied to any number from two to one hundred, or more. Both a stand and a bracket transmitter are shown in the cut.

New Books.

A POCKET BOOK OF ELECTRICAL RULES AND TABLES. For the use of Electricians and Engineers. By John Munro, C. E., and Andrew Jamieson, M. I. C. E., F. R. S. E. Tenth edition, revised and enlarged. London: Charles Griffin & Co. Price, \$2.50.

This well-known work of reference has again been carefully revised and corrected to date for this, the tenth, edition. It has also been furnished with new matter, including the decisions of the recent Chicago International Congress of



Electricians in regard to nomenclature, but the authors do not include the notation countenanced by the congress, on the ground that it is not as good as their own, and suggest a combination of the two systems—a suggestion which will probably meet with little approval. Among the new matter is an illustrated description of a ballistic galvanometer, with directions how to use it in obtaining magnetic induction, permeability and hysteresis curves, as well as for determining the capacity of a cable or condenser in absolute measure; magnetization tests by the magnetometer method; five different tests on self and mutual induction, four on the measurement of low resistances and one on the efficiency of dynamos by Cardew's method; a description of the internal arrangements of and connections for Evershed's ohmmeter and for the Crompton-Pochin arc lamp, and Lloyd's rules for ship lighting. Several important tables relating to pure copper wire and incandescent lamps have also been added.

Electric Welding of Rails.

About 10 per cent. of the electrically welded rails in Boston have broken in service. The experiment proved that a continuous rail, protected by the pavement, shows no ill effect from expansion; but whether the rails broke from contraction or from inherent weakness due to the welding, is yet to be determined. Hereafter the entire end surfaces, including the head, will be united, and care will be exercised not to injure the fibre of the metal or to restrain the expansion due to the heat.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, Feb. 17, 1894.

ELECTRICAL STOCKS have been practically featureless this week—so far as any distinct movement in their quotations is noticeable. Neither Western Union nor General Electric has been the factor. One or the other generally is in the New York market, while Boston traders have deserted Westinghouse and Bell telephone for railway shares.

GENERAL ELECTRIC common stock has held its own this week with a firmness that has been very encouraging to interested parties. There is no doubt that many of the more timid bears have been forced to cover, and this is given as a reason for the recent strength. Many shrewd operators still profess to believe that the company's condition is not yet what it should be, and continue to prophesy further declines. They argue that much of the past business has been done at a loss, and that the margin of profit even now is very narrow. There is good reason for believing, too, that many insiders who bought their stock long ago have recently parted and are still letting go of their stock—in fact, to such an extent that the shifting of the control from Boston to the New Yorkers is now understood to be a real fact. If so, a radical change in the management at the coming annual meeting is assured, though there are technical denials in plenty. The Drexel Morgan-Vanderbilt-Twombly Interests now hold control of the stock to such an extent as to practically corner it, and already talk is heard of the election to the presidency next April of Mr. Twombly. Talk is, moreover, heard of scaling down the common stock, so as to wipe off the shrinkages in assets written off on the books of the company for the past six months and assure the return of dividends on both classes of stock, but as there are no immediate prospects of any distribution among stockholders, a director's point that the discussion is premature is well taken. On the other hand, people familiar with the workings of the company say that its finances are in excellent shape again and that with any revival in general trade resumption of dividends may be counted upon. An official statement is promised for March 1, showing that the company has no floating debt and no paper outstanding.

THE ELECTRIC CORPORATION gives notices to subscribers to the capital stock that they must surrender their subscription receipts to the American Loan and Trust Company to enable the directors to carry out their plan of postponing all further calls upon the several subscriptions for stock and of distributing the 7 per cent. debentures to those who have paid 50 per cent. of their subscriptions, the debentures being issued at par value to the amount of the subscription. Pending the issue of new subscription receipts, temporary receipts will be given. The removal of the Electric Corporation from the General Electric offices in Boston to new quarters gave rise to renewed reports of a Lynn syndicate to take the old Thomson-Houston works, but these statements are absolutely denied.

WESTINGHOUSE ELECTRIC common and preferred stocks have maintained the strength imparted to their quotation by the favorable announcements of last week. Pittsburg and Boston advices continue bullish, and great things are expected in the way of profits to the company from Mr. Westinghouse's new third rail system and the other plans in operation for the company's commercial welfare. The company will pay on March 1 interest then due on its scrip.

WESTERN UNION TELEGRAPH has had an appreciable advance in recent days. It is generally attributed to covering shorts for a prominent bear operator. It is thought that interests associated with the management have taken advantage of the covering movement to reduce their holdings. A director admits that the losses from the closing up of the pool rooms has been very great, but there are hopes that the loss of this business will be compensated in some way. The company is exercising all kinds of retrenchment in order to keep earnings up, and the net revenue, as a result of the great retrenchment, will not show up so badly as expected.

THE EDISON ELECTRIC ILLUMINATING COMPANY of New York makes a good showing in its January statement. Gross receipts were \$135,184, an increase of \$14,953 over January, 1893. Expenses were only \$58,340, so that net earnings were \$76,843, or \$10,643 more than last year. The company reports 195,848 incandescent lamps installed, or 48,977 more than a year ago; 2,649 arc lamps, a gain of 980, and 5,669 h. p. in motors, an increase of 1,777 h. p.

AMERICAN BELL TELEPHONE still furnishes Boston with a deal of gossip. Indications point to the speedy granting of the petition for an increase in the capital stock to \$50,000,000. One of the company's lawyers says that, if the request is refused, the company would remove to New York, where assent to the plan would be obtained. Although an inimical spirit to the Bell company has developed in both branches of the Massachusetts Legislature, it is likely that the threatened loss of the great revenue

that the State derives from taxation of the corporation will effectually dislodge any and all opposition.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York.....	50	20	35
Detroit Electrical Works.....	10	2	3
Cleveland General Electric Co.....	—	85	90
East River Electric Light.....	100	—	65
Electric Con. & Supply Co., pref.....	15	15	16
" " " com.....	15	15	17½
Edison Electric Ill., New York.....	100	96	98
" " " 1sts.....	—	105¼	105½
Edison Electric Ill., Brooklyn.....	100	99	102
" " " Boston.....	100	112	115
" " " Chicago.....	100	145	150
" " " Philadelphia.....	100	115	120
Edison Electric Light of Europe.....	—	—	3
" Bonds.....	—	80	85
" Ore Milling.....	—	5	12
Fort Wayne Electric.....	—	4½	6½
General Electric Company.....	100	36	36¾
" deb. 5's.....	—	72	74
Interior Conduit and Ins. Co.....	100	20	30
Mount Morris Electric.....	—	—	65
Westinghouse Consolidated.....	50	45	47
" " " pref.....	50	26	27
Western Union Telegraph.....	—	83½	83½

New Incorporations.

THE ST. LAWRENCE RIVER POWER COMPANY, Buffalo, N. Y., maximum capital stock \$2,500,000. The promoters are C. F. Whitteher, C. C. Conroy, B. Kittinger, J. G. Taylor, all of Buffalo.

THE METROPOLITAN ELECTRIC COMPANY, Reading, Pa., capital stock \$10,000, has been formed to supply light, heat and power. The promoters are R. Nelson Buckley, J. A. Rigg and R. B. Jones.

THE EAST SNYDER AVENUE PASSENGER RAILWAY COMPANY, Philadelphia, Pa., has been formed to construct and operate an electric railway. D. C. Golden, H. C. Murphy and J. C. Lugar are interested.

THE NEW YORK ELECTRICAL ENGINEERING COMPANY, New York, capital stock \$10,000, has been formed to construct electrical plants. M. M. Jacobs, F. G. Writer, F. D. Kivemore, New York, are the promoters.

THE LAKE STREET MANUFACTURING BLOCK, Chicago, Ill., capital stock \$350,000, has been formed to furnish and create light, heat and power for itself and others. D. J. Davis, T. Rankin and J. A. Woodbury are interested.

THE ANTHRACITE ELECTRIC LIGHT, HEAT AND POWER COMPANY, Scranton, Pa., capital stock \$25,000, has been formed to supply light, heat and power by electricity. W. S. Mears, A. H. Turner and F. W. Bleckley are interested.

HUNTINGDON STREET CONNECTION PASSENGER RAILWAY COMPANY, Philadelphia, Pa., capital stock \$6,000, has been formed to erect and operate an electric railway. G. W. Widener, W. L. Elkins and G. Yarrow are the promoters.

THE LACKAWANNA VALLEY STREET PASSENGER RAILWAY COMPANY, Mayfield, Pa., capital stock \$100,000, has been formed to construct and operate an electric railway. The promoters are W. Walker, J. D. Stocker and J. D. Caryl.

THE PLACERVILLE ELECTRIC COMPANY, Auburn, Cal., capital stock \$20,000, has been formed to light the streets, residences and business houses of Placerville. R. F. Burns, W. S. Graham and F. P. Tuttle, Auburn, Cal., are interested.

THE CHICAGO ELECTRIC COMPANY, Chicago, Ill., capital stock \$1,000,000, has been formed to manufacture electrical apparatus and to supply electricity for various purposes. W. M. Lenhart, J. W. Alderman and E. S. Norton are interested.

THE CHERRY STREET PASSENGER RAILWAY COMPANY. Philadelphia, Pa., capital stock \$12,000, has been organized to construct and maintain an electric railway in Philadelphia, Pa. D. C. Golden, H. C. Murphy and J. C. Lugar are the promoters.

THE CALIFORNIA COLONIZATION COMPANY, Los Angeles, Cal., capital stock \$100,000, has been formed to build electric light works, waterworks, etc., etc. J. J. Caspar, F. L. Alles, G. W. MacKnight and J. H. Case, all of Los Angeles, are interested.

THE CHICAGO ELECTRIC TRUCK COMPANY, Chicago, Ill., capital stock \$25,000, has been formed to manufacture and sell electric motor trucks, wheels and appliances for electric railways. C. W. Lyman, J. Fraser and G. H. Graham are the promoters.

INDEPENDENCE AND RUSH PARK STREET RAILWAY COMPANY, Independence, Iowa, capital stock \$25,000, has been formed to operate an electric or steam railway at Independence. Iowa. R. M. Campbell, Z. Stout and A. D. Guernsey, of that town, are the incorporators.

THE SUBURBAN RAILWAY AND ELECTRIC COMPANY, Elizabeth, N. J., capital stock \$750,000, has been formed to construct and operate street railways. J. S. Bartlett, C. H. Newhall, Lynn, Mass.; W. B. Hosmer, Boston, Mass., and J. B. McGiffert, Roselle, N. J., are the organizers.

THE ELECTRIC STORAGE AND EQUIPMENT COMPANY, Chicago, Ill., capital stock \$250,000, has been formed to manufacture electrodes for storage batteries, rheostats, switches, and

lights, dynamos, etc., and to equip cars, etc. E. W. Applegate, O. R. Stratton and H. B. Lindley are interested.

THE UNIVERSAL INDEX CLEAT COMPANY, Jersey City, N. J., capital stock \$75,000, has been formed to manufacture and sell cleats for holding and carrying electric wires. G. E. Evans, Jersey City, N. J.; J. D. Gould, Boston, Mass., and H. L. Washburn, New York, N. Y., are the incorporators.

THE STERLING SUPPLY AND MANUFACTURING COMPANY, New York City, capital stock \$15,000, has been formed to manufacture supplies for electric, cable, horse and steam railways, etc. W. D. Baldwin, W. H. White, Jr., and J. R. Furman, all of 38 Park Row, New York, are interested.

THE MUSKINGUM ELECTRIC COMPANY, Zanesville, Ohio, capital stock \$50,000, has been formed to construct and operate electric plants to manufacture and distribute electric currents for light, heat and power. G. L. Foley, T. J. Barton, L. G. England, E. L. Winchell and W. D. Chapman are interested.

THE AUERBACH-WOOLVERTON ELECTRIC COMPANY, Jersey City, N. J., capital stock \$1,000,000, has been formed to manufacture and sell under letters patent of the United States electric arc lamps. G. L. Record, Jersey City, N. J.; S. H. Schwarz and J. S. Collard, New York, are the interested parties.

THE MERCHANTS' ELECTRIC LIGHT AND POWER COMPANY, Gainesville, Tex., capital stock \$25,000, has been formed to erect and operate electric light, heat and power machinery for generating light, heat and power. C. A. Zicker, San Antonio, and W. H. McGaw and E. J. O'Beirne are the promoters.

THE TAMA AND TOLEDO RAILWAY AND LIGHT COMPANY, Tama, Iowa, capital stock \$50,000, has been formed to build and equip an electric railway from Tama to Toledo, Iowa, and also electric light plants. L. H. Ong, W. B. Ong, both of New Sharon, and D. S. Couch, of Colfax, Iowa, are the promoters.

THE ELDORADO LIGHT AND FUEL COMPANY, Eldorado, Kan., capital stock \$75,000, has been formed to generate and supply electricity and fuel gas; also to construct electric and gas plants, street railway lines, etc. R. Hatfield, O. H. Beatty, H. Burnett, W. G. Thomas, and R. E. Lawrence, all of Wichita, are interested.

WADDINGTON, N. Y.—The Erie Construction Company, \$100,000, has been incorporated to develop the water power in the vicinity of Waddington. The officers are Chas. C. Conroy, president; Chas. F. Whiteher, secretary, and Wm. Hemming, treasurer. They propose to develop power for electricity to supply to factories.

THE BAKER ENGINEERING COMPANY, Seattle, Wash., capital stock \$25,000, has been formed to construct and equip steam railroads, telephones, electric lines, waterworks, etc., and to engage in the manufacture of electric and steam machinery. F. H. Coe, A. M. Brookes, C. H. Baker and John Fairfield are the promoters.

THE STANDARD ELECTRIC EQUIPMENT COMPANY, Jersey City, N. J., capital stock \$25,000, has been formed to manufacture and sell electric light, power, railway and allied equipment, and to construct and equip electrical plants of every description. J. F. O'Day, J. O'Day, New York, and L. H. Schenck, Neshantle, N. J., are the incorporators.

THE R. HAAS ELECTRIC AND MANUFACTURING COMPANY, 406 South Sixth street, Springfield, Ill., has been incorporated with a capital stock of \$10,000, the object being to manufacture electric appliances, devices and general electric business. The incorporators are Rudolph Haas, Edward C. Haas and William L. Blueke.

THE McEVoy ELECTRIC CONSTRUCTION AND SUPPLY COMPANY, Jersey City, N. J., capital stock \$250,000, has been formed to construct all kinds of electrical appliances. E. J. McEvoy, J. B. A. McEvoy, 318 East 37th street; E. C. O'Brien, 167 East 78th street; E. J. Kenney, Thomas Kenney, 227 East 35th street, New York City, and J. B. Young are the incorporators.

THE SPANISH AND SOUTH AMERICAN LOVE ELECTRICAL TRACTION COMPANY, Jersey City, N. J., capital stock \$100,000, has been formed to hold, sell, etc., patent rights and letters patent for inventions, processes and apparatus used in producing light, heat and power by electricity. E. Stanton, De Forest Manlee, New York, and A. I. Dryton, Jersey City, N. J., are interested.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
111 Park Row, New York, Feb. 17, 1894.

MR. FRANK S. DE RONDE, general sales agent for the Standard Paint Company, 2 Liberty street, New York, reports that the Metropolitan Electric Company, Chicago, Ill., who some three weeks ago secured the Western agency for the sale of P. & B. compound and other products of the Standard Paint Company, at which time they ordered a large bill of goods, have met with such flattering success that they have duplicated their original order.

THE HINE & ROBERTSON COMPANY, 106 Liberty street,

New York, announces that on account of the rapidly increasing magnitude of its indicator business it has become necessary to make a separate department of it, which is in charge of A. C. Lippincott.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., Feb. 17, 1894.

MARBLEHEAD, MASS.—At the annual town meeting on March 1 an article in the warrant will call for action on the project to purchase an electric light plant.

THE WEST END STREET RAILWAY suburban passengers were better served in and about Boston and with less delay in transportation during the recent storm than those of the steam railroads covering the same sections. The service was exceptionally good on the West End road, and the Boston public duly appreciated it.

PROF. W. L. PUFFER, of the Massachusetts Institute of Technology, Boston, in a lecture on telephone receivers delivered at the Wells Memorial Institute Feb. 13 before a large and appreciative audience, we are informed by the National Telephone Manufacturing Company, stated that as a result of his experiments, comparing the different styles and makes of instruments, the receiver telephone of the National Telephone Manufacturing Company, as shown, was the strongest and most powerful instrument. He especially remarked that the two Bell receiver telephones, as shown, were good instruments, but that the National must be rated as first. Many receiver telephones, both foreign and domestic, were exhibited.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
335 Monadnock Building, Chicago, Feb. 16, 1894.

THE ST. PAUL ELECTRIC SUPPLY COMPANY has opened a store at 315 Minnesota street, St. Paul, Minn., for the sale of motors, dynamos, electric fans and other electrical supplies. A special feature of the business will be the storage, subject to sale or exchange, of old motors.

THE INDEPENDENT ELECTRIC COMPANY, of 39th street and Stewart avenue, Chicago, well known as manufacturers of fuse wire and mining machinery, have added a new department to their business, and are now prepared to furnish promptly a high quality of slate for all purposes, but with special reference to the requirements of electrical work. They cut to any size, and furnish plain and finished slate in any desired manner or quality.

FROM THE WEST TO THE CONVENTION.—Western delegates to the Electric Light Convention, which meets in Washington Feb. 27, will arrive in the capital Monday, Feb. 26, at 2:30 P. M., over the Chesapeake and Ohio Railway. The trip has been admirably arranged. The delegates from Chicago and the Northwest will leave Chicago via the Big Four route at 8:30 A. M., Feb. 25, and at Indianapolis will be joined by the St. Louis, Kansas City and Peoria contingent; at Cincinnati they will be met by the Queen City electricians and take the famous F. F. V. limited through the most picturesque route in the East to the capital. The train will be solid vestibuled electric lighted and carry a hotel dining car through.

OREGON CITY, Feb. 12, 1894.

IT IS REPORTED that the Point Defiance, Tacoma and Edison Railway Company, of Tacoma, Wash., has issued to the Northwest General Electric Company a mortgage to secure an indebtedness of \$96,000.

OREGON CITY will make a test case of Motorman Fields, of the East Railway Company, who was recently arrested by the chief of police for operating an electric freight car on the streets contrary to the provisions of the new city ordinance, imposing a license upon street-car freight business.

THE TACOMA RAILWAY AND MOTOR COMPANY, of Tacoma, Wash., has reduced the monthly pay of its conductors and motormen from \$70 to \$60. The reduction in salaries is to be in force for three months only, and the men will be paid up to date. The hours of work will probably be shortened somewhat.

PORTLAND, ME.—Mr. C. B. Dalton, of Portland, has two large water powers within 18 and 22 miles, respectively, of Portland, which gives him the whole flow of the Saco River. The power of one is estimated at 5,000 h. p., and the other 2,500 h. p. They are the only two water powers near Portland not in use.

Canadian Notes.

OTTAWA, Feb. 16, 1894.

ST STEPHEN, N. B.—It is probable that a definite understanding in regard to the electric road will soon be reached and that the road will be built the coming summer.

TORONTO.—The street railway company has called upon local manufacturers for tenders for machinery for a new power house to the extent of 6,000 h. p. They propose constructing also 100 new cars. The total estimated expenditure on improvements will reach close on a million.

GALT AND PRESTON STREET RAILWAY.—The profiles of the Galt and Preston Street Railway are out. The entire length, from the Grand Trunk Railway station (G. W. R.), Galt, to the Del Monte Hotel, in Preston, is 4 73-100 miles. The company has purchased from the tie supplier of the C. P. R. the 10,000 ties required.

OTTAWA, ONT.—An offer has been received from the Fort Wayne Electric Company to install an electric light plant capable of supplying 500 lamps at \$70,000. Alderman Cluff also received a letter from the Siemens & Halske Electric Company, of Chicago. Their offer for the same supply was much higher, from \$125,000 to \$150,000.

NIAGARA FALLS ELECTRIC RAILWAY BRIDGE COMPANY.—Application is made to the Dominion Parliament by the Niagara Falls Electric Railway Bridge Company for power to build a bridge across the Niagara River at some point between Niagara Falls and the Whirlpool Rapids, and to operate thereon an electric railway system, with power to connect with the electric railways on both sides of the river.

A NOVEL APPLICATION for a charter is now before the Canadian government from Gillies & McEchen, of Sydney, Cape Breton, who, on behalf of their clients, are applying for the incorporation of a company under the name of the "Boynton Bicycle Electric Railway Company, of Canada," to construct and operate a bicycle electric railway from the city of Winnipeg, Manitoba, to the Port of Louisburg, in the county of Cape Breton, Nova Scotia, and between any places within the said points, with power to acquire and use water powers and to make contracts for the supply of electrical power for the operation of said railway.

TORONTO.—The Toronto Aqueduct Company is applying for a charter to construct and operate a ship canal and power aqueduct between Lake Ontario and Georgian Bay, through the counties of York and Simcoe and adjoining counties. The company will also seek power to use the waters of Georgian Bay, Lake Simcoe, Holland River and other sources of supply for the purpose of feeding the said canal and the generation or development of electric energy to be used for the production of heat, light or power. The applicants also ask for legislation ratifying any agreement that may be entered into with the city of Toronto, county of York, the townships of York, Etobicoke and Scarborough, the towns of Toronto Junction and North Toronto, the villages of Weston and East Toronto, for a supply of electric heat, light and power.

TORONTO.—President McKenzie, of the Electric Street Railway Company, in his annual report just submitted to the shareholders, says: "While the net earnings of the company have been satisfactory, as yet no dividend has been declared on the stock, although it will be seen by the balance sheet there is a considerable amount of cash in hand after paying all charges. The increased earnings which are expected will demand an increase in the number of cars and an extension of the shops, power and plant; the change of system has not yet been completed, and it is impossible at present to state with precision what amount of money will be required. The directors have entered into an agreement with the Toronto and Mimico Electric Railway and Light Company, Limited, for the acquisition of its privileges, and a ratification of this will be asked at a special meeting of the shareholders, to be specially called for the purpose."

English Notes.

(From Our Own Correspondent.)

LONDON, Feb. 7, 1894.

ELECTRIC LIGHT MAIN ACCIDENTS.—It is satisfactory to note in connection with recent electric light main explosions, both at Newcastle and Scarborough, a Roots' blower is employed to force warmed and dried air into the electric light ducts. The recent slaughtering of a horse at Bournemouth was due, I am told, to the fact that the company has omitted to connect the iron pipes on either side of the brick manholes metallically together, as was suggested by the contractors; the result being that on the main making earth on one side of the manhole, the current on coming to the brickwork had to find its way to the iron pipe on the other side through the surrounding earth.

THE BLACKPOOL ELECTRIC TRAMWAY.—It is only a little more than a year since the Blackpool corporation took over the working of the Blackpool Electric Tramway, and a few weeks ago the papers announced the line was being worked by horses, and that Mr. Thomas Parker, of the Electric Construction Company, and Mr. Holroyd Smith, the designer of the line, had been called in to report upon its condition. The reports of these gentlemen are naturally somewhat optimistic, but the report of Mr. J. Hesketh, the borough electrical engineer, is a striking commentary upon the careful nursing which an electric tramway on the open-conduit system requires, if it is to work with any degree of regularity. It must, however, be remembered, as has been pointed out both by Mr. Parker and Mr. H. Smith, that owing to its proximity to a sandy seashore, the Blackpool line is exposed

to conditions which would try even the best possible system of electric traction severely. Mr. Hesketh, after reporting upon the condition of the engines, boilers, belting, dynamos, etc., at the power house, goes on to state with regard to the car motors that the field magnet windings have had to be renewed in some cases, and repaired in almost all, the wires having been ripped bodily off the framework of the motor by the collector's end rising and catching in the coils. He also complains of the impossibility of frequently and thoroughly examining and cleaning the insulators inside the conduit, and states that the leakage during the first few hours of the day is sometimes sufficient to drive 10 or 20 cars. Mr. Hesketh also says that during the past year as many as 24 or 30 collectors have at times been sent into the shed for repairs in one day. "It is my firm conviction," said Mr. Hesketh, in conclusion, "that if the channel construction had originally been such as to admit of a wider slot with more perfect insulators and collectors, the trouble we are now experiencing would never have occurred."

THE BOARD OF TRADE ELECTRIC TRACTION REGULATIONS.—An important conference took place to-day between representatives of the electric traction interest and the leading Board of Trade officials with regard to the draft regulations published by the Board of Trade a short time ago. Each regulation was discussed seriatim, the Board of Trade officials expressing their readiness to make every reasonable concession to the needs of electric traction and gave practical evidence of their intention to do so by promising to favorably consider the majority of the amendments suggested. The main difference between the electric traction people and the Board of Trade is, however, regulation 14, which reads: "In the disposition, connections and working of feeders, the company shall avoid injurious interference with any existing wires," and around this regulation the real fight will centre. At the preliminary conference of to-day the point upon which the electric traction people concentrated their attention was the regulation providing for the interposition of a non-conducting screen between the earth return and any pipe which is within six feet of it. The regulation laying down that the separate lengths of a metal conduit shall be joined, so as to secure metallic continuity, was also objected to, but a reminder from a Board of Trade official of the recent mishap at Bournemouth, which arose from the omission of this very precaution, silenced the objectors. The regulations fixing the maximum leakage for any sized system at 10 amperes and the minimum insulation resistance of all lines insulated returns and feeders laid under ground, at 10 megohms per mile, and the maximum leakage current at 1-100 of an ampere per mile of tramway, were also discussed, and it was stated that these had been made specially stringent, with a view of provoking discussion.

News of the Week.

Electric Light and Power.

RENOVO, PA.—Residents are agitating for electric lights.

EVANS, COL.—Evans is agitating the establishment of an electric lighting plant.

HAMILTON, ONT.—There is a strong sentiment in favor of a municipal plant.

KEWANEE, ILL.—The gas company will apply for a franchise to put in electric lights.

DENISON, IOWA.—The authorities of Denison are negotiating for an electric lighting plant.

ROCKVILLE, CONN.—There is grave dissatisfaction over the electric lighting street service.

KEOKUK, IOWA.—J. C. Hubinger is seeking a franchise for a gas plant, water works and electric light.

RALEIGH, N. C.—The Raleigh "Chronicle" states that the electric lighting service is most unsatisfactory.

BRUNSWICK, IND.—The city of Brunswick recently voted \$10,000 in bonds for water works and electric light.

MARENGO, ILL.—The city will put in electric lights and water works as a result of the recent decision of Judge Belvidere.

ASTORIA, ILL.—C. E. Brockman and Alexander Bailly, of Mount Sterling, propose to establish an electric light plant in Astoria.

IRVINGTON, IND.—General Cottman is at the head of the movement which is petitioning Council to put in an electric light plant.

DALLAS, TEX.—Sealed proposals will be received to March 1 for building an electric light plant. Geo. W. Crutcher is city secretary.

VICTORIA, TEX.—The Victoria Light, Power and Ice Company will increase its plant, and is in the market for a 1,000-light 1,000-volt alternator.

BUCHANAN, MICH.—The electric light plant will be enlarged, the demand for arc lights being in excess of the original estimate.

ELIZABETHTOWN, KY.—The Council offers for sale the franchise for putting in an electric light and water plant. Address R. L. Wintersmith.

ST. PAUL, MINN.—The mayor and county commissioners are a committee to investigate the cost of a proposed electric light plant for the court house.

LOGANSPOUT, IND.—The Council Committee in the matter of electric lights is unanimously in favor of a municipal plant, and will so report to Council.

BAY CITY, MICH.—The committee of the County Board of Supervisors has recommended the purchase of an electrical apparatus for the county house.

EVANSVILLE, Ind.—An ordinance has been introduced in Council authorizing the Department of Public Works to advertise for an electric lighting plant.

CINCINNATI, OHIO.—The Council has appropriated \$5,000 for the electric equipment of Eighth street viaduct for railway operation and electric lighting.

STE. GENEVIEVE, MO.—Citizens have organized a stock company to establish a brewery and electric light plant. F. L. Jakerst and E. A. Rosler are interested.

CLEVELAND, OHIO.—Architects Lehman and Schmidt have made plans for a new armory for the O. N. G., to cost \$185,000, and to include an electric lighting plant.

TOLEDO, OHIO.—Commissioner Englehard states that the new court house will have a complete electric lighting plant. The jail and armory will be lighted from it.

BUFFALO, N. Y.—The City Council has decided to expend \$100,000 to establish an experimental station for municipal electric lighting, likely at Black Rock or East Buffalo.

MARTIN'S FERRY, OHIO.—The City Council has rejected a resolution to call for a vote of citizens in the matter of issuing \$30,000 in bonds for an electric lighting plant.

MARIETTA, LANCASTER COUNTY, PA.—The Marietta Electric Company has bought land as site for its plant. It is now soliciting subscriptions to its capital stock of \$15,000.

READING, PA.—The directors of the Reading Electric Light and Power Company have voted to lease its works to the Metropolitan Electric Company, chartered Feb. 8 for 99 years.

SPRINGFIELD, ILL.—The Council has adopted a resolution authorizing a committee to devise ways and means for purchasing and constructing a municipal electric lighting plant.

HAMILTON, OHIO.—The Council of Hamilton has accepted the plans and specifications of Engineer Cornell for the proposed electric light plant, and will receive bids for the same.

HILLSDALE, MICH.—The Council has instructed the lighting committee to negotiate for a large dynamo. This refers to a machine for street lighting, and not the dynamos recently purchased.

BORDENTOWN, N. J.—Estimates for an electric lighting plant have been received by Council of Bordentown, but the Council has decided that it is not now in financial shape to take action.

PARSONS, PA.—Secretary Breckley, of the Anthracite Electric Light Company of Scranton, Pa., has offered to put in an electric light plant for Parsons if a five-year contract is given by the borough.

SWANTON, PA.—A meeting of residents of Swanton will be held on the 15th inst. to hear the report of the electric light committee and see if the village will vote to authorize the purchase of another dynamo.

TOPEKA, KAN.—The matter of repairing the electric light plant was referred to the committee on public buildings, with power to act. The engineer has prepared estimates for the repairs, and the clerk will advertise for bids.

FLATBUSH, L. I., N. Y.—Plans are being made by the Knickerbocker Electric Light and Power Company for the erection of a power house on the property of the Flatbush Gas Company, East Broadway and Flatbush avenue.

DOVER, N. H.—There is grave complaint in Dover over the quality of light furnished by the Consolidated Light and Power Company, and unless an immediate improvement is made, some other company will be granted a franchise.

GRIFFIN, GA.—The committee on lights has been authorized to offer a lump sum for the plant of the Thomson-Houston Company now in operation and lighting the city of Griffin, as the city proposes to operate the plant hereafter.

MOMENCE, ILL.—Ex-Mayor Jas. Kerby and B. F. Gray, representing the Momence Electric Light Company, have asked Council to extend their charter for fifteen years. If granted they will reorganize with \$10,000 capital and improve the plant.

RICHMOND, VA.—At a meeting of Council Committee on Light the resolution of Mr. Davis was adopted, recommending that the Council consider favorably the Epps resolution, providing for an appropriation of \$75,000 for an electric light plant for the city.

IRVINGTON, N. J.—At meeting of Clinton Township Committee, held at Town Hall, Irvington, a petition from property owners in Hilton was received asking the committee to extend the electric light on Springfield avenue as far as South Orange.

KINGSTON, PA.—The West Side Electric Company, which has a plant at Luzerne, Pa., and which is principally owned by John C. Haddock, is applying for a franchise to serve the residents

with electric street lighting. The borough council has not yet taken action on the application.

WYOMING, PA.—A motion has been carried that the street lighting committee interview the borough attorney and ascertain if sufficient time yet remains before election on the 20th to vote for or against electric lights for the borough, and for power to levy a tax to defray the cost thereof.

FLATBUSH, L. I., N. Y.—The Town Board of Flatbush has awarded to the Knickerbocker Electric Light Company the contract to light Oaklands, Windsor Terrace and Parkville. The village of Flatbush will be lighted by gas until the present contract with the Flatbush Gas Company expires.

WASECA, MINN.—Sealed proposals will be received to Feb. 20 for furnishing a compound electric light engine and connections. Plans and specifications may be seen at office of city clerk of Waseca, or Chas. T. Loweth, 94 East Fourth street, St. Paul, Minn. Dr. D. S. Cummings is mayor.

ANNAPOLIS, MD.—The City Council has directed the special committee on city lighting to advertise by Feb. 26 for bids according to the plans and specifications of John O. Jodge. The plans call for arc and incandescent systems in one bid, and for arc and incandescent systems in separate bids.

YORK, PA.—The loan bill just recommended to the ways and means and finance committee did not contain a provision for the proposed electric lighting plant for the public buildings, as originally intended, it being the general impression that it would be better to defer this and add to estimate for paving.

IPAVA, ILL.—The Ipava Woolen Mills will, in addition to their present plant, build another, and run lines to the following towns: Lewiston (12 miles), Astoria (12 miles), Tabletown (6 miles), and Vermont (8 miles). It has the franchises for the above towns for fifteen years, and fifteen months to complete the plant.

YORK, PA.—Sealed proposals will be received to March 3, at noon, by the lighting committee of the City Council for lighting the streets of the city of York, for one or five years, with arc electric lights as now lighted. Bidders will specify the system of lighting to be used. T. B. Loucks is secretary of the light committee.

UNION HILL, N. J.—The Hudson Electric Light Company has sent a communication to the Board of Council of Union Hill, stating that it hears that there is desire on the part of residents to change the lighting system from the incandescent to the arc light, and it asks to be advised. The matter was referred to a committee.

MEADVILLE, PA.—City Electrician Geo. M. Hoag has reported unfavorably on the present condition of the electric lighting plant, and repairs will have to be made. It is likely that the city will compel the company which furnished the plant to make repairs, failing which they will have same done by contract and charge to the company.

EAST ORANGE, N. J.—The East Orange Township Committee has decided to readvertise for bids for lighting the township with electricity. According to the bid of the People's Light and Power Company, the lowest bidder, the cost would have been \$7,000 less than the gas lighting at present in use, but many of the principal streets would not have been lighted.

CONCORD, N. H.—Custodian Robinson, of the Post Office, has been authorized by the Treasury Department to wire the building for electric lighting, and he invites proposals for the work, which he will immediately forward to the Secretary of the Treasury for consideration. The Department reserves the right to reject any or all bids received, and to defer acceptance to July 1 next.

MONTCLAIR, N. J.—At a meeting of the Township Committee F. S. Woodward applied for a franchise to furnish electric lighting to private consumers, to be a 600-light, 16-candle power plant, and to be in operation within the year. He will not state who is behind the application, and for the present he will not offer to furnish street lights, but may do so later. The matter was deferred for future consideration.

ETNA, PA.—In the matter of the proposed electric plant for Etna, the fourth set of plans has been received by the Council. They were made by Edeburn & Cooper, of Pittsburgh, and the estimated cost is \$22,000. The matter was placed in the hands of the finance committee with instructions to get estimates from contractors on building, and bids will then be received for the machinery and apparatus as soon as needed.

OTTAWA, ONT.—The local authorities of Ottawa have decided to ask for power to purchase and operate an electric light plant. Alderman Morris has filed estimates for a plant at \$135,000, and the matter will be voted on at special election. It was also decided to call for tenders for an arc light plant of 500 lamps, and to ask the Ottawa Light Company to state the terms upon which they would carry on the lighting for an extended term of five years.

MERIDIAN, MISS.—is in complete darkness except for a few gas lamps. Where two months ago it had two electric lighting plants, it now has none. One company, known as the Edison Lighting Company, became financially involved in January, and its apparatus was sold out by the sheriff, thus cutting off 100 arc lights used in lighting the city. The other company—the gas company—lost all its electric apparatus by fire on Feb. 4, cutting off 25 city arc lights. The latter company will shortly rebuild to carry out the entire city lighting.

The Electric Railway.

BRIGANTINE, N. J.—The electric railway at Brigantine Beach will be rebuilt on a trestle, to be beyond the reach of the tide.

SIoux CITY, IOWA.—The Sioux City cable railway has been granted permission to equip with electric power.

FREELAND, PA.—A contract for the construction of the Freeland branch of the electric railway will be awarded in a few days.

READING, PA.—An ordinance has been introduced granting right of way to the Pottstown, Reading and Boyertown Electric Railway Company.

NEW HAVEN, CONN.—The Fairhaven and Westville Horse Railroad Company asks for leave to extend its lines and to equip with electricity.

WOODBURY, N. J.—The Council has passed an ordinance granting right of way to the Camden, Gloucester and Woodbury Electric Railway Company.

BRIDGEWATER, VA.—Surveyors are going over the road between here and Harrisonburg, and it is likely that an electric line will, ere long, be built.

ROXBOROUGH, PA.—The Roxborough Railway Company in its annual report states that its road will adopt the trolley system during the coming season.

RIDGWAY, ONT.—Capitalists have offered to build an electric line from Ridgway to Crystal Beach for a bonus of \$2,000. No names have yet been made public.

HARRISBURG, PA.—As soon as the weather permits, President Denny states that the East Harrisburg Railway Company will begin many important improvements.

NEWARK, N. J.—The Consolidated Traction Company has applied to the Essex County Road Board for permission to extend its road to Millburn, and thence to Short Hills.

MARION, OHIO.—Sealed proposals will be received to March 19 for the construction of a street railway and operation thereof over routes one and two. James Williams is city clerk.

SPRING CITY, PA.—After rejecting the ordinance granted by the Borough Council, the Phoenixville Electric Railway Company has decided to accept it, and work will soon be begun.

HAGERSTOWN, MD.—O. H. Ormsby and S. Ritter Ikes, of the Cumberland Valley Railroad Company, have accepted the franchise offered by the authorities of Hagerstown for a street railway.

GLOUCESTER, MASS.—The directors of the Gloucester Street Railway Company have decided to begin the construction of the branch to Rockport as soon as the weather permits, about 5½ miles.

NEWBURGH, N. Y.—The Newburgh street railway line has been sold to a syndicate headed by Benjamin Norton, of the Atlantic avenue line of Brooklyn, and it will be converted into an electric line.

WASHINGTON, D. C.—The Commissioners of the District have received for report House Bill 557, "To incorporate the Boundary and National Park Elevated Railroad Company in the District of Columbia."

AUSTIN, ILL.—The Town Board of Cicero has passed an ordinance giving to the Lake Street Electric Railway Company the right to build an elevated road in streets and boulevards of Oak Park, Austin and Ridgeland.

HARTFORD, CONN.—The directors of the proposed Hartford and Manchester Tramway Company will take action in the matter of their proposed road to connect with the Hartford street railway line, now extending to Burnside.

MEDINA, N. Y.—A public meeting has been called for Feb. 16 to take action in the proposed electric railway of Captain Lina Beecher from Batavia to the lake, by way of Medina. It is estimated that the road would cost \$600,000.

NEW CASTLE, DEL.—A special to the Wilmington "News" states that the proposed electric road from Newcastle to Wilmington is now a certainty; that the incorporators have agreed upon a plan of action, and that work will be begun in the spring.

HOLYOKE, MASS.—The People's Electric Street Railway Company will soon apply for a franchise. Wm. F. Whiting, Chas. H. Curran, T. H. Sears, Rollo F. Kelton, Clark O. Carpenter, all of Holyoke are interested. It is proposed to build a 9½-mile road.

LANCASTER, PA.—The Pennsylvania Traction Company has acquired control of the Lancaster Traction Company, of the Columbia and Donegal road and several others in pursuance of its project to build an electric line from Philadelphia to Harrisburg.

WATERTOWN, MASS.—As soon as frost is out of the ground the Newtonville and Watertown Street Railway Company will extend its tracks to the Boston line. The West End Street Railway Company will also build to the Watertown line this spring.

DAVENPORT, IOWA.—Electrical Engineer Fredericks, of the Davenport and Rock Island Railway Company, is completing plans for the electrical equipment of the bridge line. It will be about May when the company will substitute electricity for horse power.

LAWRENCE, MASS.—The South Side Street Railway, to connect Lawrence and Lowell, came before the Board of Selectmen with an application for a franchise, and the matter was taken under deliberation. Larkin T. Trull, of Lowell, Mass., is leader in the movement.

GARDNER, MASS.—The Gardner Street Railway Company has petitioned the Selectmen for leave to build and operate an electric railway in the streets of Gardner. If permission is granted it is the intention of the company to proceed with the work as soon as the frost is out of the ground.

CORNING, N. Y.—F. D. Kingsbury, of Corning, has bought the franchise for a street railway, which was offered to a company last year and rejected. He proposes to build a street railway in Corning, and will form a company for that purpose. There is promise of strong local support.

BOSTON, MASS.—Two applications were made for charters for elevated roads in Boston and vicinity on Feb. 7. John W. Ayers asks for incorporation of the Metropolitan Elevated Railway Company, \$5,000,000, and Reynolds T. White also asks for authority to build and operate an elevated road.

BOONSBORO, MD.—The Boonsboro "Times" states that as soon as the matter of building the proposed electric road can be gotten out of the hands of the contractors, a new contract will be let and the road, which Hughes & Rigby wanted \$103,500 to build, will be built for one-half that amount by local workmen.

WATERBURY AND STOWE, IOWA, are to be connected by an electric freight and passenger railway ten miles long, to be run from water power, at an estimated cost of \$150,000, of which Stowe has already voted \$40,000. The company is named the Mount Mansfield Electric Railway Company, and E. D. Blackwell, of Montpelier, is president.

LOCKHAVEN, PA.—E. B. Carr, of Jersey City, N. J., is in Lockhaven, Pa., and is agitating for the building of an electric railway from Lockhaven to Mill Hall. He is interested in a firm of contractors which builds trolley railways. He is conferring with the gentlemen who were recently granted a franchise to build a street railway, and is offering them liberal terms.

SPRINGFIELD, MASS.—Preliminary steps have been taken to incorporate the Wyman-Lea Street Railway Company, \$300,000, to connect Holyoke, Willimasset, Chicopee Falls and Springfield. Amongst those interested are W. B. C. Pearsons, of Holyoke; George S. Taylor, of Chicopee; George Nye, of Springfield; Henry S. Dickinson, of Springfield; Horatio Gore, of Boston, and B. W. Woodward, of Cambridge.

MIDDLETOWN, CONN.—It is now stated that the proposed electric road between Middletown and Meriden will be built and in running order by July 1. The Middletown Company will spend \$150,000 on this extension this spring. The company is in the hands of a syndicate represented by ex-Governor Waller and Attorney S. H. Wagner, of New Haven. A large power house will have to be built in Middletown.

ST. LOUIS, MO.—At a meeting of the stockholders of the Fourth Street and Arsenal Railway Company it was voted to issue \$150,000 gold bonds, payable to the Union Trust Company, of St. Louis, at 6 per cent interest. Contracts will immediately be let for the building of this road. Chas. Green is president of the company, and he is preparing an ordinance granting permission to run north to Baden and south to Carondelet.

TEWKSBURY, MASS.—The hearing of the petition of Larkin T. Trull, Jos. L. Chalifoux, Wm. S. Knox, N. E. Clemons and Winslow, representing the South Side Street Railway Company, for right to build, equip and operate an electric street railway in Tewksbury, will be heard at public hearing in town hall on Feb. 21 at 2 P. M. F. H. Farmer, George E. Marshall and Frank A. Fitzgerald are selectmen of Tewksbury.

LEWISTON, NIAGARA COUNTY, N. Y.—The Lewiston and Youngstown Electric Railway has again come to the front with an offer to build a line to Fifth, Centre and other streets, but there is strong opposition to the Fifth and Centre street route from residents, and unless an agreement is arrived at, there will not be an electric road between Lewiston and Youngstown this summer. It was generally understood that the company would light the streets on their line from their trolley poles, but it has decided not to do so.

Personal Notes.

MR. R. J. M. DANLEY, Columbus, Ohio, superintendent of telegraphs of the Columbus, Shawnee and Hocking Railroad since its organization, has resigned and will hereafter devote his entire time to electrical work, and open an office in Columbus. Mr. Danley is the inventor among other things of an improved repeating transmitter, and of a highway crossing alarm.

MR. JOHN WALKER, one of the founders of the Walker Manufacturing Company, Cleveland, Ohio, has withdrawn from its active management, still retaining his financial interest, however. Mr. Frank Billings was elected to the office of vice president, left vacant by the withdrawal of Mr. Walker. There was no change in the other officers, who are as follows: J. B. Perkins, president; W. H. Bone, manager, and Z. M. Hubbell, secretary and treasurer.

HOUSTON AND KENNELLY.—It will doubtless surprise many of our readers to learn that two gentlemen well known in the electrical field have determined to sever the connections they have held for so long in their respective avocations. We allude to Edwin J. Houston, president of the American Institute of Electrical Engineers, recently professor of physical geography and natural philosophy in the Central High School of Philadelphia, which chair he has just resigned after holding it for the past twenty-six years; and A. E. Kennelly, now one of the vice presidents of the American Institute of Electrical Engineers, who during the past six years has been Mr. Edison's right-hand man and chief electrician of the Edison laboratory. These gentlemen have decided to establish in Philadelphia a firm of electrical experts, to be known as Houston & Kennelly, and it is needless to say that they will be most cordially received in the field they are about to enter, not only on account of the general recognition of their eminent professional ability, but also from the high appreciation in which their personal qualities are held. Prof. Houston has been so prominently before the public for more than a decade and a half, and Mr. Kennelly in more recent years has so firmly established his professional reputation, that any extended reference to the work of either is unnecessary. Prof. Houston's connection with the Thomson-Houston company in the days when the apparatus was designed which gave it a world-wide reputation is best known, but in later years his attention to the problems of electricity has not slackened, and the public will now have the practical benefit of the wide studies he has made during this later period, besides the experience gained in earlier days. While Mr. Kennelly is perhaps best known generally from his advanced theoretical researches, which have placed him in the highest rank of electrical scientists, his practical work has been none the less valuable. His experimental researches on the heating limits of electrical conductors have formed the basis of all underwriters' rules on this subject, not only in the United States, but in Europe, while in invention his volt and ampere meters and apparatus for determining the permeability of iron take a high rank among measuring instruments. Another qualification is his thorough knowledge of the principles of alternating and multiphase currents, in which respect Mr. Kennelly has few rivals in any country. With the professional, mental and social equipment possessed by these gentlemen, there can be no doubt as to the value of their services to the public in their new capacity, and, consequently, of the success of the new firm.



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Miscellaneous Notes.

ELKTON, MD., asks for proposals for a fire alarm register for an engine house and 50 signal bells for firemen's houses. Address C. R. Maxwell.

THE WADDELL-ENTZ COMPANY, Bridgeport, Conn., has passed into the hands of a receiver, Mr. Montgomery having been appointed temporary receiver on Feb. 10. We are informed by an official of the company that the embarrassment is only temporary and due to the general business depression and difficulty of making collections. The Second avenue storage battery experiment will not be affected.

MR. JOSEPH SACHS read an interesting paper before the New York Electrical Society on Feb. 15 on "Electrical Canal Propulsion, with Special Reference to the Erie Canal." After describing the various plans proposed and discussing the conditions of the problem, Mr. Sachs favored a haulage plan with an electric motor on a light track on the bank of the canal, each boat to have its own hauling motor. He estimates that such a system could be installed for \$4,500,000, and operated for \$800,000 annually.

M. J. FRANCISCO, of Rutland, Vt., is battling with the city authorities and a rival company, which recently was given the contract for city lighting that before was done by the Rutland Electric Company, of which Mr. Francisco is president. In a recent letter to a local paper he charges that the lines of the rival company have been constructed in the most outrageous and lawless manner, and that they purposely made "crosses" with the lines of the older company in order to destroy its machinery. In conclusion, he intimates that "boodles" influenced the award of the contract.

Trade and Industrial Notes

M. E. BLASIER & CO., 9 Charlotte street, Utica, N. Y., have issued a circular describing some of the many electric fixtures and brackets they manufacture.

THE BUSHNELL MANUFACTURING COMPANY, of Easton, Pa., maker of car seats, will increase its capital from \$50,000 to \$100,000 and double its force.

H. WHITFORD JONES, electrical contractor, of Cleveland, Ohio, has secured the contract for wiring and switchboard work for 1,000 lights in the new Permanent Block on Euclid avenue.

THE FIBRONE-TERRALOID COMPANY, Newark, N. J., has placed on the market a Bell receiver telephone case, which has the exact appearance of the regulation rubber, but can be sold at a much less price.

THE CRESCENT ELECTRIC COMPANY, of Lancaster, Pa., has issued a handsome cloth bound catalogue of its high-grade electric fans, in which are described and illustrated the neat and efficient ceiling, column and other combination fans and motors made by it.

THE GOUBERT MANUFACTURING COMPANY has opened a branch office at 402 Lewis Building, Pittsburgh, Pa., which will be in charge of Mr. J. H. Harrison. A full line of the Goubert feed water heaters and Stratton steam separators, of which this company is the sole manufacturer, will be carried.

THE CONSOLIDATED ELECTRIC STORAGE COMPANY, 44 Broad street, New York, has issued a circular, No. 8, calling attention to the advantages of storage batteries for central stations. A list of European stations using storage batteries is given, besides much technical data of interest relating to the subject.

THE PAGE BELTING COMPANY, Concord, N. H., has issued a pamphlet entitled "After the Fair," giving a history of its exhibit at the Chicago Exposition. Views of a large number of important exhibits using Page belting are given, and the fac-similes of St. Gaudens' medal which have raised such a national commotion.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has issued a neat 16-page pamphlet, in which Walton Day gives "The History of a Lead Pencil," which will be found interesting by all and useful by many. The various processes in the manufacture of lead pencils are described, and useful information given as to the selection of various grades.

THE OHIO BRASS COMPANY, Mansfield, Ohio, is gratified by the number of requests already received for its new catalogue, which indicate that a lively interest is taken among street railway men concerning this new edition. The catalogue is now ready for distribution to the trade, and it is to the interest of every street railway man—contractor, engineer or manager, as the case may be—to supply himself with one of them.

HUEBEL & MANGER, 286 Graham street, Brooklyn, have been busy during all the dull times, and are keeping a large force of hands hustling to fill orders. The reputation that this firm has achieved for first-class, reliable goods is widespread. They employ none but first-class mechanics, as shown by their products. The bells, push buttons, switches, etc., they manufacture embody many improvements, and dealers would do well to get a copy of their new catalogue and price list, which will be of interest to them.

NALDER BROTHERS & CO., electricians and engineers, London, England, state that owing to the numerous inquiries they have had recently as to whether they have changed the constitution and address of their firm, they feel it incumbent upon them to state that there has been no change whatever, and that the partners, F. H. Nalder, H. Nalder, C. W. S. Crawley and A. Soames, who have conducted the business during the last six years, still carry it on as Nalder Brothers & Co., and that their sole place of business is at 16 Red Lion street, Clerkenwell, London, E. C., as heretofore.

MR. W. W. HESS, formerly representative of the Car Publishing Company, of Philadelphia, has resigned his position from that publication and accepted the position of general manager for the Car Equipment Company, located at 232 Carter street, of the same city. This company will handle the street railway specialties manufactured by the Allan Electric and Supply Company in addition to the Graham truck and Ajax metal for electric purposes. Mr. W. A. Barrett, Jr., is the president. Mr. Hess has a host of friends in the street railway field, and no doubt his success will be as marked in his new position as it has been in the past.

MR. T. MCCOURBRAY (P. O. Box 34, New York), the inventor of the McCourbray auto-telephone system, was secretary of the National Electric Light Association during the first years of its existence and is very generally known. At the same time he was the secretary of the Baxter Electric Motor Company, having previously occupied a similar position with the Morrison Electric Works. He has since been identified with the Westinghouse company at Boston, the Crocker-Wheeler company and the Okonite company. The McCourbray auto-telephone system is claimed to be far superior in merit and appearance to other systems, though sold at a low price.

tion. It is proposed to manufacture the apparatus on a large scale in order to meet an expected large demand.

ACCUMULATOR LITIGATION.—We have received a communication from Mr. W. W. Gibbs, president of the Electric Storage Battery Company, Drexel Building, Philadelphia, Pa., in which he states that the Consolidated Storage Battery Company, controlling the Brush patents, has instituted a suit against his company, for the sole reason, he believes, of frightening intending purchasers of batteries. He further states that his company is advised by eminent experts, after a most thorough examination, that its batteries do not infringe the Brush or any other patents. Among these experts are Prof. Charles F. Chandler, of Columbia College, and Prof. George F. Barker, of the University of Pennsylvania, who distinctly state that in their opinion the chloride battery composite plate consists of tablets of chloride of lead and chloride of zinc in a frame of metal; that there is no active ma-

terial in the composite plate, nor is there any material ready to become active in a secondary battery, nor is there a secondary battery, nor is there any material which is absorptive in a secondary battery; and, further, it "does not either in its use, infringe the claims of the Brush patents." Mr. Gibbs adds that his company proposes to continue making and selling its battery and to protect all users of the chloride accumulator.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED FEB. 13, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

481,149. **ELECTRICAL CONDUCTOR**; Dallas B. Hayward, Easton, Md. Application filed July 21, 1893. An electrical conductor formed of twisted or woven graphite-coated asbestos fibre, substantially as described.

514,461. **ELECTRICAL SIGNAL APPARATUS**; George W. Hey, Syracuse, N. Y. Application filed April 22, 1893. A circuit closer comprising in its organization the normally separated movable terminals of an electric circuit, mechanism operated by electric current pulsations for bringing the terminals into contact with each other, mechanism being automatically reset to its initial or starting point without disturbing the contact of terminals and means for separating the terminals.

514,462. **ELECTRICAL APPARATUS**; George W. Hey, Syracuse, N. Y. Application filed May 9, 1892. The herein described electrical apparatus, the same comprising a circuit wire, stations connected to the circuit wire, generators at each of the stations, and connections between each station and the portions of the circuit wire on opposite sides thereof for passing a current from the generators at stations through opposite sides of the circuit wire.

514,480. **CUT-OUT**; Herman Lemp, Lynn, Mass., assignor to the Thomson-Houston Electric Company of Connecticut. Application filed Oct. 5, 1888. The combination substantially as described of an electric lamp, a reserve lamp, an automatic cut-out mounted upon or within the first named lamp and connected to a lamp contact or terminal thereof, with which the reserve lamp is connected; an automatic switch for the first lamp normally tending to close the connection between its extreme terminals and held open by said lamp when on its support, connections from switch to the reserve lamp, and an automatic switch or current closer governed by the latter and normally tending to complete connection to the lamp terminal or contact, which is mounted upon the first named lamp and is connected to the cut-out device thereon.

514,491. **ELECTRIC FIREARM**; John L. McCullough, Brooklyn, N. Y. Application filed April 7, 1893. In a breech-loading firearm, the combination with the tubular loading plunger, provided with the angular cutter near its forward end, of an electric circuit, a loop forming a part of said circuit, a carrier for said loop, and means intermediate the trigger and loop carrier, whereby when the trigger is pulled the loop will be moved forward within the cutter.

514,501. **ELECTRICAL ANNUNCIATOR**; Charles F. Scattergood, Albany, N. Y. Application filed Nov. 3, 1893. An electric annunciator having a transmitting plate with push buttons arranged in connection therewith in concentric circles and a receiving annunciator, consisting of a plate having a series of drops or indicators, one series in circular form and the other series on the face of the plate, each push button on the transmitter plate having an electrical conductor leading to and in electrical connection with the operating mechanism of a number of drops or indicators on the receiving plate, said conductor forming an electrical circuit, in order that when a single push button is operated a number of drops will be operated indicating the number of the circle and the point on the circle of the push button operated.

514,504. **CURRENT REGULATOR FOR DYNAMO-ELECTRIC MACHINES**; Charles E. Scribner, Chicago, Ill., assignor to the Western Electric Company, of same place. Application filed Dec. 10, 1888. The combination with a dynamo-electric machine of an electromagnet in the main circuit thereof, a movable armature for magnet, a clutch attached to armature, a clutch rod actuated by clutch adapted when actuated to shift the brushes of dynamo-electric machine, and contact points controlled by armature to close a short circuit about electromagnet when its armature has moved through a predetermined distance.

514,505. **ELECTRIC ARC LAMP**; Charles E. Scribner and Ernest P. Warner, Chicago, Ill. Application filed May 27, 1890. In an electric arc lamp, the combination with a series magnet, supported upon the frame of the lamp, of a magnet connected in

shunt of the arc, supported upon a movable frame, said movable frame carrying the armature of the series magnet, whereby said frame may be raised, a clutch connected with the armature of the shunt magnet and adapted to be actuated thereby, a feeding board adapted to move with the frame carrying the shunt magnet whereby the clutch may be actuated by the shunt magnet along and not by any differential action of the shunt and series magnets.

514,506. **ELECTRIC ARC LAMP**; Charles E. Scribner, Chicago, Ill. Application filed Aug. 1, 1891. Two electric lamps, each having a lifting magnet and a pair of carbons, and each having a feeding magnet in shunt around both the carbons, of circuits connecting the lifting magnets in series and the pairs of carbons in multiple with each other and in series with said lifting magnets.

514,524. **INFLUENCE MACHINE**; Harry Fuller Waite, New York, N. Y. Application filed Oct. 28, 1893. In a device adapted to be used with influence machines, the combination with the case, the condensers therein and connections with the condensers of electrodes movable with relation to each other, and means outside of the case for moving the electrodes.

514,561. **ELECTRIC RAILWAY**; P. W. Leffler, Minneapolis, Minn. Application filed May 13, 1893. The combination with a car of field magnets in the line of travel, a non-rotating armature on the car, electric connections for the field and armature magnets and an automatic rotary pole changer carried by the car, located in connections to the armature magnets and operated by the field magnets.

514,566. **ELECTRIC RAILWAY CROSSING SIGNAL**; Michael J. O'Sullivan, Baltimore, Md. Application filed May 22, 1893. In a railway crossing signal a supporting post having a lamp at the upper end thereof, arms or paddles connected thereto, a gong secured to such support, two circuits, one containing therein a relay battery and track connections and the other a suitable motor for operating such arms or paddles and bell, and suitable connections, whereby when the train is in the section where the crossing signal is located the arms will be vibrated and the gong sounded continuously.

514,580. **APPARATUS FOR TESTING THE RESISTANCE OF CONDUCTORS OF ELECTRICITY**; Elmer G. Willyoung, Philadelphia, Pa. Application filed June 26, 1893. In an apparatus of the class described a variable resistance block, consisting of a pair of plates connected in series, a series of conductors of graduated resistance connected with one of said plates and adapted to be also connected with the other.

514,581. **ELECTRICAL MEASURING INSTRUMENT**; Elmer G. Willyoung, Philadelphia, Pa. Application filed Oct. 13, 1893. A casing, two of the opposite sides or faces of which contain panels of quartz or glass, and are respectively provided with a pair of adjacent quadrants, adapted, when the casing is closed, to be assembled in their appropriate relationship.

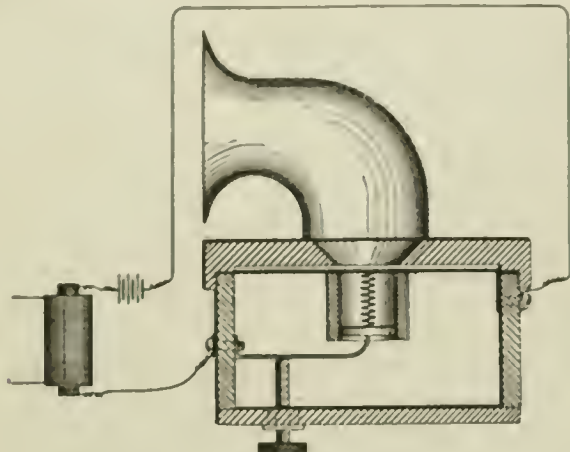
514,582. **ELECTRICAL MEASURING INSTRUMENT**; Elmer G. Willyoung and Madison M. Garver, Philadelphia, Pa. Application filed Oct. 13, 1893. In a measuring instrument for measuring electrical currents in combination, a working wire through which a current is caused to pass, a pointer connected with said wire, a plurality of compensating wires each substantially identical with the working wire, and a spiral spring support for maintaining all of the wires under tension.

514,583. **ELECTRIC ARC LAMP**; John E. Woolverton, New York, N. Y. Application filed Sept. 22, 1892. In an arc lamp the combination of a pair of converging rods, one at least of which is an arcing electrode, and a corresponding arcing electrode with means for equalizing the feed of the pair of rods comprising a pair of lazy tongs mechanically connected therewith.

514,584. **GARMENT HOOK**; Richard Ahlers, Brooklyn, N. Y. Application filed Dec. 9, 1893. The combination of a perforated case with a perforated face plate, a movable garment hook having a headed upper end, an encircling spring, a pair of contact springs, and an electric circuit embracing a switch and alarm and connected to said springs.

514,593. ELECTRICAL MEASURING INSTRUMENT; Elmer G. Willyoung and Madison M. Garver, Philadelphia, Pa. Application filed Oct. 13, 1893. In a measuring instrument for measuring electrical currents, in combination with the case of an electric measuring instrument for measuring electrical currents, a chamber for an extra resistance, mounted upon the exterior of the case, composed of metal plates, and formed with a central flue, which serves as a core for the resistance coil and as a means for carrying off its heat.

514,641. ELECTRIC PENDULUM CLOCK; Henri Campiche, Geneva, Switzerland. Application filed July 28, 1893. The combination of a pendulum and an electric circuit connecting an electric source with an electric clock, with an electromagnet, and a device for interrupting the circuit, consisting of a contact fork and a device which acts temporarily upon the said interrupter of the circuit so as to close the circuit after a certain number of vibrations of the pendulum, the armature of the electromagnet so



NO. 514,641.—TELEPHONE.

arranged as to give a mechanical impulse to the pendulum each time the electric circuit is closed and the jump of the hands of the clocks produced.

514,647. CIGAR TIP CUTTER AND LIGHTER; W. E. Duthie, Indianapolis, Ind. Application filed Dec. 8, 1893. The combination of a perforated base plate, a torch holder adapted to rotate thereon, a knife secured thereto and arranged to traverse the perforation, and lighting mechanism in the path of the torch.

514,651. ELECTRIC CIGAR LIGHTER; A. J. Graydon, Indianapolis, Ind. Application filed March 6, 1893. The combination of a series of batteries and an induction coil in a casing, which also carries small receptacles of oil adapted to be ignited by an electric spark.

514,686. ELECTRIC ANNUNCIATOR; I. E. Rickey, Oakland, Cal. Application filed May 10, 1893. The combination with a drop plate having a swinging ball and armature pivoted below the plate, a magnet located at the rear of the armature and means for electrically resetting the drop plate.

514,695. TELEPHONE; C. T. Bloomer, New York, N. Y. Application filed May 9, 1893. The combination of a diaphragm, a conducting fluid included in the circuit of the transmitter, a flexible strip mechanically connected at one end with the diaphragm, suitably supported at its other end and immersed in the fluid. (See Illustration.)

514,697. ELECTRIC ALARM FOR PRESSURE GAUGES; W. H. Bradt, Troy, N. Y. Application filed Nov. 22, 1893. A gauge having electrodes adapted to be brought in contact by the movement of an index-operating mechanism, a lever fulcrumed on the case-wall of the gauge and engageable with the index-operating mechanism and an operating handle on the lever.

514,714. BOND WIRE FOR ELECTRIC CONDUCTORS; A. Hoffmann and J. Brogan, Milwaukee, Wis. Application filed July 5, 1893. A bond wire having bent ends and washers provided with concentric apertures for the admission of the bent ends, and with radial grooves for the admission of the portions of the wire next to the angles therein.

514,718. ELECTRIC RAILWAY SYSTEM; P. W. Leffler, Minneapolis, Minn. Application filed Nov. 22, 1893. The combination of a magnetic field extending along the line of travel, an armature and local battery on the car, and a reversing device in the armature circuit.

514,739. INCANDESCENT ELECTRIC LAMP; G. H. W. Timbrell and J. C. Fyfe, Denver, Col. Application filed Sept. 18, 1891. An incandescent lamp provided with a transparent tube projecting into the vacuum bulb and exteriorly sealed thereto, the wires leading to the filament being carried there through and sealed therein in combination with a detachable lamp holder provided with a reflecting rod adapted to enter the transparent tube and engage one of the leading wires, and suitable switch mechanism connected with the rod and located in the circuit of the lamp. (See Illustration.)

514,746. APPARATUS FOR PERIODICALLY COMPLETING AND INTERRUPTING ELECTRIC CIRCUITS; E. L. Berru and F. Harrison, London, England. Application filed Oct. 6, 1893. The combination of a time keeper provided with contacts to maintain a shunt circuit closed for any determined time and a clockwork operating a circuit changer also in the shunt circuit, in which is an electromagnetic device operated at intervals to complete a circuit.

514,775. ELECTRIC ALARM; S. T. Sanders, Granite, Mont. Application filed July 29, 1893. This consists of an insulated slide connected with mine gallery chair operating-mechanism, conductors on the slide and a circuit-closing arm on the cage adapted to engage with the conductors on the slide.

514,801. TROLLEY; J. A. Williams, Altoona, Pa. Application filed Oct. 7, 1893. The combination of a hanger having bifurcated arms curved inwardly, removable shaft blocks seated in sockets of the bifurcated members, and a trolley wheel shaft keyed to the blocks and to integral positions of the hanger.

514,813. ELECTRIC CLOCK; R. V. Cheatham, Louisville, Ky. Application filed Feb. 7, 1893. This comprises a spindle arm secured to the knob spindle and adapted to actuate the door bolt, a spring secured on the arm and a lever pressed by the spring and adapted to lock the door bolt.

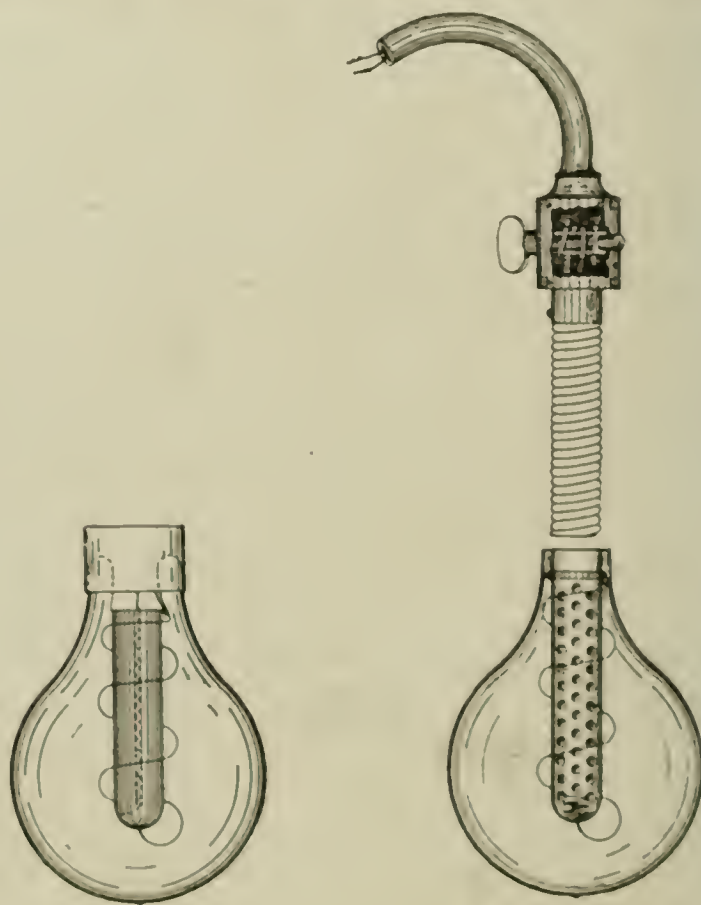
514,817. ARMATURE CONNECTION FOR DYNAMOS; O. Dufault, Spencer, Mass. Application filed Oct. 27, 1893. The combination with a commutator bar having a grooved arm provided with a dowel hole of an L-shaped conductor fitted to the groove in the end of the arm and provided with a dowel formed on the end of the lead.

514,822. INSULATING JOINT; E. F. Gennert, Brooklyn, N. Y. Application filed Aug. 10, 1893. This comprises two flanged sections in combination with a collar, which is spun over the flanges and which alone holds itself in place and the sections together.

514,823. TELEPHONE SIGNALING SYSTEM; W. Gillete, New York, N. Y. Application filed July 13, 1893. This comprises a main circuit and battery, a local circuit and battery, an alarm in the local circuit, a receiver and transmitter of a switch for shifting the main circuit from the alarm to the receiver and for shifting the local circuit from the alarm to the transmitter.

514,827. ELECTRIC RAILWAY CONDUIT. R. I. Hampton, Athens, Ga. Application filed May 25, 1893. This comprises a trolley rail chamber, a drain below the chamber, and a cable way located at the side of the rail and provided with removable rack bars superimposed transversely in the cable way to support and hold apart the cables.

514,845. ELECTRIC BATTERY CELL; P. C. Burns, Peru, Ind. Application filed June 12, 1893. In a battery cell, a carbon ele-



NO. 514,739.—INCANDESCENT ELECTRIC LAMP.

ment having grooves in which are plugs of insulating material projecting beyond the surface of the carbon element.

514,849. ELECTRIC CABLE; T. Guilleaume, Cologne, Germany. Application filed March 27, 1893. A crimped cable cylinder of non-conducting material having spiral grooves or air channels, in which naked conductors may lie.

514,878. ELECTRICALLY OPERATED STREET INDICATOR FOR CARS; H. C. Barker, St. Louis, Mo. Application filed June 23, 1893. The combination of an indicator carried by the car, a cam block on the conductor, a trolley arm having a contact piece, and a contact point mounted on the car having electrical connection with the indicator, whereby when the trolley engages the cam the indicator is operated.

514,886. ELECTRICAL TRANSMISSION OF POWER; C. S. Bradley, Yonkers, N. Y. Application filed June 23, 1890. The combination of a continuous current generator, a phasing device electrically connected therewith for converting the continuous current into alternating currents of differential phase, an electric motor, the field magnet of which is charged by a continuous current, and the armature of which is charged by the alternating currents of differential phase.

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No. 9.

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1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 289 " "
1884 " 82 " "	1891 " 325 " "
1885 " 100 " "	1892 " 316 " "
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No announcements of the Publisher are included in this list.

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41 Park Row, New York.

VOL. XXIII.

NEW YORK, MARCH 3, 1894.

NO. 9.

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ADVERTISING IN CONVENTION ISSUES.

The following comparison of the advertising in the convention issues of The Electrical World during the last four years shows—it this may be accepted as a criterion, as it probably can—that the popularity of the National Electric Light Association with business men continues unabated, and indicates the healthy condition of the electrical industry.

	Pages.	Number of advertisements.	Inches of advertising.
March 7, 1891.....	42	391	2,099
Feb. 27, 1892.....	52	357	2,613
March 4, 1893.....	56	378	2,828
March 3, 1894.....	76	386	3,219

Owing to the recent change of form the number of pages cannot be directly compared, the present page aggregating 44 inches of advertising space, against 56 in former years, but this does not, of course, apply to the number of advertisements, or to the number of inches of advertising. The present issue of The Electrical World is the largest number of an electrical journal that has ever been published.

REMOVAL OF THE ELECTRICAL WORLD'S OFFICES.

About April 1 The Electrical World will remove its publication offices to the new Postal Telegraph Building, 253 Broadway. This is directly across City Hall Park from its present quarters and adjoining the building in which it had its first offices, No. 9 Murray street. The Electrical World will occupy the entire Broadway front of the building on the third floor, and for its signs will have twelve different windows extending across the Broadway front and on Murray street. It is believed that this will be the pleasantest and most attractive home of any strictly technical journal published. The Electrical World was the first tenant to take rooms in the new "Times" Building, and will be one of the first to move into the just completed headquarters of the Postal Telegraph Company. This is the fourth building in New York in which the paper has had offices. In each it has occupied larger and more desirable quarters than before, and at higher rent. This is particularly true in the present instance, but considering the building and the location our friends will, we feel sure, say that the move is a judicious one, and be gratified to know that a journal devoted to electrical progress should find itself at the beginning of its twenty-first year in so commodious quarters, desirably located on such a prominent business thoroughfare.

ARC LAMP GLOBES.

In referring in these columns before to the subject of the loss of light from the use of arc lamp globes we expressed a hope that some experiments would be made to test the truth of the older data on the subject, which showed this loss to be very great with the kinds of globes in ordinary use. Elsewhere in our pages Prof. Shepardson gives the results of experiments made under his direction, which in some respects confirm the truth of the statement that this loss is indeed large. A mean spherical candle power of 319 from the bare arc we find is reduced to 235, 160 and 144 candle power when clear, ground glass or opal globes are used, which gives a loss of light of 26, 50 and 55 per cent., respectively. For interior illumination the loss from the use of ground glass and opals is somewhat compensated by the better distribution and quality of light, but for exterior lighting the waste is so great as to counterbalance in most cases the benefit arising from the employment of such globes. The complaint of the small power of the arcs on Fifth avenue of this city in the light of these figures is seen to have a real foundation, but this is one of the few special cases in exterior

lighting in which the sacrifice is perhaps justifiable. In lighting large interior spaces, where the quality of the light is an object, the use of opaque globes and a great part of the consequent loss of light involved may not only be avoided, but the quality of light also improved by the use of inverted arcs, which is a method of illumination that should be more often applied than it has been in the past.

TWENTY YEARS OF ELECTRICAL PROGRESS.

The story told in another column of the triumphant march of the electrical industries during the last two decades has no parallel in the history of material progress, and marks a period that will always add lustre to the nineteenth century. While some grand fundamental discovery may give rise to another similar period, the electrical age, like the Augustan age and the few other remarkable periods in the history of the world, will nevertheless always stand out prominently and be one of the glories of a century otherwise so richly endowed. Those who have taken part in the work that has produced such magnificent results will feel a pleasure in reviewing the various steps with the competent writers who recount them elsewhere, while to the younger aspirants to electrical honors the recital will possess a direct value, and perhaps awaken in some a determination that their names shall eventually be added to the list of those who will receive mention by future writers of electrical history.

THE WASHINGTON CONVENTION.

The meetings of the National Electric Light Association have long occupied a prominent place in the electrical field and have been looked forward to for months in advance with great interest. The fact that they now occur but once a year, the Washington meeting being the second under the new regime, tends to emphasize their importance and give additional assurance of success. The seventeenth meeting of the association, which occurs this week at Washington, promises to prove a dangerous rival to its predecessors. From present indications, the attendance will be considerably in excess of that of any previous meeting, an unusually large delegation going from New York City and vicinity. The officers of the association have been untiring in their efforts to render the arrangements perfect and to provide an attractive programme. In addition to several important papers, a large number of topics for discussion are announced, which is likely to prove an important feature of the meeting and bring out facts of interest and value. Among other questions of timely interest that will receive consideration are the proper rating of arc lamps, the most economical size of arc dynamos, and meters vs. flat rates. The paper on "Poly-phase Transmission," by Mr. Charles F. Scott, and the discussion of Mr. Tesla on "Alternating Current Motors" will doubtless attract considerable attention.

INSTITUTE POLITICS.

While the friends of the American Institute of Electrical Engineers will be pleased, and many, under the circumstances, doubtless astonished, at the argument made at the last meeting in favor of the position that legislation affecting the institute should only be considered at the annual meetings, they will at the same time, we think, be disappointed at the fate of the measure designed to prevent a repetition of last year's inexcusable manipulation of election machinery. While we have earnestly advocated the relegation of all legislation to the annual meetings, we would have gladly had the recent practice continue until the rule referred to was adopted, and scarcely expected that the inception of what was looked forward to as so desirable should defeat what was considered of even greater importance. As the secretary stated, however, the amendment of the election rules would have had no effect on the coming election, though,

it may be remarked, this was due to deferring action upon it when introduced. We trust that the matter will now be brought before the annual meeting, as well as a definite measure making illegal any legislation at other than the general meetings of the institute. The action of President Houston in appointing an honorary secretary for the Chicago local meeting inaugurates the principle for which those in sympathy with the reasonable demand of members not resident in New York and vicinity have contended, and will, we feel sure, meet with general approval. If now the annual meeting fixes the ruling referred to, that the New York meeting cannot legislate, which is equivalent to placing it on the same basis as the Chicago or any other local meeting, as it should be, and takes the proper measures for preserving the purity of the ballot, the institute will be placed on a basis that all of its real friends, among which we include ourselves, have hopefully looked forward to—an action which also, we trust, will put an end to Institute politics.

ENGINEERING DICTA.

In every branch of engineering there seems to be an element which, upon the appearance of a new discovery or invention that attracts general attention, proceeds to make what capital it can out of the occasion by "pointing out" limitations, which frequently have the merest shadow of an existence, but nevertheless serve the desired purpose of connecting the name of the objector to the subject and give him an ephemeral reputation for deep wisdom. In the early days of electric lighting, for example, a then well-known author called the attention of the electrical public to the so-called fact that the law of maximum efficiency also applied to dynamos and other electrical apparatus, and that as a consequence to attain that efficiency, the internal resistance of the apparatus should be made equal to that of the exterior circuit—a dictum that for a time was dubbed a law with the author's name prefixed. Again, but extending to a more recent date, there was considerable discussion as to the relative requirements of incandescent machines to be run in parallel, and it was maintained by some and believed by many for some time that it was necessary that such machines should possess identical characteristics to be thus successfully operated—which conclusion practice has shown to be unwarranted. In another column Mr. Steinmetz successfully attacks other hypotheses built up by mathematical writers, that certain specific conditions are absolutely necessary for running alternators in parallel. By actual tests under the most extreme conditions he conclusively proves that we may discard all the usual theoretical statements on parallel working relating to the effect of frequency and self-induction and the use of artificial loads. The experiments showed that machines properly designed for the highest or the lowest frequencies work equally well when respectively coupled in parallel and that the self-induction of well designed alternators has nothing to do with their successful running in parallel—a statement that demolishes several cherished mathematical theories, as does the one denying the theoretical conclusion that the condition of best synchronous running is with a lag of 45 degrees. As an examination of the experiments made will show, the conclusion is amply sustained that with properly designed alternators parallel running is perfectly feasible, and that even under extreme conditions of load and excitation, no special or careful adjustment is required to throw two machines run at the same frequency in parallel.

CENTRAL STATION BOILERS.

Prof. Fessenden elsewhere discusses the subject of boilers for central and power stations and describes a remarkable boiler which has lately been attracting the attention of the

steam engineering profession. A boiler somewhat similar was designed some years ago by the Herreshotts and exclusively used for torpedo boats and launches, but has, we believe, been discarded. The great difficulty with boilers designed with a small water capacity is the extreme attention they demand in operation, and the serious and immediate results from any neglect. Torpedo boat boilers, which are all of this type, require a supervision and an intelligence in the firemen that would be very expensive adjuncts to a steam plant ashore. In addition, the exhaustive strain on those operating such boilers through the strict attention required, while not impracticable with the short watches and intermittent steaming of torpedo boats, would be quite a different thing in continuous work. Nevertheless, much in regard to boilers may be learned from marine practice, and there are special boilers now in use on ocean vessels, and particularly on men-of-war, whose adoption ashore would be perfectly feasible, and at the same time beneficial. The remarks of Mr. Fessenden on artificial draft are very suggestive. The neglect of keeping in mind the distinction between forced and artificial draft through the extreme wastefulness of the former and its injury to boilers has resulted, in keeping the subject of the latter in the background. It is probable, however, that in time the use of blowers worked at a low pressure—normally less than a half-inch of water—will largely supersede the building of high chimneys, particularly where the demands for power fluctuate during different periods. The Howden system of low-pressure artificial draft, in which the air is heated in the uptake before going to the furnaces, has given excellent results in ocean work and points out the line to be followed. The subject of artificial and liquid fuel will also before long doubtless become one of importance, as is foreshadowed by an announcement made a few days ago that a vessel in the transatlantic trade had adopted the use of petroleum fuel with a fair prospect of attaining an economy over the use of coal. Aside from any question of superior economy of the fuel itself is that of the considerable saving that would undoubtedly result from the almost ideal manner in which such fuels can be supplied to the furnaces, thus saving the great wastes that result from the manner in which coal is fed and burned, and at the same time reducing the labor bill. The land steam engine was at least twenty years behind marine practice until the demands of the younger men connected with electrical engineering advanced it in a comparatively few years to its present state, and when the same element bestows similar attention to the boiler-room we may expect a proportionate change in practice there.

The Meeting of the American Institute of Electrical Engineers.

The eighty-fourth meeting of the American Institute of Electrical Engineers was held Wednesday evening, Feb. 21, at headquarters, 12 West Thirty-first street, with President Houston in the chair.

The papers of the evening were "Concerning a Change of Policy in the Administration of the Patent Office," by Mr. Philip Mauro, and "How Shall We Operate an Electric Railway Extending One Hundred Miles from the Power Station?" by Mr. H. Ward Leonard. Mr. Mauro's paper was read first, contrary to the published programme, in order to give Mr. Leonard a better opportunity to display his apparatus. Mr. Mauro's paper excited considerable interest, as it touched upon the question of curtailing the privileges of inventors. Written discussions from Mr. Vansize and Mr. E. P. Thompson were read by the secretary and verbal comments were made by Messrs. Olan, Forney, Sachs and Houston.

Mr. Leonard's paper was the attraction of the evening, and

was thoroughly discussed by Messrs. Curtis, Mailloux, Perry, Hill, Hewitt, Kennelly, Field, Woodbury, Sachs and others. After reading his paper, Mr. Leonard exhibited a working model of his system installed upon the platform, and gave a practical illustration of its operation.

After the discussion, the report of the committee on revision of rules came up for action. It was moved and seconded that it be adopted, but Mr. Phelps objected, on the ground that there had already been adverse comment concerning the enactment of legislation by the monthly meetings, and a member moved that the report be laid on the table, but the motion was not seconded. Mr. Upton, in behalf of the committee, begged that some action be taken in the matter, as the proposed amendments in no way altered the spirit of the rule, but on the contrary rendered its original meaning clear and removed ambiguity therefrom. Mr. Phelps, however, insisted on his point, saying that much as he appreciated the need of the proposed amendments, he feared that the action of the meeting in adopting them would be adversely criticised, and considered it better to let the report stand until the annual meeting. The secretary then asked for information regarding the effect of adopting the report with regard to the coming election, and it was ruled that the election notices having been already sent out, the amendments, if adopted, could not take effect until the 1895 election. The motion to adopt was then withdrawn, and the motion to lay on the table was seconded and carried. Mr. Kennelly gave notice that the report of the committee on units and standards would be called up from the table at the March meeting.

Mr. Edward Caldwell was appointed honorary local secretary for Chicago, the requisite number of signatures having been obtained.

Moonlight Tables for April, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of April under his modified form of moonlight schedule.

TABLE NO. 1. Standard Moonlight System.				TABLE NO. 2. Frund's New Moonlight System.			
Date.	Light.	Date.	Extng.	Date.	Light.	Date.	Extng.
1	5.50 P. M.	2	4.40 A. M.	1	6.50 P. M.	2	4.40 A. M.
2	7.00 "	3	4.40 "	2	7.00 "	3	4.40 "
3	7.00 "	4	4.40 "	3	7.00 "	4	4.40 "
4	7.00 "	5	4.40 "	4	7.00 "	5	4.40 "
5	7.00 "	6	4.40 "	5	7.00 "	6	4.40 "
6	7.00 "	7	4.30 "	6	7.00 "	7	4.30 "
7	7.00 "	8	4.30 "	7	7.00 "	8	4.30 "
8	7.00 "	9	4.30 "	8	7.00 "	9	4.30 "
9	7.00 "	10	4.30 "	9	7.00 "	10	4.30 "
10	11.10 "	11	4.30 "	10	7.00 "	11	4.30 "
11				11	7.00 "	12	4.30 "
12	12.10 A. M.	12	4.30 A. M.	12	7.10 P. M.	12	12 M.
13	1.10 "	13	4.20 "	13	1.10 A. M.	13	4.20 A. M.
14	1.50 "	14	4.20 "	14	1.10 P. M.	14	12 M.
15	2.20 "	15	4.20 "	15	1.50 A. M.	15	4.20 A. M.
16	2.50 "	16	4.20 "	16	1.10 P. M.	16	12 M.
17	3.10 "	17	4.20 "	17	2.20 A. M.	17	4.20 A. M.
18	No Light.	18	No Light.	18	7.10 P. M.	18	12 M.
19		19		19	7.10 "	19	12 "
20	7.10 P. M.	20	8.40 P. M.	20	7.10 "	20	12 "
21	7.10 "	21	9.50 "	21	7.10 "	21	12 "
22	7.20 "	22	10.50 "	22	7.10 "	22	12 "
23	7.20 "	23	11.50 "	23	7.10 "	23	12 "
24	7.20 "	24	12.50 A. M.	24	7.20 "	24	12.50 A. M.
25	7.20 "	25	1.40 "	25	7.20 "	25	1.40 "
26	7.20 "	26	2.30 "	26	7.20 "	26	2.30 "
27	7.20 "	27	2.50 "	27	7.20 "	27	2.50 "
28	7.20 "	28	3.20 "	28	7.20 "	28	3.20 "
29	7.20 "	29	3.40 "	29	7.20 "	29	3.40 "
30	7.20 "	30	4.00 "	30	7.20 "	30	4.00 "
Total hours, 170.10.				Total hours, 215.40.			

Note.—These schedules are made up on sun time. Where standard time is used and it varies considerably from sun time, the proper deduction or addition must be made to all the times here given.

Alternate Current Working.—III.

BY HARRIS J. RYAN.

The relation between alternating magnetism and the E. M. F. that it produces for a given current was found to be

$$B_{max.} = \frac{E' \times 10^9}{1.4 \pi a \sim i}$$

or

$$E' = 1.4 \pi \sim i a B_{max.} \times 10^{-9}.$$

Many cases occur in practice where the magnetism established is proportional to the magnetizing force, and, therefore, to the current in the electric circuit that is active in producing magnetism about itself. For many purposes under these circumstances it is usual to make use of the coefficient of induction. This coefficient of induction is the constant with which the magnetizing current must be multiplied, so that the product will equal the turns in the circuit multiplied by the magnetic flux. Its symbol is L , and its practical unit is called the henry.

$$CL = i M \times 10^{-9},$$

or

$$1.4 CL = i a B_{max.} \times 10^{-9}.$$

Substituting this value for $i a B_{max.} \times 10^{-9}$ in the above equation, we have

$$E' = 2 \pi \sim CL.$$

In making this substitution the product of 1.4 into 1.4 equals 1.96 was taken as 2. This is customary and is sufficiently accurate for practical purposes, because of the uncertainty of the precise form of the alternating E. M. Fs., or currents. Again it is used to write $\omega = 2 \pi \sim$, for this value is constant for any particular periodicity. This brings us to the form in which the relation between the E. M. F. current and coefficient of induction for a particular periodicity is usually written

$$E = \omega CL.$$

When the fall of potential produced by the ohmic resistance of a circuit is small compared to the pressure produced by the induction caused by the alternating current, the former may be neglected. Under such circumstances L for any circuit is determined by passing an alternating current of known periodicity through the circuit, the current and pressure that it produces are observed from an ammeter and voltmeter, and the values obtained are substituted in the above expression when L becomes known. L being known for such a circuit, the current that will be set up at any given

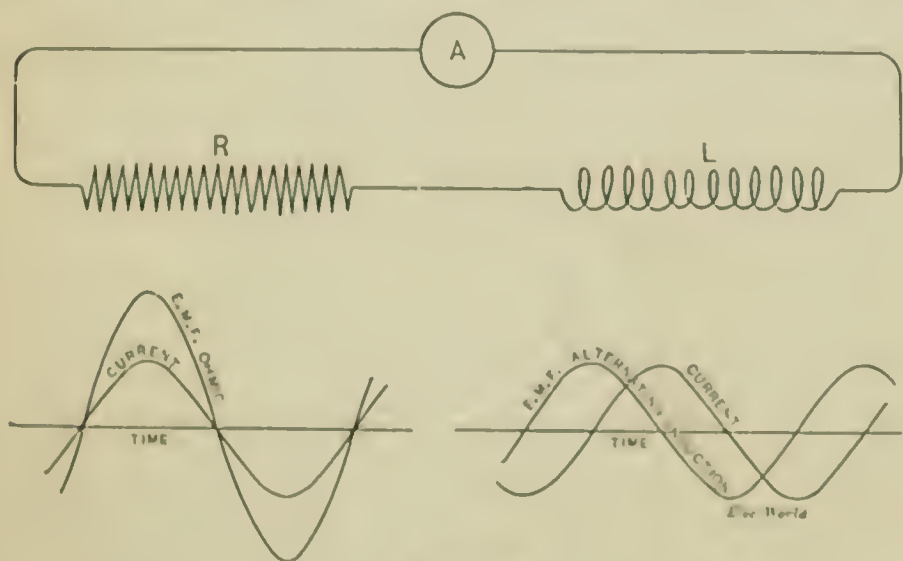


FIG. 10

pressure is easily estimated. For example, in the circuit given in Fig. 10, $R = 0$, and L has a value of .1, while the alternator at A furnishes current at a periodicity of 125. What pressure will the alternator have to furnish to set up a current of 10 amperes?

$$\omega = 2 \pi \sim = 2 \pi 125 = 790.$$

$$E = \omega CL = 790 \times 10 \times .1 = 790 \text{ volts.}$$

Many conditions have to be considered, however, where

the ohmic resistance of the circuit cannot be neglected. In all such cases we need to know how to determine the resultant E. M. F. that compensates for fall of potential, due to ohmic resistance and the pressure produced by the alternating induction. The same current is the cause of both these pressures, and though they are in series, they can only be added by determining the value of the sum of their instantaneous values. Fig. 10 illustrates a circuit in which we have a source of alternating pressure at A that establishes current through the circuit RL . R is non-inductive and possesses ohmic resistance, L is inductive and possesses no appreciable ohmic resistance. The magnitudes of R in ohms and L in henrys may in practice be any values. For the purposes of illustration in this case, we will assume that the fall of potential around R is double the pressure developed by the induction in L , as caused by the current that is common to both. The current and the E. M. Fs. that compensate for the fall of potential and induction pressure must be furnished by the alternator. They are plotted in their corresponding positions below R and L .

We have seen through earlier considerations that the E. M. F. that sets up current through a non-inductive resistance is in unison with the current, and the E. M. F. that establishes current against the pressure due to alternating magnetism is one-quarter period in advance of the magnetism, and, therefore, one-quarter period in advance of the current that establishes the magnetism or causes the induc-

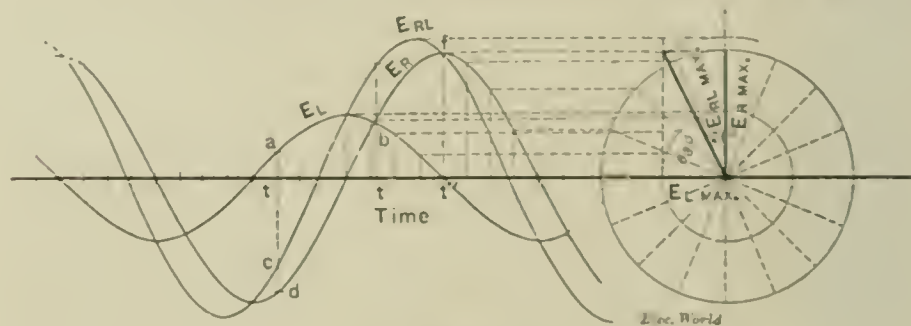
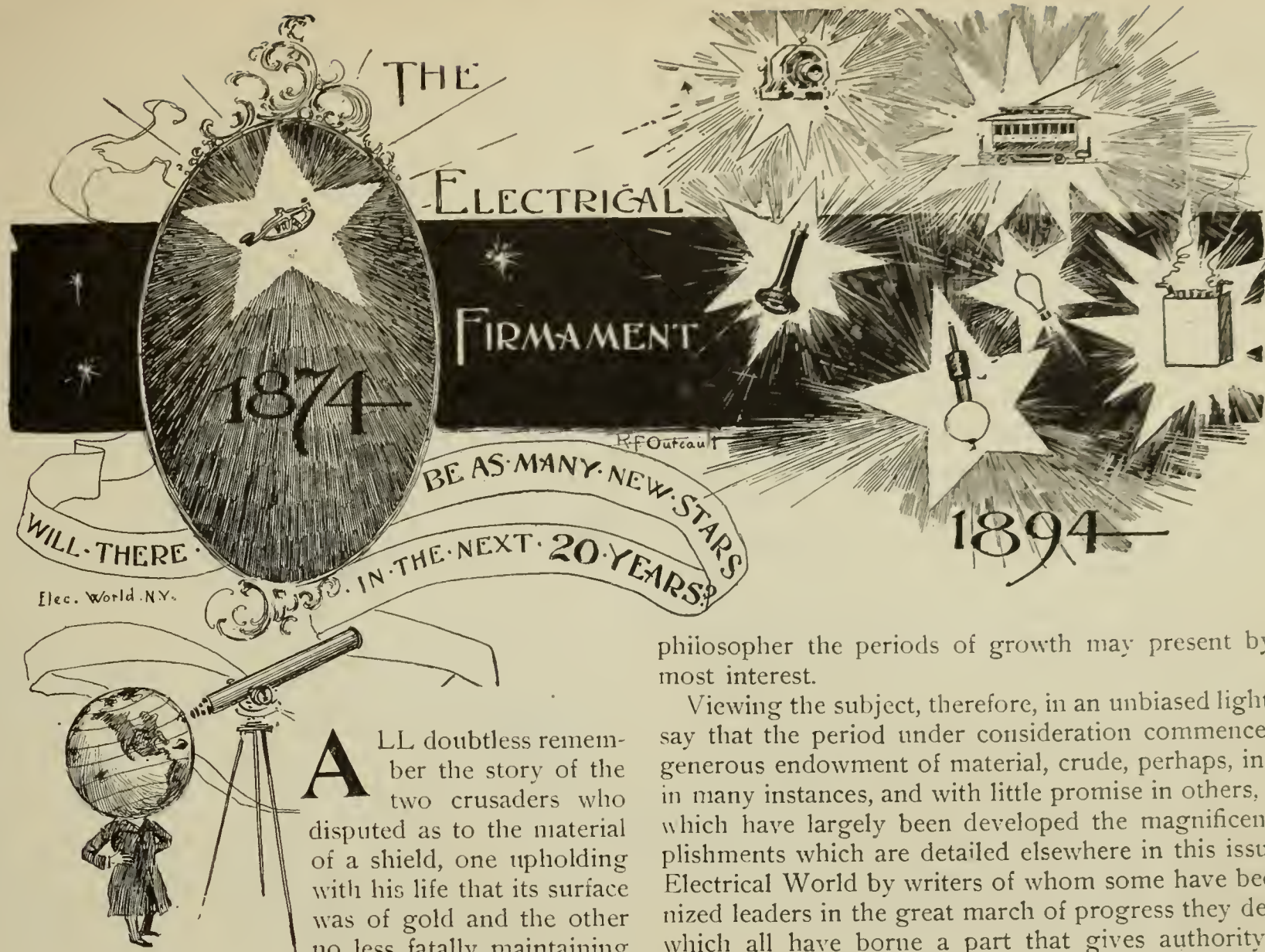


FIG. 11.

tion. In Fig. 11 these E. M. Fs. are plotted in such a manner that the induction E. M. F. E_L is one-quarter period in advance of the ohmic resistance E. M. F. E_R . A few of the construction lines are given for the purpose of showing a convenient method for drawing curves of sines. One circle is used for each of the curves E_L and E_R . The radius in each case equals the maximum value of the curve to be laid down, according to the chosen scale. The circle is then divided into as many equal parts as the number of divisions that have been chosen for the complete period. We then have one radius for each ordinate that is to be determined for the purpose of tracing in the curve. The vertical projections of these radii are sine values and determine the length of the corresponding ordinates of the curve, as is indicated by the broken construction lines. Positive rotation of the position of the radius whose vertical projection develops a curve of sines is anti-clockwise. Accordingly, since the fall of potential curve is one-quarter period behind the E. M. F. curve of alternating induction, the radius that develops E_R is at all times 90° behind, or a quarter of a period in a clockwise direction from the radius that develops E_L . When the E_R radius is vertical, its vertical projection is a maximum, and E_R is, therefore, maximum; at this time the E_L radius is horizontal, its vertical projection is 0, and the value of E_L is, therefore, 0. When the curves E_R and E_L are thus located graphically in their proper time relation, the resultant of E_R and E_L is the E. M. F. curve formed by the sum of their individual values at any instant. The curve whose ordinates are equal to the sum of the ordinates of E_R and E_L is determined by adding the ordinates graphically.

(To be continued.)



finding, however, when too late, that one side was of silver and the other of gold. With pens for weapons the same combat is constantly being repeated in the intellectual arena, every question presenting different views to different minds, many of them having distinct and apparently opposing practical and theoretical aspects that lend weight to either side of the argument.

For example, the assertions that, as compared with the first half of the century, electrical knowledge has made immense strides during the last twenty years, or that, in the same period, its progress has been slow, can both be maintained, if in the latter case the discovery of grand underlying principles is the criterion kept in view, or in the former the application of electrical science to the needs of man. For it is true that aside from the discovery of the electrical transmission of speech (if the friends of Philipp Reis will permit us this exception) no purely fundamental discovery can be claimed for the period under consideration. On the other hand, with the exception of the telegraph—and if we add a few years more this branch will then also be largely included—almost every application of electricity worth noting has had its birth or development in these two decades; and it does not require the gift of prophecy to predict that even thousands of years hence the last quarter of this century will stand out in the annals of progress as the age of Pericles does now in the records of antiquity.

While thus both of these two partisan views contain truth, yet each is the complement of the other, and we should no more sneer at the barren, practical record of the former period than accord a too transcendent importance to the later one. Without Faraday's electricity might yet be in swaddling clothes, and without the practical spirit of our age it might still remain but little more than a plaything for the curious. The development of a science differs but in kind from an organic development; each period is necessary to the succeeding one, and while from a materialistic point of view the mature stage may be the important one, to the biologist or

philosopher the periods of growth may present by far the most interest.

Viewing the subject, therefore, in an unbiased light, we may say that the period under consideration commenced with a generous endowment of material, crude, perhaps, incomplete in many instances, and with little promise in others, but from which have largely been developed the magnificent accomplishments which are detailed elsewhere in this issue of *The Electrical World* by writers of whom some have been recognized leaders in the great march of progress they describe, in which all have borne a part that gives authority to their views.

If an investigator had no other method at his disposal to determine the extent of growth during the last twenty years than the catalogue of an electrical library, he would have sufficient for his purpose. In a catalogue of almost four hundred electrical books before us, scarcely a score can be assigned a date as early as 1874, and the greater part have been published during the last eight years. While it is true that the great works of Faraday, Thomson and Maxwell were at that time printed and have not since been rivalled, yet the former then contained only a message for the initiated few, and the two mathematical works had a circle of readers still more restricted. Only in later years, when each new advance gradually revealed the profound scope of Faraday's thought, and other works furnished stepping stones to the heights of Maxwell, and when the experiments of Hertz had revealed the meaning of his wisdom—only then did they become to be understood. Aside then from these works and some on telegraphic science, electrical literature may therefore be said to have had its entire growth within the period considered. What the dearth of electrical books meant, even fifteen years ago, will be appreciated by those who then labored unassisted, even though under professorial instruction, with Jenkin, or one of its few contemporaries among text-books, and who also will recall the gratitude felt toward Gordon, Niaudet, Hospitalier, S. P. Thompson and other pioneers when their works appeared to assist them in the study of a science then bristling with difficulties and mysteries. Now all but the very newest branches of electrical science are elucidated in all of their details by an ever increasing army of authors, and the student also amply prepared beforehand for every probable development.

The subject from a technical standpoint is so fully covered by the articles which follow, that it is needless to further refer to technical progress here. As intimated before, the theoretical advances have been rather in the line of interpreting and extending the work of masters, but few of whom—though Maxwell and Thomson are of the number—lived

within the period considered. Those, however, whose labors have come within the era deserve none the less credit, for any lack of new discoveries must be ascribed rather to a lack of the opportunities so largely harvested by the earlier reapers than to lack of ability, as the work within the lines to which they were restricted have shown. Of these, Hertz, so lately with us in the prime of his intellectual life, was perhaps the greatest, and one whose experimental demonstration of the theories that Maxwell founded on the great conceptions of Faraday will always give additional lustre to our epoch. Rowland's researches in magnetism, his pre-Hertzian proof of the electromagnetic theory of light and other original work in electrical science, Ferraris' and Tesla's independent discovery of the rotary field, Joubert's discovery of the form of the alternating current curve, Hopkinson's theories upon which the design of electrical machinery is now based, Pupin's researches in resonance, Steinmetz's work in hysteresis, and the mathematical writings of Poincaré, Heaviside, J. J. Thomson and Gray—these are some of the additions to knowledge that have been made, and the list might be extended by mention of further contributions in a more practical field by Elihu Thomson, Kennelly, Ewing, S. P. Thompson, Ayrton, Fleming, Duncan, Shallenberger, Kapp, Kelly and some others.

Of periodical literature we can speak with authority, for with this number *The Electrical World* enters upon its twenty-first year, the first number of *The Operator*, of which it is the direct successor, having been issued March 1, 1874. On this occasion we may perhaps be permitted to say a few words about our own career, offering as an excuse, if one be necessary, that its course almost exactly reflects that of the electrical industries in general. Beginning in an humble way with "P. O. Box 3,332" as an office and the use of a desk at the printer's, the first permanent quarters of the journal consisted of a single room, well up toward the roof, at No. 9 Murray street. Increasing prosperity had at first a depressing tendency as far as location was concerned, and finally the needs of expanding business and circulation and the ambitions naturally thus inspired, led to a search for larger quarters, which were found in the Potter Building, at a rental, it may be added, of more than three times that paid in Murray street. The next removal was to still more commodious and high priced offices in the "Times" Building. Neither excursion had gone beyond the immediate vicinity of the modest building in which the foundation of prosperity was laid, there being a seeming reluctance to lose sight of that landmark, and it may be that this is the determining cause for the next removal. For about April 1 *The Electrical World* will transfer its abode to the new Postal Telegraph Building at the corner of Broadway and Murray street, adjoining its original quarters, where it will occupy the most spacious as well as the most expensive offices of any purely technical journal in the world.

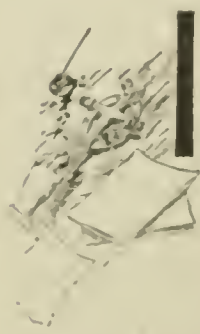
For the first seven of the twenty years to date it may be said that *The Operator* alone sufficed for the electrical public; what competition existed was merely ephemeral, the only permanent contemporary being the official organ of the Western Union Telegraph Company. Glancing through the slim files of *The Operator* and the progressively portly ones of *The Electrical World* (which name was assumed in 1883), we can trace every development of the period under consideration, while the rate of progress may be almost exactly measured by the growth of this pioneer journal. With but eight to ten small pages of reading matter and but two to four pages of advertisements in the first years, and but little other than telegraphic information in its columns, we gradually see the number of items and articles on the advance of other branches of electrical science increase. Shortly after the discovery of telephony, we are not surprised to see the change from a semi-monthly to a weekly, an increase both in read-

ing and advertising pages, and the gradual appearance of cuts to assist in the explanation of the discoveries, then so singular to readers, which had begun to be made. Finally, with the first number of 1883, coincident with the change to the present name, we are made fully conscious of the strength which the electrical industry had begun to develop.

Perhaps no better measure of this growth from an industrial standpoint can ever be attained than that given by a survey of the advertising columns of *The Electrical World*. With but 63 advertisers in January, 1883, we find this number more than doubled three years later (138), and almost quadrupled in another three years (234); in 1891 the number reached 325, and the record since points to that year as the end of what we may call the period of electrical "promotion" and the beginning of an era based upon more stable business methods—an era that will probably be definitely fixed by the expiration of the great electrical patents.

A Review of the Progress of Telegraphy During the Past Quarter of a Century.

BY WM. MAVER, JR.



It would be useless to claim that electrical telegraphy has made as rapid advances within the past twenty or twenty-five years as some of its sister branches, in view of the fact that several of the latter which are now in extensive successful operation were practically unknown for a long time after electrical telegraphy had reached maturity. For instance, arc and incandescent electric lighting, telephony and electric railroading, all of which, within a considerably briefer time than that mentioned have made such wonderfully rapid forward strides as to fairly entitle their progress to be classed as marvellous, even although occurring in an era which has been not inaptly termed the electric age.

But while it will not be claimed that electrical telegraphy has made in recent years as remarkable progress, whether considered from the scientific or commercial standpoint, as has been made in some other departments of applied electricity, yet should any one, distracted perhaps by the whirring of the more rapidly moving machinery of those sister pursuits, imagine that electrical telegraphy has been at a standstill for the past quarter of a century, or even for the last ten or fifteen years, such an one would, it may safely be asserted, find upon investigation that this has not by any means been the case.

A brief retrospect of the art of electrical telegraphy as it then was and a consideration of it as it exists to-day will, it is thought, confirm this assertion.

Twenty-five years ago the only systems of telegraphy in vogue in this country were the Morse telegraph system, the House and the Phelps printing telegraph systems, and some not very successful chemical automatic telegraph systems.

The speed at which messages were transmitted at that time by the Morse and printing telegraph systems was from 20 to 40 words per minute on land lines, and these figures represented the full capacity of a telegraph wire when those systems were employed. In Europe the systems most in use were the needle and dial telegraph systems and the Wheatstone automatic system, the speed of signals transmitted by the latter being about 80 or 100 words per minute.

Then, also, the Atlantic cable was, it may be said, in its infancy, and a speed of from 10 to 12 words per minute was the maximum rate of transmission by that cable. At that time the duplex system of telegraphy was scarcely known, except among telegraph experts—indeed, it was unknown as a successful practical method of telegraphing—and men of eminence in the profession alluded to it as a pretty scientific

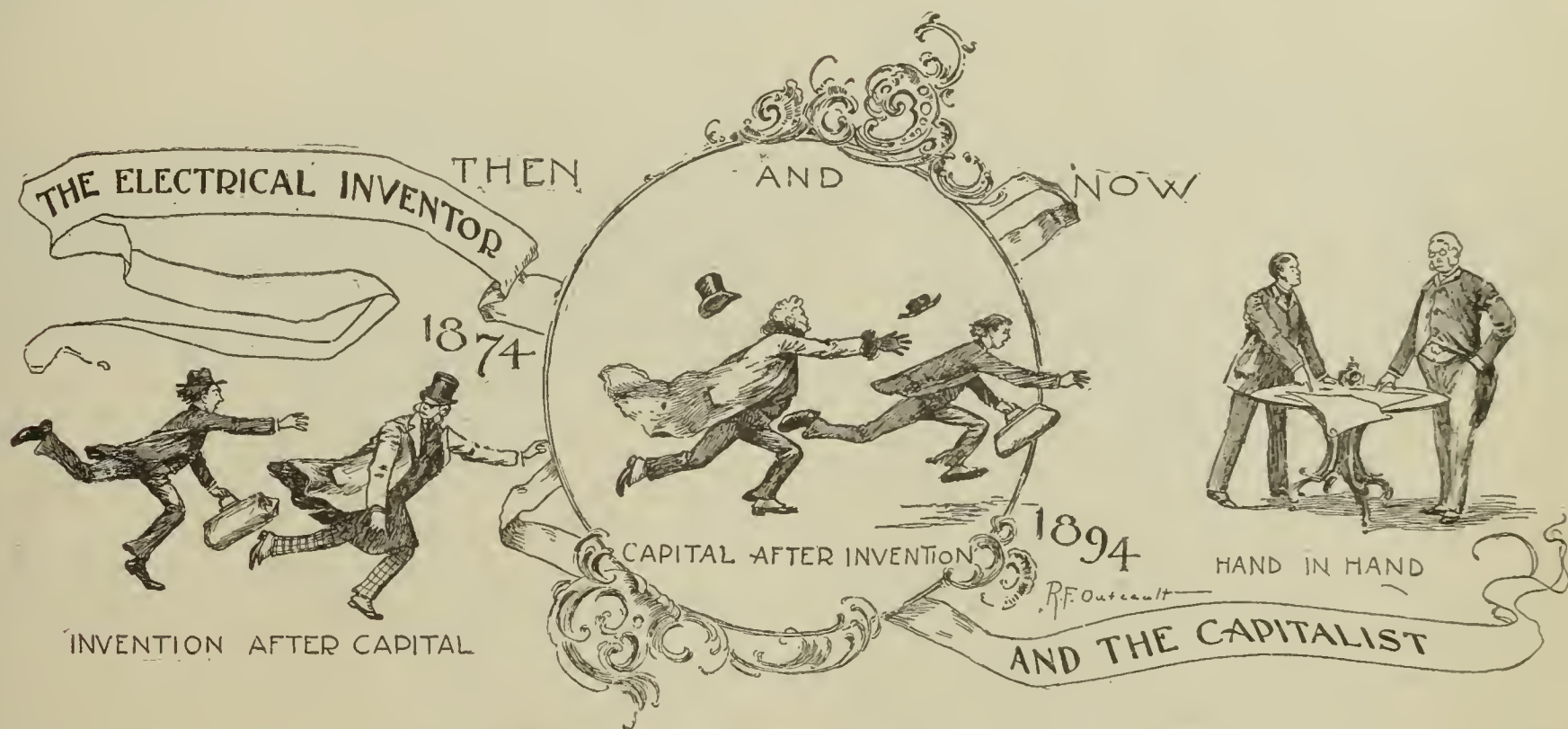
toy, and as something that was likely to remain such. One author wrote: "Systems of telegraphy designed to transmit more than one message at a time must be looked upon as little more than feats in intellectual gymnastics, very beautiful in their way, but quite useless in a practical point of view."

Since then the Phelps and other printing telegraph systems have been constantly improved, until now they are capable of performing excellent work at the rate of from 50 to 60 words per minute. The duplex has long since ceased to be a scientific plaything and has been put to the most practical kind of service, and from it has been evolved the wonderful quadruplex system, by means of which four messages may be sent simultaneously over the same wire, on circuits from 100 to 600 miles in length, and at a rate of speed about equal to that at which one message is transmitted on a single Morse wire. The Wheatstone automatic telegraph has developed into a system by which from 400 to 600 words per minute can be transmitted over one wire, and this system is now in extensive use in this country and Europe. The Atlantic cables have all been successfully duplexed, so that now each cable may be said to have a capacity of at least 40 words per minute. More recently the Delany synchronous multiplex system has been perfected and is giving successful

dynamo machine was utilized as a source of supply of current for the New York offices of the Western Union Telegraph Company, and its use in that capacity has been constantly spreading since that time. The importance of this use of the dynamo machine can scarcely be overestimated, its importance not alone consisting in the economy of maintenance of the dynamo machine, as compared with the chemical batteries formerly employed, but also in the economy of room space when space is very valuable. It is calculated that to supply the current now furnished by 10 or 12 dynamo machines in the New York main office of the Western Union Telegraph Company, about 50,000 gravity cells would be necessary, a quantity which could scarcely have been contained in two of the floors of that large building.

Much also has been done in the way of improvement in the practical operation of the telegraph by superior construction and insulation of the lines and in the employment of wires of better conductivity, such as larger iron wire, but more especially of hard drawn copper wire, the use of which latter, in telegraphy, was begun by the Baltimore and Ohio Telegraph Company in 1884, and has since been continued very extensively by the chief telegraph companies of this country.

It will be seen from the following figures that the increase



results in Great Britain, where, by its aid, six messages are transmitted over one wire at one time in either direction. This system, it may be remarked in passing, was tried quite thoroughly in this country, but was not found to give the satisfactory results reported from Great Britain. This is probably due to the more humid atmosphere of that country; the system, when tried here, having been found to operate more satisfactorily during rainy weather than during dry weather. Presumably, also, the system may have been modified and improved on the other side.

Other systems of telegraphy have also been developed within the past few years, such as that one whereby it is possible to communicate to and from moving trains. The system by which simultaneous telegraphing and telephoning over one wire has been made possible has also been introduced within the past dozen years. Various new systems and improvements on the older systems of fire-alarm telegraphy, burglar-alarm telegraphy, etc., have also been brought out during the time mentioned, and, generally speaking, a marked improvement in the manufacture of telegraph apparatus has also been quite noticeable. It is not, however, only with the improvement of apparatus and with the invention of new systems of telegraphy that telegraph engineers have been occupied. For example, in 1880 the

of the telegraph business from the commercial standpoint has also kept pace with the improvements in the systems, apparatus and conductors of the telegraph service. Thus, from a few hundreds of thousands of telegrams handled per annum in 1868, the telegrams now handled, in this country alone, have reached the enormous number of seventy-five millions per annum.

The increase of wire facilities for the dispatch of this large volume of business has of necessity also been very marked during the same period.

For example, in 1868 there were but 120,000 miles of telegraph wire in this country, all operated as single wires. To-day there are close upon one million miles of "actual" wire in operation, to which may be added, at a low estimate, one-quarter of a million of so-called phantom wire, obtained by duplexing and quadruplexing "single" wires. Furthermore, thousands of miles of these wires, besides being duplexed, are now carrying telegrams at the rate of from 100 to 300 words per minute, by means of the Wheatstone automatic system.

All of which, it is thought, will tend to bear out my opening assertion, and will also show that electrical telegraphy still maintains a steady onward progress.

The Birth and Growth of Telephony.

BY THOMAS D. LOCKWOOD



IN 1874 there was no speaking telephone. The possibility of the electrical transmission of speech had been recognized, and more than one person had indulged in the pleasures of the chase. By 1875 the idea which was the forerunner of practical success had been conceived, and the art of electrically transmitting speech had been embodied in a real working instrument; but not until 1876 was an electrical speaking telephone in the hands of the public.

The telephone was exceptionally fortunate in that it struck the Centennial year, and had the luck to be examined by such philosophical giants as Sir William Thomson and Prof. Henry, who did not scruple to pronounce it a scientific marvel, as wondrous as it was meritorious; and thus it came about that it entered the arena of public life with flying colors.

Many of us have vivid recollections of the childhood of the telephone—a brief epoch during the latter half of 1876 and the year 1877—when it appeared for a short space of time as though nothing more than a scientific toy (as it was termed by many) had been created—something forming an interesting subject for a short lecture, or a not too scientific amusement for a brace of telegraph operators when off duty.

Meanwhile its inventor and associates were not idle, and they improved the shining hour by devising improved forms of the instrument itself; suitable polarized bells; small but efficient magneto-electric generators adapted to actuate such bells; switches, manual and automatic, to facilitate the operation of the instrument and to improve the quality of its reproduced speech by withdrawing "resistance" and what subsequently has been named "inductance" from the circuit.

The earliest use of the instrument was in association with private lines, and though the magneto telephone had but a minute voice, such a one, in fact, as might be expected from a cheese-mite if it could talk, and required some experience and education before its utterances could be understood, it did good work, serving both as transmitter and receiver; and it is an interesting fact that the first telephone exchange commercially installed was equipped with such magneto telephones only.

The first line actually built for the operation of the speaking telephone was about two miles long, and was finished April 4, 1877. It extended from the factory of Mr. Chas. Williams, Jr., 109 Court street, Boston, to his house at Somerville.

Long-line telephony is supposed to be a rather recent development, but it also is among the achievements of the magneto telephone, for as early as the fall of 1877 communication was successfully effected between New York and Boston, and Boston and North Conway, N. H., by means of magneto telephones.

During the years 1877 to 1879, inclusive, marked progress in telephones, appliances and telephonic politics was made. We see the gradual introduction of the variable resistance telephone transmitter, based on the inventions of Berliner and Edison, and taking first the form of the carbon transmitter of Edison and later that of the well-known Blake transmitter, in which the variable contacts are provided with a delicate spring adjustment. The principles underlying these have, by the aid of Hunnings and later inventors, bloomed out into the powerful long-distance transmitter of the present time.

We see also in 1878 the microphone of Hughes, brought out in England in ignorance of the work done in the United States, and we cannot but note the deserved acclaim which greeted the publication of his researches.

The inception and the early growth of the now universally

known exchange system also has its place in these years. There are many claimants to the honor of having first suggested this idea, but as they all know so much more about their own thoughts, sayings and work than they do about anybody else's, as a rule, they see one side of the shield only.

The truth is the telephone exchange to the intelligent telegraph man was self-suggestive, the telephone itself once having been produced.

We had already telegraph systems operated on the same plan. There were, for instance, the "Law" and Gold and Stock Bank systems in operation in New York, the local telegraph company in Philadelphia and a dial exchange in Newcastle, England.

In the Chickering Hall lectures of Professor Bell I myself heard him outline the workings of the telephone exchange. This was in May, 1877, and in the same month of the same year an experimental exchange was operated in Boston.

However, the first commercial telephone exchange was opened in February, 1878. There are now more than a thousand such exchanges.

The determination of the Western Union Telegraph Company in 1878 to enter the telephone business had one remarkable, though unforeseen, result, viz.: In the race between the rival companies, each to get ahead of the other, the principal cities of the country were provided with telephone exchanges supplying service long before such a condition of affairs could otherwise have taken place.

Such a race in the nature of things was not profitable, and about the end of 1879 the two parties reached an amicable understanding; the National Bell Telephone Company and its successor from that time alone carrying on the telephone business.

The telephone exchange is, of course, the principal industry connected with the instrument and art, and any one can see that a connection with a large exchange means virtually a private line and a bonus in the form of a good genius acting to provide from one thousand, say, to six thousand distant ends for such line, and a like number of different stations with which it can connect. It is easy to show that such a convenience is not merely the great time economizer of the world, but that the average cost to the user in a large city of each complete conversation is actually less than the cost of sending a letter.

Over 560,000 telephones are to-day in use in the country, and it is estimated that in the year 1893 some 650,000,000 conversations (in round numbers) took place by means of the telephone.

In 1884 the telephone in this country alone furnished employment to about 4,800 persons; and at the present time it employs upward of 10,000 persons directly and a host of others indirectly.

The long-distance business, as we now understand it, does not go further back than 1884 or 1885, but since its introduction it has strung many circuits between New York and Philadelphia and New York and Boston; a goodly number from Philadelphia to Washington; has brought the cities of the eastern coast in close communion with Chicago, Milwaukee and Cincinnati, and is now stretching out towards St. Louis; and it has truly been said that "soon it will not be a figure of speech to say that one-half of the population of the country is within talking distance of the other."

The telephone was the earliest electrical industry to recognize the importance of underground work, and conduits were constructed as early as 1882. Of course many mistakes were made as the work went on, but I do not think the same mistake was made twice; and, in 1894, nearly every large city in the United States has a first-class and well-built system of conduits containing telephone wires.

In 1877 there were no underground telephone wires; in

1885 there were in the United States but 1,200 miles; but at the present time, roughly stated, the figure stands at about 100,000 miles.

This work has reacted upon the manufacture of the cables occupying such conduits, producing corresponding improvements in them, which have resulted in cables of high and constant insulation resistance, and having capacity much lower than in 1874, and for many subsequent years would have been considered possible.

The invention of the telephone was the voice crying in the wilderness, announcing the speedy coming of electric illumination, power transmission, transit, and metal working, and the supposedly immense profits accruing from its installation and operation constituted the incentive for the thousands of other related and analogous, as well as dissimilar, inventions in applied electricity which during the following eighteen years have sprung into being.

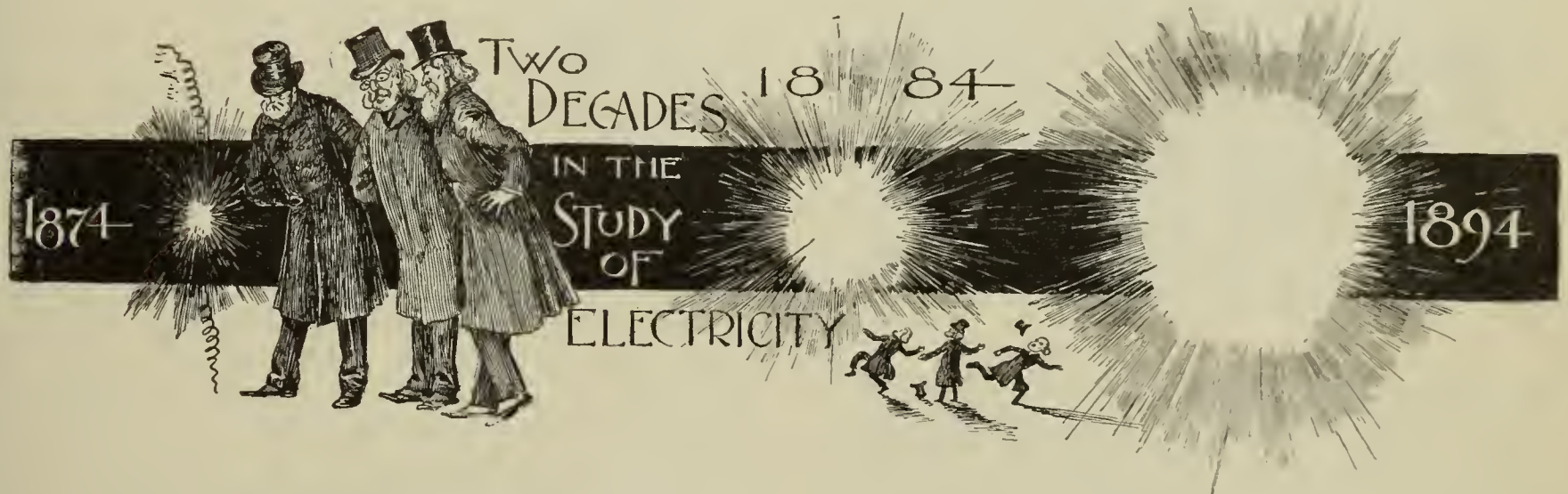
The very inventions made in telephones and supposed improvements, and in devices made necessary by the telephone, such as calls, disturbance remedies, switchboards and appliances, automatic switches, cables, underground conduits, coin-controlled apparatus, exchange systems and multiple and compound systems are quite considerable in number, for, on Jan. 1, 1894, no less a number than 805 patents on telephones and 2,235 patents on telephone ap-

many excellent lamps were devised by Staite, Petrie and others, but there was practically only one electric source in those days; viz., the primary battery and the earlier efforts in the direction of commercial arc lighting were thereby rendered unsuccessful.

The invention by Gramme, in 1870, of his improved magneto-electric generator, and his subsequent inventions of a dynamo-electric machine and a self-exciting alternating-current generator, placed at the disposal of the world a cheap and reliable source for the production of electricity, and so rendered arc lighting a possibility.

The exhibition of the Gramme machine at the International Exhibition of 1876 in Philadelphia may justly be regarded as a circumstance which greatly tended in this country, and indeed all over the world, to turn the attention of inventors again to arc lighting.

Jablochkoff had already, on March 21 of that year, taken out a patent in France for his well-known electric candle, consisting of two parallel carbon rods, maintained at a constant distance from each other by a strip of non-conducting material. By means of this device Jablochkoff did away entirely with the expensive regulating mechanism employed in the earlier forms of arc lights for maintaining the carbons at a constant distance apart. Jablochkoff's invention created great excitement in the world, and was extensively intro-



pliances and systems had since March 1, 1876, been granted by the United States Patent Office, representing more than \$106,000 paid by inventors in this line to the Patent Office in fees alone.

Notwithstanding the immense development of this industry, it is evident that there is room to branch out into many fields of utilization which are, so far, relatively unploughed.

The immediate future of telephonic advancement will probably be in the direction of an increased number of private lines; in a considerable expansion of hotel, factory and institution installations for intercommunication between the departments, and to some extent in a renewed application to mining and, perhaps, also to diving operations.

The Last Two Decades in Arc Lighting.

BY EDWIN J. HOUSTON.

THE two decades through which the electrical world has just passed have witnessed remarkable activities in all directions. In the early part of the first decade these activities, though manifested in various lines, were most marked in the field of electric arc lighting. It would be impossible, in the limits of a brief article, to more than generally indicate the particular lines along which these developments have occurred.

After Davy and others had shown the possibilities of the carbon arc as a source of artificial illumination, numerous attempts were made to apply the arc to commercial use, and

duced into use. It formed an important feature of the Paris Exposition of 1878, and was employed in the same year for street lighting in the Avenue de l'Opera in Paris. At first Jablochkoff employed the direct current in connection with his candle, but soon experienced a difficulty on account of the more rapid consumption of the positive carbon. He subsequently avoided this difficulty by the use of the alternating current in place of the direct current.

Despite its seeming simplicity, the Jablochkoff candle was soon found in actual practice to be far inferior to arc lamps employing larger carbons and containing more or less complex mechanisms for maintaining the carbons a constant distance apart, despite their consumption.

It would be impracticable even to name the various inventors who have competed with one another for superiority in the development of the arc lamp; suffice to say that of all the forms of lamps tried those in which the positive carbon is held vertically over the negative carbon and fed toward it by the action of gravitation were the ones that proved fittest to survive, and which are now extensively in use over the whole world. In all these lamps, with the exception of the lamp used with a projector in the search light, the upper carbon alone is fed. In the latter both carbons are fed.

Among the earlier inventors in the field of arc lamps are to be found Wallace, Wallace-Farmer, Brush, Maxim, Weston, Wood, Thomson-Houston, and somewhat later, Westinghouse, with his alternating arc lamp, and numerous others. In their earlier use arc lamps were employed on

single circuits. Brush was one of the earliest, if not the earliest, to adopt series lighting in this country. That is, he placed a number of arc lights in series on a metallic circuit.

The use of the series circuit in arc lighting must be regarded as a step of the greatest importance in the history of the arc light, for the series circuit readily affords the means for the distribution of a great number of lights over a large area, with a comparatively small weight of copper conductor.

But before series arc lighting could become a possibility an invention fundamental to the art was required; viz., the production of the derived circuit lamp, which finally developed into the differential lamp; that is, a lamp in which a regulating device is placed in a shunt circuit around the arc established between the carbons. An electromagnet placed in the shunt circuit is employed to antagonize the action of a magnet placed in the main or arc circuit, and employed to separate the carbons. It acts briefly as follows: When the carbons burn apart, and the resistance of the arc formed between them consequently increases, a greater proportion of current passes through the shunt magnet and energizes its coils sufficiently to permit the release of a clutching device, thus leaving the upper carbon momentarily free to fall toward the lower carbon.

Like all great inventions, the derived circuit lamp and the differential arc lamp were the gifts of many inventors. The first lamps of this type were produced by Lacassagne and Thiers in 1855. Subsequently Lontin, De Mersannes, Brush, Siemens and others greatly improved them.

The use of the series circuit in arc lighting at once demanded the invention of a safety device, whereby the extinguishment of any one of the lamps placed in the series circuit should not destroy its continuity. This invention, therefore, was made early in the history of the art, and was practically contemporaneous with the production of the series system in arc lighting.

The enormous development of arc lighting soon rendered the artificial carbon or graphite formed on the interior of gas retorts, in which soft coal had been carbonized for the production of illuminating gas, insufficient in quantity, and various manufactories were established for the production of artificial carbons. Artificial carbons consist mainly of mixtures of carbonaceous and carbonizable materials, moulded into form and subsequently carbonized.

All such artificial carbons are greatly improved by an electrolytic deposit on their surface of a thin coating of copper. A French patent was taken out for such a process by Reynier under date Oct. 11, 1875, and Jablochkoff employed such a coating early in the use of his invention. Reynier, however, was anticipated in this event by Carre, who took out a patent in France, Aug. 23, 1867, in which he describes carbons coated with zinc and tin for electric light purposes. So, also, Van Malderen claims to have coated carbons with copper in 1867, and Bouliguine and Tchikoleff appear to have coated carbons with copper about the same time. In America Brush took out patents for copper coated carbons early in the history of arc lighting.

Arc lights are peculiarly adapted to outdoor lighting; i. e., to the illumination of extended areas, and this requires the burning of a light, in many cases, during all the hours of darkness. It soon became evident from the limits of the dimensions which it was found practicable to give the ordinary arc lamp, and the size of the carbons best adapted to insure steadiness of light that a single pair of carbons, a long upper or positive carbon and a short lower or negative carbon, would not suffice to last through the hours of darkness. In the early history of the art it was customary for trimmers to climb the poles and recarbon the lamps while the rest of the circuit was in operation. A great improvement was introduced into arc lighting by the invention of

the all-night arc lamp. The disc regulators of Harrison, in 1857, were the prototype of this form of lamp. In America Wallace's plate-carbon lamp was a step in the right direction; but the type of all-night lamp which is now almost universally employed in America is the double-pair carbon arc lamp. The priority of this invention has been awarded by the courts of this country to Brush.

The production of a good dynamo for use in connection with series arc lamps was a problem that was solved early in the history of the art, and a variety of excellent dynamos have been invented for this purpose, namely, the closed-circuit dynamos of Weston, Maxim, Wallace-Farmer, Wood, Hochhausen, and the open-circuit dynamos of Brush and Thomson-Houston.

The past two decades have witnessed a wonderful development in arc lighting. Will the next two decades witness an equally marked improvement, or will the arc light be, to a certain extent, replaced by some other form of light, say, for example, an improved, high-candle power, incandescent lamp?

The Growth of Incandescent Lighting.

BY W. A. ANTHONY



It is now almost a hundred years since it was first observed that a metallic wire could be heated to incandescence by the passage of the electric current. And yet it may be said that twenty years ago the history of incandescent electric lighting had hardly begun. From almost the beginning of the century scientists experimented upon the heating of conductors by the current and studied and formulated the laws governing the rise of temperature. Teachers of electrical science performed for their classes experiments in which wires were heated to redness and melted by the current. And yet up to twenty, or even fifteen years ago, little was done toward the use of such incandescent conductors for the purpose of illumination. The slow progress in those early days was due undoubtedly to the cost of electrical energy, for which there was no cheaper source than galvanic batteries. It was not until the great improvements in magneto and dynamo electric machines, 1866 to 1871, resulting in the continuous-current machines of the Gramme and Siemens types, that electric lighting became commercially practicable. Two ways were open for the application of the current to the production of light—the electric arc and the incandescence of small conductors. The intense brilliancy of the arc light, and especially the fact that, for the energy expended, so large a return in light was rendered, led experimenters to the perfection of regulators for arc lamps to the neglect of the methods of lighting by incandescence. But, although dynamo-electric machines and regulators for the arc light were at hand in 1871; although carbon in vacuo had been used for an incandescent lamp in 1845, the subdivision of the battery current for the operation of incandescent lamps had been achieved in 1850, and the subdivision of the dynamo current for the same purpose in 1871; yet at the Centennial Exhibition in Philadelphia in 1876 no one was ready to furnish electric light for any of the buildings or any portion of the grounds. Dynamo-electric machines were there, and arc lamps were there, and they were sometimes shown in operation, but nowhere were they depended upon for illumination. Up to 1876, therefore, there was no commercial electric lighting system. In 1871 Lodyguine exhibited in St. Petersburg 200 incandescent lights operated by one machine*; in 1875 Farmer operated

*"Nature," XIX, 72.

by means of one machine 42 platinum lamps, but these experiments attracted little attention and were soon forgotten. The two or three years following 1876 saw the arc light rapidly assume importance in outdoor and large area lighting, but all attempts to make a small arc light suitable for domestic lighting failed. Any attempt to reduce the brilliancy of the light was attended by a loss in efficiency. It seemed to follow somewhat the law of gas lights, where, as is well known, a small burner gives, in proportion to the gas consumed, much less light than a large one. This loss in efficiency seemed to be fatal to the "subdivision" of the light to any such extent as was needed for general indoor illumination. It was known that incandescent lights could be made as small as desired, but incandescent lights gave, for the energy consumed, only about one-tenth the light of the arc lamp, and this was enough to deter many experimenters from seeking the solution of the problem in that direction.

There is a mistaken idea that eminent scientific men about that date, 1877-1879, declared the subdivision of the electric light impossible. Nothing is further from the truth. What scientists did say was that it seemed to be impossible to subdivide the light and maintain the efficiency obtained by the electric arc, and that is as true to-day as it was then. That problem in the subdivision has never yet been solved.

At the beginning of 1878 the position was this: The laws governing the subdivision of electric currents and the fall of potential along conductors—all the laws and principles involved in the proportioning of conductors for distributing electric currents—were well understood. For at least twenty-five years these laws had been considered in making designs for electrical instruments and apparatus; they had been taught to college classes and questions and problems based upon them had been given at examinations. The dynamo-electric machine was well developed, and needed only to be properly proportioned to adapt it to the supply of energy for incandescent lamps. Incandescent lamps had been made with platinum and other metallic burners, and also with burners of carbon. Currents from a galvanic battery and from dynamo-electric machines had been divided among a number of such lamps. What was lacking was a cheap and durable lamp, a willingness to accept the low efficiency of incandescent as compared to arc lights, and a demonstration that the distribution could be effected and the system operated upon a commercial basis.

Fortunately, a few workers in the electric lighting field had confidence in the incandescent lamp, notwithstanding the waste of energy its use involved. Sawyer and Man, Edison, Maxim, Swan and others turned their efforts in this direction, and the success of the incandescent lamp is due in some degree to each of these. A lamp possessing the elements of commercial success was completed by Mr. Edison in the latter part of 1879, and in the latter part of December in that year an exhibition plant was started at Menlo Park by which the streets and many of the buildings, including private residences, were lighted—the first example of house-to-house lighting that approached the fulfillment of the conditions necessary to commercial success.

In the May following the first commercial plant to use the Edison lamps was installed and started on the steamer Columbia. But the other workers in the field had not been idle. Successful lamps had been made by Maxim, and in the autumn of 1880 a plant of about fifty Maxim lamps was started in the Equitable Building, at 120 Broadway, New York City. This was the beginning of commercial incandescent lighting in New York, only a little more than thirteen years ago. Since that date the growth of incandescent lighting has been marvelously rapid, and yet there has been no striking or fundamental change from the methods and apparatus used in those first plants, except the introduction of the alternating system in 1886-1887, which, permitting the

use of high potentials, solved the problem of distribution in suburban districts and small places, where consumers are scattered over large areas.

Lamps have been improved by improvements in the manufacture of filaments, adapting them to use at a higher temperature, by which it obtained a higher efficiency. Within a year the lamp has been still further improved by the substitution of an artificial atmosphere of bromine for the vacuum in the lamp chamber, which, although it may shorten the life of the filament, certainly prolongs the useful and efficient life of the lamp.

Generators have been somewhat improved in efficiency and regulation, and they have, of course, increased in size with the demand for larger plants.

Probably the greatest improvements have been made in the methods of wiring buildings and such details as cut-outs,

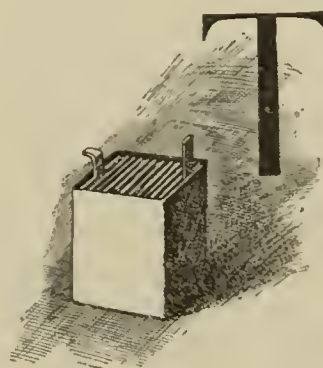


switches, etc., in response to the demands for safety, convenience and good taste.

The most striking evidence of the growth of the incandescent lighting industry was seen in the plant that was installed and started last year at Jackson Park, just about thirteen years after the plant at Menlo Park, and there could be no stronger evidence of the activity in that line than the fact that one manufacturing company alone was able to take and execute a contract to furnish for that plant nearly 100,000 incandescent lamps with all the machinery and appliances required for the complete installation.

The Storage Battery from Its Introduction.

BY TOWNSEND WOLCOTT.



THE history of the development of the storage battery in the last twenty years practically includes its whole history. The first recorded instance of the observation of electrolytic polarization is that of Gautherot, in 1801, who discovered that platinum or silver wires which had been used to desaline water electrolytically, possessed the property, after having been cut off from the original source of currents, of themselves furnishing a current of short duration in the reverse direction. Ritter, in 1803, observed the same phenomenon with gold wire, and made the first secondary battery by superposing pieces of gold, separated by cloth discs, moistened with a saline solution. Subsequently Volta, Davy, Becquerel, Marianini and others added somewhat to the knowledge on the subject, and Sir William Grove, in

1842, constructed his well-known gas battery, in which the E. M. F. came from the oxygen and hydrogen evolved in the electrolysis of water acidulated with sulphuric acid. Faraday, when electrolyzing a solution of lead acetate, found that peroxide of lead was produced at the positive, and metallic lead at the negative pole of the electrolytic bath, and in his "Experimental Researches" he comments upon the high conductivity of lead peroxide and its power of readily giving up its oxygen. This may be considered the next step in the evolution of the storage battery, although Faraday apparently made no such use of it. According to Niblett, Wheatstone, De la Rue and Niaudet all seem to have been well aware that peroxide of lead was a powerful depolarizer, but the first cell which could be called in any proper sense a practical storage battery was made by Gaston Plante, who, in 1860, constructed his well-known cell with coiled plates. This cell was made by rolling into cylindrical form two long, narrow plates of lead, separated by thick cloth, and placing the roll on end in dilute sulphuric acid. Plante made further improvements in his apparatus, and advanced the art so far that he may be considered, more than any other one man, as the inventor of the modern storage battery. Plante's researches extended up to the year 1879, and in the year 1874, which is the beginning of the period which we are here especially considering, they practically determined the state of the art. As to the theory at that time, it may be stated that in the year previous Maxwell published his treatise on electricity and magnetism. So great was the merit of this work, that it at once placed its author in the position of the leading electrician of his time the world over; and yet the only way in which Maxwell speaks of the storage battery is as storing up a charge of electricity in a manner somewhat analogous to the ordinary condenser (or accumulator, as he calls it by preference, which is the name since applied by some authors to the storage battery itself). To-day the theory of the storage battery differs in no respect from that of the primary battery; the current and E. M. F. depend in the same manner upon the amount of electrolysis and the energy of the chemical action, and the distinctions once considered so important are really differences of practicability rather than of principle. That is to say, in any primary battery where the chemical action which takes place during the discharge can be reversed by a reverse current from an outside source, we have theoretically a storage battery, and on the other hand a battery which, as ordinarily made, is not active until charged from an outside source, may be made active at once by the use in the first instance of those chemical substances which are otherwise formed by the outside current. The Plante cell, as is well known, consists essentially of two lead plates, which, by the prolonged action of the "forming" current, are converted to a greater or less extent, the one into metallic lead in a spongy condition and the other into peroxide of lead. This type of cell, in the hands of its inventor, gave results far surpassing anything ever obtained, or even hoped for, from primary cells, yet, nevertheless, it fell far short of what was necessary in many commercial applications. The process of manufacture was tedious and expensive, and the life of the positive plates was short, owing to the oxide falling off. In 1881 Camille A. Faure conceived the idea of avoiding the tedious forming process by applying mechanically to the lead plates a coating of minium, or other oxide of lead, which was held in position by felt covers, and which was converted into peroxide and spongy metallic lead on the positive and negative electrodes, respectively, much more quickly and economically than in the Plante type of cell. It was one of these Faure cells which was sent to Lord Kelvin (at that time Sir Wm. Thomson), and which caused his now famous letter to the "Times" about a "marvellous box of electricity" in which "a million foot-pounds of energy" had

traveled from Paris to Glasgow. These remarks, coming from so high an authority, gave a great impetus to the storage battery industry, and inventors began to crop up at a rate that was truly astonishing. Sellon and Volkmar introduced the "grid," or grating, to which the Faure paste was applied, and which supported the latter so well as to obviate the necessity of the felt. This was a real improvement, but after the first grid appeared dozens of so-called inventors, who had merely altered the form of the grid, came forward, each claiming to have a new battery. The Faure-Sellon-Volkmar cell, with some minor improvements, is practically the cell of to-day, of the mechanically applied oxide type. Charles F. Brush worked independently in the same field with Faure, and the United States courts have after lengthy litigation decided that priority in this country belongs to Brush.

On the other hand, many claim that the mechanical application of oxides was discovered, or invented, by Plante himself. The Plante type proper has been greatly improved of late years, and to-day has no favors to ask from the Faure type, even if it is not really better, as it is believed to be by many. The Laurent-Cely, or chloride, cell has come into prominent notice of late years in consequence of undoubted merit. The cell belongs to the Plante type, but is manufactured by a process peculiar to itself. Blocks are first cast from a mixture of the chlorides of lead and zinc, and the chloride of zinc removed by washing. The blocks are then placed in a mould and the grid cast around them. The chloride of lead is then reduced by metallic zinc, and the plates then formed in a manner similar to the Plante disintegration process.

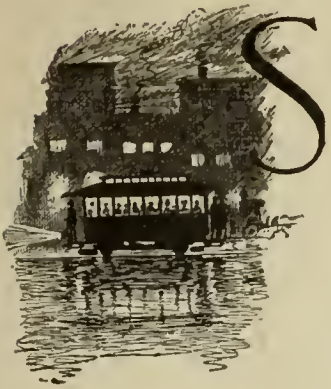
We can here only briefly touch upon two other types of storage battery, omitting all others as having so far attained no commercial importance.

By replacing the spongy lead plates of the Plante or Faure types by metallic zinc the E. M. F. is materially increased, but new difficulties are introduced, which interfere with the commercial operation of the cell. These difficulties have been largely overcome by later inventors, so that this type holds its own commercially, though it has not materially interfered with the Plante and Faure types. The first use of the confinement of zinc and peroxide of lead appears to have been by Wheatstone in 1843. The battery of Commelin Des Masures and Bailhoche consists of zinc and copper electrodes in caustic alkali. This type has in the last two or three years attained a good deal of importance in this country in the hands of Waddell and Entz. All the types described are in commercial use to-day, and mark a considerable advance since 1874.

In Europe storage batteries are largely used in central stations for equalizing the load. They are charged from the dynamos during the hours of light load, and discharged in connection with the dynamos during the hours of heavy load. They are also beginning to be used in the same manner in this country, and it is to be hoped that they will come into more general use. In the field of lighting of railway trains they are also doing good work in this country. On the Continent of Europe the most popular types for station work are those which are very heavy in proportion to their output, in consequence of their greater durability. For traction purposes, however, the great desideratum is lightness in proportion to output, necessitating a different construction. The alkaline battery is remarkable for its lightness in proportion to its current output, but as its E. M. F. is only about three-eighths of that of the lead and sulphuric acid types, its watt output per pound weight is not larger than in some makes of the latter kind. Storage battery traction has thus far been chiefly experimental, but its promoters are still confident of ultimate success, which all will admit as highly desirable.

The Development of Electric Traction.

BY CHARLES HEWITT.



So far as we now know, electric traction had its beginning some time in the thirties of this century, and slumbered for many years, with an occasional awakening, until Mr. Charles Van Depoele and Mr. Leo Daft took up the subject. These inventors had the advantage over all their predecessors in that they had the dynamo in a fair state of development. They worked on similar lines, and built several roads with the double trolley wire and overrunning trolley, and with motors mounted on the car platform. The few roads built on this plan demonstrated two things—the feasibility and the demand for electric traction. Although thoughtful railroad managers saw in this system the beginning of a future revolution, still they held aloof. It was too crude, too mysterious, too new, too radical. The onus of expense fell heavily upon the inventors and their friends. Nor was the bat-

the loss of thousands then has been offset by profits of millions since. "To err is human" applies most truthfully to this road. Not to have made some mistakes would have been supernatural. When two indifferently fed mules could give a service that was thought to be satisfactory, it was natural to suppose that two 5-h. p. motors would answer all requirements. But with the new method of propulsion, new possibilities were revealed. People were no longer willing to jog along at five or six miles an hour behind two stumbling animals. A cry for more rapid transit arose, and a demand for more powerful motors, until the original 5 h. p. has grown to 30 h. p. and for locomotives even to 200 h. p. Among those who early realized the value of the Richmond experiment was Mr. Henry M. Whitney, president of the West End Railway Company, of Boston. By the signing of the contract for the electrical equipment of the West End Railway, electric traction was given an impetus that was simply phenomenal.

Imperfect as the apparatus at that time was, the demand for it soon grew to be overwhelming. In five years the business had grown from nothing to no less than twenty million dollars for one year's sales. Is it not remarkable



tle yet to be won without the expenditure of large sums of money and the exercise of undaunted energy and pluck. In 1885 or 1886 Mr. Sprague astonished the electrical fraternity by his plans for the equipment of the Richmond Street Railroad—motors placed beneath the cars, geared directly to the axle and flexibly suspended from the car body or truck; a single trolley wire with an underrunning trolley; an earth return circuit. As we look back we cannot but admire the pluck of the man who conceived and the men who carried out his ideas; no precedent to go by, everything was to be demonstrated. Be it said to their credit that the "system" in all its essentials remains to-day as it was then conceived. The apparatus has been wonderfully developed and improved, but the "system" remains unchanged, and has relegated its older brother to utter oblivion. Perhaps the whole history of the Richmond road will never be written, but it is now well known that the experience gained there cost the promoters many thousands of dollars. But

that so many millions should have been invested in apparatus that in less than ten years has been entirely superseded, and in a large measure replaced and relegated to the scrap heap? What hopes were blighted; what illusions dispersed by those early motors. The promises of the enthusiastic salesmen were so far from being realized that these men were considered just candidates for eternal punishment, and yet I believe in most cases they honestly believed their rosy stories. All thought each new type of motor would overcome all the troubles in the former type. But armatures would burn out and, in fact, each type seemed to develop faults peculiar to itself. The old No. 5 Sprague motor, with its two commutators, soon gave place to the No. 6 motor, with one commutator, larger fields and more powerful armature. This was followed by the No. 8 Edison motor with improved frame and wound for 250 volts, the two motors on a car being connected in series. This in turn was followed by the Edison multipolar motors with Gramme

ring armatures, Nos. 10, 12, 14 and 16. Each of these types went through a development of its own before giving way to a succeeding type. One feature, however, was common to the Sprague and Edison motors, viz., regulation by commutation of the field coils.

Contemporaneously with these motors appeared the Thomson-Houston R 20 and R 30 motors—bipolar motors with drum armatures. These were followed by the S. R. G. 30 and S. R. G. 50 motors with Gramme ring armatures and single reduction gears. No improvement heretofore had been so marked as this change to slow-speed motors with Gramme ring armatures. The Westinghouse company was somewhat late in entering the field, but it finally brought out a bipolar high-speed motor with drum armature, resembling in many respects its competitors, but differing especially in the design of its supporting frame. This was followed by a motor of similar design, but with single reduction gears running in oil or grease. All the motors up to this time were much exposed to the water, mud, dust and slush in the streets, and it became evident that some radical change in design must be made to protect the motors from such rapid deterioration. Finally Mr. W. H. Knight, so well known in connection with the Bentley-Knight company, designed for the Thomson-Houston company his W. P. (water-proof) motor, with its single field coil and Gramme ring armature. This type, known in England as the "box" type, marks a most decided improvement. The Westinghouse company soon after brought out its "box" motor, which is essentially its motor of to-day. The latest motor is the G. E. 800, made by the General Electric Company. It is a multipolar motor of the box type, with either drum or Gramme ring armature. Other motors than those referred to have at various times been put upon the market, but of these it is only necessary to refer to two types, viz., the gearless and the single motor geared to both axles. The gearless motor for street car service is probably only a dream of the past. Howsoever desirable such a motor may be, it is more than likely that the single reduction motor will monopolize street car work for a long time to come. Mr. Short's work on the gearless motor, however, has not been entirely in vain, for the 1,200-h. p. B. & O. locomotive is made up of six 200-h. p. motors, built substantially on the lines of one of Mr. Short's street car motors. The single motor geared to both axles was first introduced by Mr. Frank Rae, and was received with considerable favor, but the results were disappointing. Lately Mr. Elmer Sperry has developed a single motor equipment, with a slow-speed motor, flexibly suspended. Such an equipment is certainly to be desired, on account of its greater simplicity, and we will watch the success of this apparatus with much interest.

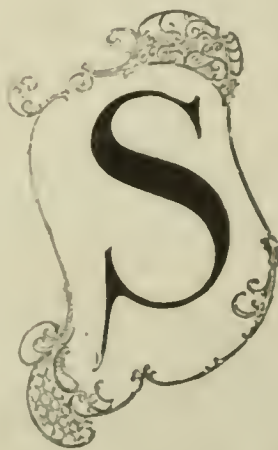
Space prevents mentioning the many and important improvements that have been made in the various devices that go to make up a car equipment, but perhaps the change in controllers is the most marked. The controlling device is of the utmost importance, and is second only to the motor itself. As before stated, the Sprague company and its successor, the Edison General Electric Company, adhered to the commutated field method of control, with the well-known barrel switch. At first the resistance of the fields was relied on entirely, and how well we remember the complaint that passengers were compelled to sit several feet from where they expected to, or perhaps in somebody's lap, due to the sudden starting of the car. Other manufacturers used the rheostat method of control almost entirely. Almost every style of rheostat that human ingenuity could devise was tried. Some were better than others, but all were troublesome. The present method of control is a combination of all previous methods, with the additional one of commutating the wires.

The development of the power-producing machinery has gone on simultaneously with that of the motor. New engines have been designed to meet the requirements. The compound and triple expansion type have largely replaced the single cylinder. Multipolar generators of largely increased output have replaced the small high-speed bipolar machines. Perhaps the highest development has been reached in the slow-speed generators coupled directly to the shaft of the engine, dispensing with all belts and counter-shafts. The step from the 40-kw. machines of 1889 to the 1,500-kw. direct coupled generators of 1893 tells its own story.

And what shall be said of the future? Is the alternating-current motor to have no place in this wide field of usefulness?

The Electrical Transmission of Power During the Past Twenty Years.

BY CARL HERING.



SETTING aside telegraphy as being a transmission of signals rather than of energy, a review of the progress made in the electrical transmission of power since the birth of this journal should include practically the entire history of this branch, with the exception of what we might be permitted to call the very first application, by which we refer to the amusing experience of one of the earliest electricians of history and the greatest of his time, Benjamin Franklin, who, in the year 1749, entertained some friends by transmitting the charge from one of his machines through a wire across the river Schuylkill, at that time a few miles from Philadelphia, and killing a turkey with the transmitted electricity, after which he roasted it by an "electric jack" in a fire kindled by the transmitted electricity; the feast was completed by drinking "the health of all the famous electricians of England, Holland, France and Germany in electrified bumpers, under the discharge of guns from the electric battery"; what the "electric jack" was is not described, but "an electrified bumper" is explained as being a glass of wine electrified while held in the hand, as if it were a Leyden jar, so as to give a shock "if the party be closely shaved and does not breathe on the liquor." That Franklin appreciated other good things besides a joke and electrical experiments, is shown from his remark that "the birds killed in this manner eat uncommonly tender."

But to return to the subject: Although motors with permanent magnets had been long known, the electrical transmission of power on a practical scale really owes its origin to the accidental discovery of reversibility of the self-excited dynamo, which occurred, if our recollections are correct, about the same year as the one during which this journal was started. It is said to have been due to an error made by a workman at an exhibition in Vienna, who connected one of the old Gramme machines to the wrong circuit; the circuit being that of another machine which was running, he noticed that the dynamo which he had just connected started to revolve, generating considerable power. This little incident was followed by an investigation of the subject by the physicists and mathematicians, and with their usual activity the latter at once developed all sorts of theories, some of which, though correct, were so misleading that it is to be regretted that they were ever published, as it checked progress in the right direction. They informed us that the best conditions were those which we now know to be the worst, and it took some time before these wrong impressions could be eradicated.

The next year was one in which much time and paper were wasted in mathematical theorizing, but still it resulted in several important conclusions, among which were a more thorough understanding of the action and meaning of the counter E. M. F., of the true mathematical relations in the whole transmission, etc., which laid the foundation for future progress. Marcel Deprez, who at that time gained the great fame which he afterwards lost again, made the well-known experiment near Munich in 1882, about which so much was written at that time, all of which is now merely of historic interest. The great importance of high tension was then being recognized, but the Gramme machine, which he used, could not stand such high voltages. Elaborate tests were made, but only a few important results were obtained, one of which was that that installation was not a success; the failure, however, being due to the insulation of the armature, or more correctly speaking, to the want of proper insulation.

About this time the advantages of electric motors began to be appreciated in the United States, and although no important transmission of power installations were made, yet a foundation was being laid in the perfection of the motors. Distances gradually became longer, and soon the

rapid that it would be hard to find an equivalent development in any other industry. In Europe the introduction of electric railways, which were not experimental, began later, after the commercial success had been fully demonstrated here.

The boldest and most daring experiment in the electric transmission of power was made in 1891, between Lauffen and Frankfort, in Germany, a distance of over 100 miles. The motor—the missing element in alternating-current transmission—having been supplied by the multiphase system, two of the largest firms in Europe combined to make a practical demonstration, which, in long distance and high tension, far surpassed anything before attempted. The results of the official tests may, perhaps, be of some use to our grandchildren as historical records, we, in the present generation, having given up all hopes that the easy-going professors will finish their calculations in time for us. But although these promised results of the tests are already too old to be of much use, many valuable conclusions may be drawn from this experimental installation. The possibility and even the practicability of using such high voltages was demonstrated; also their danger. The efficiency was very good, distribution was shown to be possible, and the importance of a number



electrical transmission of power was no longer an experiment. Meanwhile the high-tension alternating current transmission was introduced, and although this solved the problem of long-distance transmission of electricity for lighting, motors were wanting to enable it to be used for power purposes; it is only quite recently that the latter want has been filled, at least in a modified alternating-current system.

While transmission combined with distribution to many small motors was developing rapidly in this country, the simple transmission from one generator to a single distant motor was receiving more attention abroad, especially in Switzerland; the contrast between these two different directions of development was shown very well at the exhibits of the Paris Exposition in 1889. The application to electric railways, although begun early in the eighties, did not really emerge from the experimental state until about 1888, after which year its progress in this country was so

of factors, such as the frequency, the static capacity of the line, etc., was shown. In this particular installation the cost of the transmitted energy was greater than that produced by coal at Frankfort, even though the water power at Lauffen cost nothing but the machinery to utilize it. This was due to the great cost of the installation. This, which has been made use of by some to pronounce the test a failure, is of no real importance to the electrical engineer, as it was never intended that this plant be used for that city; the object was to demonstrate the possibility of such a system even under exaggerated conditions, and thus to show to the skeptical that it would be practicable under more favorable conditions. Where coal is expensive, that same plant would doubtless have been a commercial success.

Up to within the last few years there was still a certain experimental element in all but the smallest installations, but

now even the most skeptical advocates of the hydraulic and compressed air transmission admit that up to moderate distances electrical transmission is no longer an experiment and has advantages over its older competitors. Electrical transmission has been used side by side with hydraulic and pneumatic. It has gained ground which the latter have lost. No better proof could be desired. At first it was decided to use both compressed air and electricity in the great Niagara Falls plant, but little is heard now about the former, from which it appears that it has been abandoned.

The field which is now entering its experimental state is the very long-distance transmission and the transmission of very great powers, in both of which new elements enter. Distances of ten miles are now almost every-day matters, as are also transmissions of several hundred horse powers, but in the present year schemes are seriously proposed of such magnitude that they can well be said to open up an entirely new field. Besides the Niagara Falls plant, which is no longer a mere proposal, other plants of enormous proportions are being considered. It is proposed to supply the whole Kingdom of Saxony with light and power from one central station near a coal mine; the currents in the Bosphorus may be used for lighting Constantinople; St. Petersburg may be supplied with light and power from a distant waterfall in Finland; it is proposed to send heavy trains of cars, not light pleasure cars, across the Alps by means of the water power which at present is running to waste side by side with the railroad. Although it may take some years to carry out such bold projects, there is little doubt that at least some of them will be begun before many years. The main question is not so much whether it can be done, but whether it would pay financially to do it.

That high voltages must be used is evident; how high is a question which can be decided only by experiments and not by theory. Prof. Elihu Thomson, whose propositions, though sometimes very bold, are not of a wild character, suggested two years ago transmitting by means of three-phase currents 130,000 h. p. over 240 miles at 500,000 volts through small wires contained in an iron pipe and insulated with cheap cotton and oil. Although this is still, as it was then, a mere prediction of future possibilities, it is nevertheless interesting, as it comes from one who is able perhaps better than any one else to make such a prediction.

Regarding the future, it is no doubt safe to say that continuous currents have reached nearly, if not quite, their limit in high voltages, and that therefore very great distances or very large powers through small wires are beyond the sphere of continuous currents; should a commutatorless continuous-current machine for high voltages ever make its appearance, which seems quite unlikely, this field will be opened again for continuous currents. More debatable questions are the relative merits of single and multiphase alternating currents, the main factor in which is the motor. A single-phase alternating-current motor as satisfactory as a shunt or series continuous-current motor would probably decide the fate of multiphase systems, at least in many transmissions in which their other advantages are not important. It would not be safe to predict that such a motor was not forthcoming, and until it has been shown that its invention is unlikely, it will be wise to be cautious in choosing between the two systems; at present the best multiphase motors seems to be better than the best single phase. The combination of the two systems, as in the Niagara Falls plant, admitting the use of either or both of the two different-phased currents, and even the use of continuous-current motors slightly modified, seems to be a good and safe happy medium. The most important debatable questions are those concerning the best frequency and voltage, about which it will not be possible to arrive at any indisputable conclusions until more reliable data are at hand for making comparisons which are free from personal opinions.

When the behavior of high voltage alternating currents is more thoroughly understood and admits of definite calculation, and as soon as the results of using different frequencies can be reduced to dollars and cents, then the "parallel column method" will decide very quickly and definitely what the best probable values will be in each case. These two questions and the construction of a satisfactory single-phase alternating-current motor, or a proof that it can never be satisfactory, seem to be to-day the most important of the uncertain factors in the long-distance transmission of power.

Programme of the Washington Convention.

The annual meeting of the National Electric Light Association at Washington this week bids fair to prove one of the most interesting of the long series of successful gatherings which this organization has already held. The programme, which is given below, is an attractive one and will probably receive a thorough discussion, as the attendance promises to be larger than at any previous convention. Following is the programme in detail:

TUESDAY, FEBRUARY 27, 1894.

Meeting of the Executive Committee, at 9 A. M., Parlor 36, Ebbitt House.

Morning session, 10:30 o'clock, Grand Army Hall.

Address, President E. A. Armstrong.

Report, Committee on Legislation, C. H. Wilmerding, chairman.
Report, Committee on World's Columbian Fair, B. E. Sunny, chairman.

Report, Committee on Relation Between Manufacturing and Central Station Companies, Frederic Nicholls, chairman.

Afternoon session, 2 o'clock.

Report, Committee on Data, H. M. Swetland, chairman.

Report, Committee on Finance, John A. Seely, chairman.

Report, Committee on Underground Conduits and Conductors, M. J. Francisco, chairman.

Report, Committee on Rules for Safe Wiring, William J. Hammer, chairman.

Paper, Lucius T. Stanley and Walter E. Harrington, "Faults Incident to the Protection of Lighting and Power Circuits." Questions and Answers. What is it You Wish to Know?

Executive session.

WEDNESDAY, FEBRUARY 28, 1894.

Morning session, 10 o'clock.

Paper, J. H. Vall, "The Importance of Complete Metallic Circuits for Electric Railways."

Topic, "Electrolytical Effects of Return Currents." Discussion.

Topic, "Storage Batteries." Discussion.

Report, "Electric Light Tests at Buffalo," Charles R. Huntley. Discussion.

Afternoon session, 2:30 o'clock.

Paper, A. B. Herrick, "Development of Switch Boards for Modern Central Stations."

Topic, "What is the Most Economical Size for Arc Dynamos?" Discussion. Charles R. Huntley, George A. Redman, E. F. Peck, G. H. Blaxter, and H. H. Fairbanks.

Topic, "Underground Circuits." Discussion. C. H. Wilmerding, John A. Seely, H. J. Smith, and M. J. Francisco.

Topic, "How to Rate Arc Lamps." Discussion. James I. Ayer, C. E. Hesser, A. J. De Camp, E. W. Rollins, George R. Stetson, and M. A. Beal. Questions and answers. What is it you Wish to know?

Executive session.

Evening session, 8 o'clock.

Paper, T. Commerford Martin and Luther Stieringer, "Electric Lighting at the World's Fair and Some of Its Lessons." Illustrated with stereopticon.

THURSDAY, MARCH 1, 1894.

Morning session, 10 o'clock.

Paper, Charles F. Scott, "Polyphase Transmission."

Topic, "Arc Lights on Incandescent Circuits." Discussion. C. L. Edgar, L. B. Marks, J. T. Ridgway, W. S. Barstow, Thomas Spencer, John C. Knight, and Frederic Nicholls.

Topic, "Meters vs. Flat Rates." Discussion. Charles E. Scott, J. D. Barth, W. J. Greene, J. J. Burleigh, J. Gwynne, and J. J. Moore.

Topic, "The Alternating Motor." Nikola Tesla.

Afternoon session, 2:30 o'clock.

Executive session.

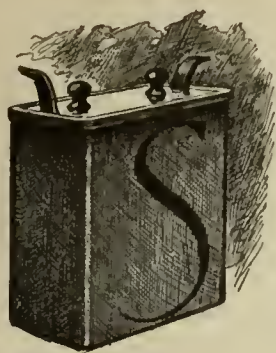
Reports, secretary and treasurer, executive committee; election

INSIGNIA.

Officers, red bow; executive committee, blue bow; active members, red ribbon; associate, blue ribbon; guests, olive ribbon; honorary members, white ribbon; reception committee, yellow ribbon.

Storage Batteries.

BY ELIHU THOMSON.



STORAGE batteries or accumulators of many forms during the past ten years have come into my hands for inspection and test, with a view to utilizing them in connection with the electric industries in which the Thomson-Houston and General Electric companies have been directly or indirectly interested. These industries have, as is well known, covered the widest range of elec-

trical application, and the experience gained therein has been of the most varied character. In connection with Mr. Robert Shand, my assistant in this work, very complete tests of each cell submitted have been conducted, and under varying conditions of charge and discharge rates. Special forms of battery have been manufactured by us on a moderate scale and put to use in our work, thus adding the experience of methods of making to that of testing.

With but a few exceptions, storage batteries depend on the formation during charging of spongy or finely divided lead on what is called the negative plate, and of peroxide of lead about the positive plate. In charging, the current passes from the positive to the negative plate in the cell, or electrolyte, and in discharging, from the positive to the negative outside the cell, or on the circuit which is traversed by the current set up in whole or part by the electromotive force of the cell.

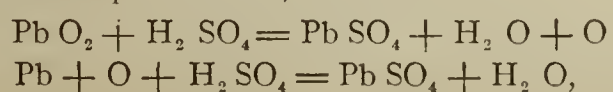
It may be useful here to state in a simple way the general character of the reactions which occur in charging and discharging a cell of the ordinary type, or a lead to lead peroxide cell.

Whether the forming process of Plante be used in giving origin to the active material associated with the support or plate from which such active material is derived, or the material be applied in masses to the supporting and conducting plate, either in an active condition or in a condition which is suitable for the formation of the active material itself by the passage of current, makes no difference so far as the reactions themselves be concerned, but may be of vital importance in determining the characteristics of the cell itself, as to durability, economy, capacity, charging rate and discharging rate, etc.

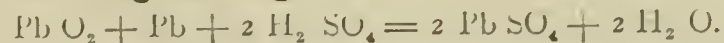
In a charged cell the negative support or conducting plate will have in contact with it a quantity of lead in a metallic yet spongy state, sufficiently coherent to keep its place in the cell and conduct electricity. The positive plate will have, in like manner, in contact with it a quantity of peroxide of lead in a porous state, dark brown in color and in coherent masses—a partial conductor of electricity. These are immersed in the electrolyte of the cell, which is generally dilute sulphuric acid, or solutions of acid sulphate of potassium or sodium, which may be considered to contain free sulphuric acid.

The sulphuric acid is not only essential to the reactions occurring in the cell, but happens also to give to the liquid a very low specific resistance compared with that of many other liquids or electrolytes.

Now the tendency of the acid is to form sulphate of lead both from the spongy lead of the negative plate and from the peroxide on the positive plate. To do this, each molecule of peroxide must lose an atom of oxygen and each atom of the spongy lead gain an atom of oxygen, so as to combine with the sulphuric acid, as here shown,



or, including the reactions of the two plates in one equation, we have during discharge



The final result of the complete discharge of the cell is then to form sulphate of lead and water, thus removing the sulphuric acid from the electrolyte and forming white sulphate of lead on each plate.

It is not to be supposed that the above simple statement of reactions covers all the changes which the materials undergo. They are doubtless far more complex, but the tendency is to the result stated.

But it is here important to note that the formation of sulphate during discharge is a self-limiting process, and on this self-limitation the possibility of again charging the cell depends. Sulphate of lead is a non-conductor of current. Spongy lead and peroxide are each conductors. But in any given mass of the latter the conductivity will fall as more and more sulphate is produced within that mass, until a further formation of sulphate becomes impossible, owing to the low conductivity of the mixed sulphate and spongy lead, or mixed peroxide and sulphate. It is then "out of the cell," so to speak, for it is only by the passage of an electric current discharge that the formation of sulphate can go on, and as soon as the conductivity is low in any given portion of active material it is not further acted upon, except under a prolonged and, of course, weakened discharge.

So, also, as the nearer portions of active material of each plate, or those most closely held to the support plate or conductor, are the first to be affected and lose their conductivity during discharge, the more remote portions then take a greater and greater part in furnishing the discharge, provided they are not embedded in the other portion, and thus insulated or rendered ineffective. A careful consideration of the above will show why it is that the effective electromotive force of a badly constructed cell will fall rapidly during discharge, while that of a well-constructed cell, with all of its active material closely associated both with the supporting plate and electrolyte, will hold up much better.

It will also be seen to be essential that electric conduction must exist between the active material and the plate, and that the acid must easily reach the active material during discharge or the said material will become virtually inactive through no fault in itself, but merely of its environment.

The gradually falling conductivity of the active material during discharge also explains the fact that the theoretical value of a given amount of peroxide, or of spongy lead, is never to be realized in any cell, for a considerable portion of it only acts the part of a conducting network, so to speak, which carries current to and from those portions or particles which alone are acted on. When the active material is in the form of plugs or masses of considerable size it is necessary that they be made not too compact, or the acid of the electrolyte will not penetrate the blocks, and the capacity of the cell will therefore be very limited. The capacity of a cell may be broadly stated to be dependent on the amount of material which during discharge remains open to the action of the electrolyte, as well as in good conduction to the support plate.

If a cell be discharged below a certain electromotive force, it is liable to be injured by excessive loss of conductivity of the active material due to the conversion of too large a proportion into sulphate, and from the consequent shrinking or swelling and distortion of the material, which may cause it to drop away.

The recharging of such an exhausted cell may be either impossible, owing to the low state of conductivity of the lead compounds, or to the actual rupture of contact with the support plates due to swelling or shrinking, or the charging may require to be carried on very slowly and through a long time to recover the cell as much as possible.

Hence, a battery should never be overdischarged, nor be allowed to rest for a long time in a discharged condition.

The discharged cell is in a weak state, and should be recovered as soon as practicable by recharging, for although a discharged cell left on open circuit may be assumed to remain as it was when the discharge stopped, it in reality is the seat of slow reactions which are in the nature of those occurring during discharge.

The fact that the active material during normal discharge does not become wholly converted into sulphate of lead, but retains conductivity conferred upon it by the presence of peroxide on the one hand and spongy lead on the other, makes it possible to again charge the cell by passing current in the opposite direction, which current thus reaches each part of the active material, decomposes the lead sulphate on both plates, oxidizing the lead compound to peroxide on one and reducing the compound to metallic lead on the other, restoring the conditions before discharge.

Evidently, however, this restoration, to be economical, must be effected at not too high a rate of current. Too high a charging rate will be uneconomical for two reasons. The electrical resistance of the fluid and the plates is highest after discharge, and too large a current in overcoming such resistance converts the electrical energy into heat, and may cause copious evolution of gas long before the cell has received its charge. Even as much as forty to fifty per cent. of the energy of the charging current could be wasted in the case of such cells as have a comparatively high internal resistance by employing too rapid a rate in charging. The most economical rate of charging, so far as the cell itself is concerned, is a very low rate. So in discharge the most economical rate is a low rate. A very high rate of discharge, while liable to injure the cell by disintegration, is objectionable also from the standpoint of economy, as the efficiency of the discharge may then be very small.

The curious fact of the recovery, on standing after partial discharge, of nearly the full electromotive force is easily explained when one considers that the contact of the acid is requisite to discharge. During a fair rate of discharge there will be some parts of the active material which are not so freely reached by the acid as to be so fully discharged as others. They will then only exhaust the acid already soaked into their pores, and stop discharging when this acid is exhausted, though the material itself remains highly active. On standing, by osmosis, new acid diffuses into contact with such material and confers, of course, renewed activity for a short discharge, or one made at low rate. This recovery action may be repeated a number of times before the cell fails.

From this it may be seen also that a small current rate, in discharging, will be kept up for a much longer proportionate time than a large rate, for the reason that more of the active material is used in the former case, while, of course, in addition the electromotive force at the cell terminals is always higher with the smaller rate of discharge.

Of the various forms of battery tested by us, we found that none of such types as departed from the lead to lead peroxide in sulphuric acid type gave results in any respect superior to the latter; and, in fact, our experience has taught that the best forms of the latter do not differ among themselves very much in their merits, notwithstanding variations in methods of preparation.

The user is, of course, more interested in the working of the cell than in the various details of the manufacture. In general, the Brush type, with lead compounds applied to conducting grids or supports, has been found better than the Plante types, in which the lead compounds have been formed by a more or less tedious process of disintegration from the plate itself.

Neither can it be said of any particular make or form of battery or plate that it is best for all conditions of use. High

capacity for a small weight seems to be inconsistent with great durability. High charging and discharging rates are inconsistent with great economy; and so it goes, the special feature demanded must determine the type of cell to be used.

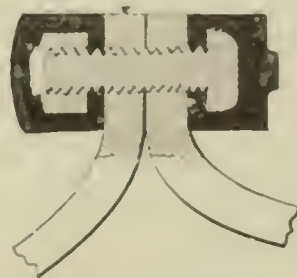
The greatest disadvantage met in the use of storage batteries is the fact that the cells require watching or constant inspection to detect any incipient weakness or short circuit indicated by the voltage of the cell being too low.

In such case, it is essential that the cause of the difficulty be at once found and removed and the cell be carefully brought to a condition of full charge. A cell that has become short circuited and has remained so for some time is either ruined or can only be restored by careful charging at a low rate continued for a long time.

It is well to have the connections of a series of cells made so that any faulty cell can easily be disconnected, and, if need be, removed from the set. Where the terminals are soldered or melted together, this is not easy, but if the cells could be relied upon to give no trouble, it undoubtedly would be the best way to make the connections.

If the connections be made by the use of copper or brass bolts binding the lugs or clamping them, trouble is frequent on account of the corrosion of the metal of the clamps by the acid spray and by the creeping of the acid to the joint. Silver plating the brass or copper pieces is a great assistance in avoiding corrosion, and, in fact, instruments having exposed baser metal should have the metal surfaces silver plated or gilded if they are to be used near storage batteries undergoing charge.

A good way of making connections of the lugs of the cells is to employ a bolt of silver plated brass with a cap nut, both bolt and nut being covered all over, except the thread, with hard rubber, as also the faces of nut and bolt which bear on the lead lugs. In making a joint with this connector the thread is to be covered with a grease or oil, such as vaseline, and the cleaned surfaces of lugs where they meet may be likewise coated before screwing the parts together as in the figure. The oil or vaseline is effective in keeping the acid out of the joint, and the joint may be broken at any time and renewed with equal ease. With such provision the removal or replacement of a cell is easily accomplished. "A stitch in time saves nine" is a saying which will apply forcibly in storage battery work, and it is safe to say that if the attention given to them is based on such a principle, there are several forms of storage battery which, for stationary use, will cost but little for maintenance if the service required of them be well within the limits of capacity and rates of charge and discharge set for them.



Whether or not they can be employed in any given case in connection with station work with continuous currents is a question which cannot be answered generally. The particular conditions of use would need to be carefully considered and estimates of cost of working with and without storage made, so as to determine the relative economy of each plan before deciding on the introduction or non-introduction of the storage plan in an installation. Each case is a problem by itself and should be solved as such. For traction work, such as furnishing current for electric cars, the experience hitherto has not been in favor of storage batteries, either from the standpoint of economy or technical adaptability. This has been the case even under favorable conditions of grades, etc., and it is therefore hardly to be expected that under the harsh conditions imposed in most of the street railway service the storage battery car could compete with the system of direct supply of current.

Who Invented the Rotary Field Motor and Biphase System of Power Distribution?

BY LIEUT. F. JARVIS PATTEN.



THE above question may seem like heresy now that six years have passed since the rotary field motor was brought to the attention of the electrical public. Though it was then received with undisguised admiration, and practical machines were exhibited in operation at the time, still this admiration was not unmixed with wonder as to whether the thing was really any good or not.

For a long time there existed general apprehension that this unique conception might be simply a beautiful theory without a practical side to it. At that time also electrical engineers were struggling with the difficulties of direct-current machines and earnestly wishing that a motor could be found without a troublesome commutator and brushes.

When, however, this much-desired result was shown, they did not quite like it, after all; it did not look quite right, somehow, and that sort of skepticism and doubt arose that ever attends the announcement of anything unexpectedly novel; it is the old story of the world's inventions. In this country the invention was almost forgotten for a few years, until it again blossomed out in Europe, dressed in a more finished form. Then the skeptics began to realize that this invention had come to stay, and had some work to do in the world. Then discussions arose as to who invented it that have not yet been settled to the satisfaction of all concerned, and many inventors began to improve and change it, calling the change or improvements independent inventions having no relation to the broad conception before announced.

That is the way with most good things the world wants done and offers a prize for. The inventor presents his solution and the world says: "We cannot quite believe you now. That is ingenious, very, but it isn't quite the thing we want."

Then the time comes when it is found to be the thing, and it is accepted by sheer force of merit, and the world then says: "Yes, it is a good thing, after all; but it's old. Smith

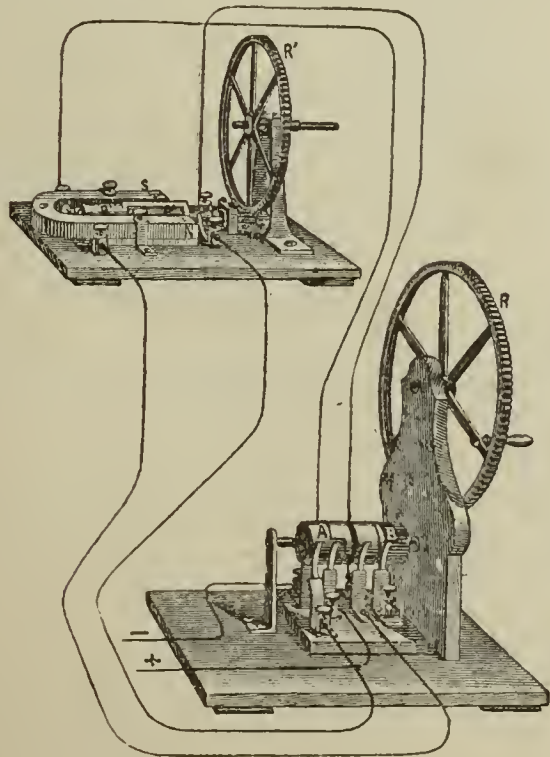


FIG. 1.—DEPREZ ROTARY FIELD MOTOR.

made it years before he died, and it belongs to us now if it belongs to anybody."

The plausible claims to the invention of the rotary field motor, whether actually asserted by the inventors or not, are historically interesting. Let us examine a few of them and see what they amount to. The first mention of a

rotary field in the records to which I have access is found in the "Philosophical Magazine" for October, 1879, where Mr. Walter Baily in a short article shows how to obtain a rotating field effect by shifting a battery current by means of a commutator to different pairs of magnet poles in rotation. These magnets, acting upon a copper disc, the surface of which is in close proximity to the poles of the magnets, caused it to revolve. We have here an instance of a shifting field and very crude form of a rotary field motor.

The first thing shown, however, that I can construe as the equivalent of the rotary field motor, as shown in its simplest form by Mr. Tesla in 1888, is a very interesting device produced by Marcel Deprez and operated by him in 1880.

A perspective view of this apparatus is shown in Fig. 1. It is called a synchronous motor, and is described in "La Lumiere Electrique" of that time simply as a machine for

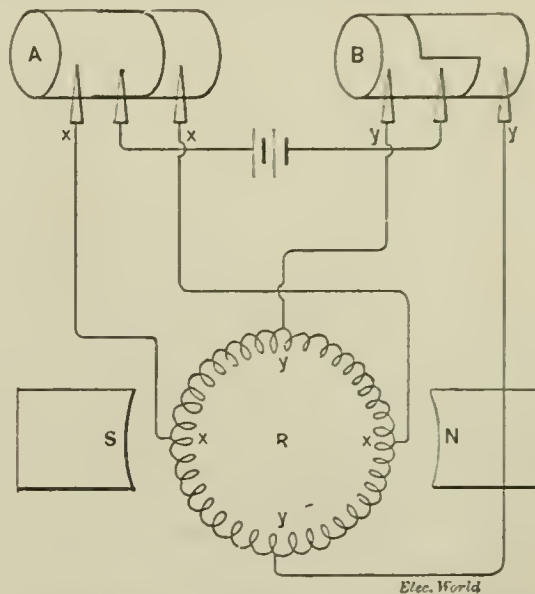


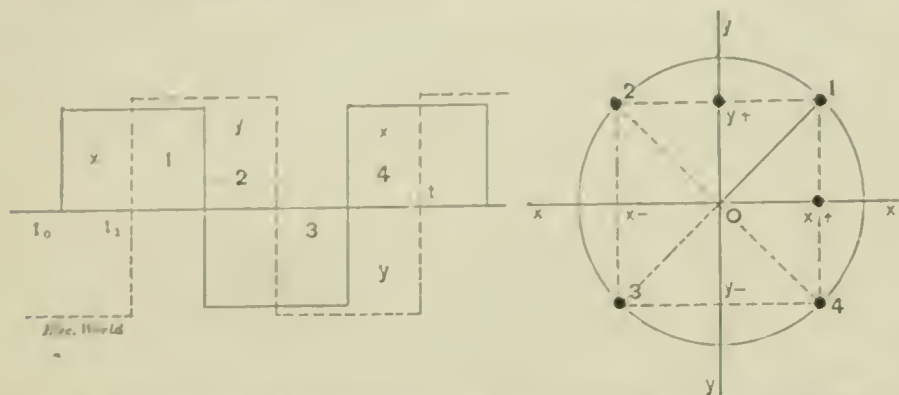
FIG. 2.—DIAGRAM OF DEPREZ ROTARY FIELD MOTOR.

effecting the synchronous rotation of two spindles placed at a distance from each other, as indicated by the figure.

The wheel *R* of one machine is turned by hand, or other power, and drives two commutators, *A* and *B*, that are carried by the driven spindle. The commutators are simply two part current reversers and the two segments of both are connected to four separate contact rings. Direct current from a battery, or like source, is led to brushes that bear on the commutator segments, while four other brushes that bear on the rings are connected to leads that go to brushes bearing on four rings of the distant motor. To each pair of these motor rings are connected the terminals of a single coil Siemens armature, the two being fixed at right angles to each other on the spindle of the motor and placed in a two-pole field, indicated in the figure by the permanent magnet *NS*. Under these conditions this double armature of the machine *R* moves in perfect synchronism with the commutator of the near-by machine *R*, when driven forward or backward by the hand or otherwise.

The operation of this device—the driven motor of which bears so striking a resemblance to a two-phase rotary field or Tesla machine—will be better understood by reference to the diagram of operative parts shown in Fig. 2, where, for sake of comparison, the armature of the driven motor is shown as a ring winding, with the operative circuits connected to the extremities of two diameters at right angles to each other, which amounts, in fact, to the same thing as the other arrangement. *A* and *B* are the two commutators and four rings of the driving machine; they correspond in effect to the two-phase generator, or source of supply, in such a system of power distribution. The dividing planes of the commutator segments are at right angles to each other, as shown, while all the brushes are on the same line, from which arrangement it results that the two currents in the circuits *XX* and *YY* are interrupted and reversed intermittently, producing the

two reversed currents shown in Fig. 3, where the heavy line XX represents the current in one of the motor circuits, and the broken line YY is the current in the other during a single revolution of the commutator spindle. These currents, therefore, when referred to the same time line as in Fig. 3, appear as two continuously reversed, or alternating, currents in quadrature relation, and are, in fact, a particular case of such currents just as much as are those represented by the two sine curves similarly superposed in Fig. 5, the only difference being that the latter follow a law of constant change, while the former do not. We may, therefore,



FIGS. 3 AND 4. CURRENTS IN DEPPEZ ROTARY FIELD MOTOR.

consider the motor in this case supplied by two-phase reversed currents in quadrature with each other.

So far the resemblance to a rotary field motor operated by two-phased alternating currents is certainly very close, but here the resemblance ceases, for, upon examination, we shall find that these intermittently reversed currents cannot produce a true rotary field effect in the armature circuits of the motor, as would two alternating currents of the sine or continuously changing form under the same circumstances.

In Fig. 4 is plotted the successive effects of these currents in the armature R as they successively occur during the periods 1, 2, 3, 4, Fig 3, of a complete revolution of the commutators. During period 1 we have both the x and y currents positive in direction and equal in strength, giving a resultant magnetization, $o1$, Fig. 4, which represents the successive magnetizations of the armature ring R . Then we have y positive and x negative and both equal again, giving the resultant $o2$, and in a complete revolution we have four successive polarities in as many different positions around the ring; and it is important to bear in mind that each polarity in turn remains fixed in direction for a certain time, when it ceases and the next begins in a new position a quarter turn further on, and there is no movement of the polar line between two successive positions. In other words, the polarity of the ring, in this instance, jumps from one quadrant of the ring to the next in turn, and this is not a true rotary field effect like that produced by two sine currents in the same circuits, for such currents produce a polarity that remains constant and moves uniformly from point to point around the ring, as in Fig. 6. The latter is the true rotary field effect, and the only known way of producing it

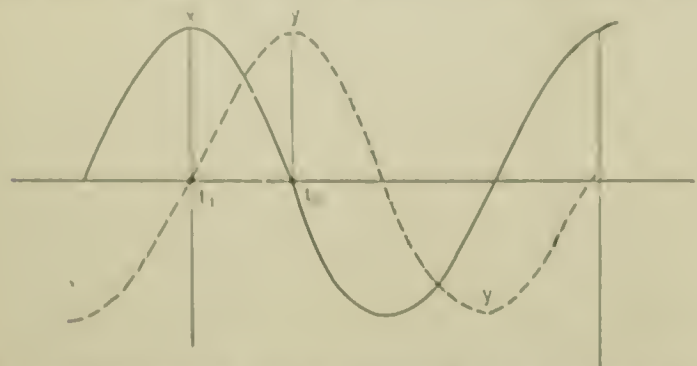


FIG. 5. CURRENTS IN MODERN ROTARY FIELD MOTORS.

was first enunciated by Professor Ferraris in 1887 in a description of what he termed "electrodynamical rotation," wherein he explains that a progressively shifting rotary

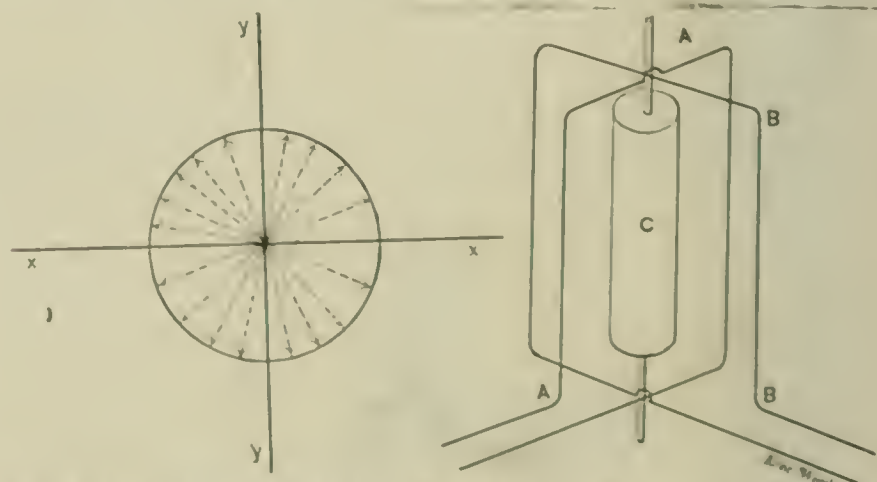
field is produced by the introduction of two continuously changing alternating currents into two coils fixed in planes at right angles to each other, as indicated in Fig. 7, which shows two such coils, A and B , in vertical planes at right angles to each other, with a cylinder of copper, C , free to move about a vertical axis, which coincides in position with the line of intersection of the planes of the coils. Two continuously varying alternating currents of the same frequency, Fig. 5, being sent through each of the coils A and B , the copper cylinder C is set in rotation about its axis. Each coil by itself produces an oscillating magnetic field, due to its own reversing current, the lines of force of which are at right angles to the face of the coil, and the two coils acting together produce a resultant field that turns continuously around the vertical axis of the apparatus. Note that here the field is not alternating in the plane of one coil and then in the other at right angles to it, as in the Deprez machine, but is moving progressively around the entire circle.

The description and apparatus were elementary, but the enunciation was broad and fundamental and bears the true stamp of discovery. The principle thus stated by him and given to the world underlies every practical rotary field motor to-day.

Following closely upon the enunciation of this principle by the Italian professor came Mr. Tesla's announcement of his invention of the rotary field motor in May, 1888, while during the winter of '87 and '88 he had constructed a number of practical machines, and he was certainly the first to bring an application of the true rotary field principle to practical form.

The Deprez machine was not an application of the true rotary field effect, while Tesla's first machine was, and his broadest patent claims are directed to this effect.

Mr. Tesla also clearly showed at the same time the tri-phase and multiphase rotary field, so that it is hard to see



FIGS. 6 AND 7. DIAGRAM OF FERRARIS' ROTARY FIELD MOTOR.

how any variation depending upon the use of three or more currents can be claimed by later inventors, as I understand it has been.

While, however, Deprez did not show or use a true rotary field and did not show a practical method of operating motors by multiphase currents, because the method he described is not really suited to a system of power transmission, still it is interesting to note that the motor he showed is in every sense a rotary field machine, having all the essential elements of such a machine, and requires only to be supplied with true alternating currents in quadrature to act as such. The Deprez motor is a simple form of Tesla motor; the system of distribution is different and defective, and as this is the only difference that separates the two, it leads us to the question, "Who first used multiphase or biphasic currents?"

Who first used the method of supply that would have made the Deprez invention a clear anticipation of the Tesla invention in all its essential features? It would require the

search of records not now at my command to answer this question definitely, but it was certainly not Tesla, and apparently neither Ferraris nor Deprez, for I find mention of biphasic currents in connection with arc lighting more than twenty years ago. The Haselwander dynamo, a triphase generator, antedates the Ferraris and Tesla inventions, so it may be assumed that Tesla was using a previously known method of supply in 1887 that made all the operative difference between his machine and the Deprez machine. Thus, the method of supply which would have made a true rotary field motor of the Deprez machine was a well-known one at the time, and had such a system of distribution been applied to the Deprez machine, it would have constituted a broad and complete anticipation of both the Ferraris discovery and the Tesla invention.

The Tesla motor had its complete parallel in the electro-mechanical contrivance of Deprez; it only needed the biphasic currents used by Jablochkoff years before. The long separation of these two elements, both known and both necessary requisites to a simple and useful combination, is a pertinent illustration of how slow invention really moves even in the nineteenth century. There were years during which the application of then known biphasic currents to a machine of the Deprez type, also well known, would have brought the true rotary field motor to public notice.

I am aware that it is almost splitting hairs to say that the system of supply given by Deprez to his machine is not a true biphasic system of distribution; many would contend, and perhaps justly so that it is. It may be contended that a rotary field that makes four jumps in a revolution and might make any number short of actual infinity is just as much a true rotary field as one that actually does make an infinite number, and I am not prepared to say definitely that it is not. Then, again, if the currents of the Deprez apparatus are rounded off by self-induction, we would then have a true rotary field indeed.

No sooner, however, had the real value of the Tesla machine become an accepted fact than it was turned and changed from one form to another, all involving the Ferraris principle applied in a slightly different way, and being explained upon principles of induction and varying magnetic flux gave their inventors foundation enough to claim the rotary field motor as their own.

In view of the fact, however, that the Deprez motor, open to the public, has all the essential elements of a rotary field motor, for the permanent magnet may well represent a closed-circuit field winding, and that biphasic current generation and distribution are not broadly patented, are not, then, the rotary field motor and biphasic-current power distribution also open to the public?

Take, for instance, the Niagara plant, in which two separate alternating currents are to be generated in quadrature relation and sent to consumers on two independent circuits for use singly or in conjunction with each other, why may not a motor of the Deprez type, public property for fourteen years, be connected to the four mains without infringement of patent rights? Such an instance would be a true rotary field motor operated by a biphasic system of power distribution.

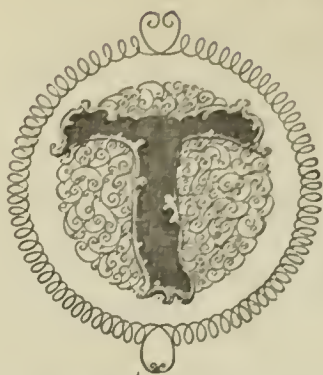
In conclusion it would seem that no single inventor can claim broadly very much of a complete system of power distribution by means of biphasic alternating currents and some form of rotary field machine.

Not an Admirer of Mathematics.

Galileo is reported to have said that he was very glad that he devoted only two years of his life to mathematics and the parently neither Ferraris nor Deprez, for I find mention of

Parallel Running of Alternators.

BY CHAS. PROTEUS STEINMETZ.



THE practice in continuous-current circuits from the beginning has been to run all the generators in parallel on the same bus bars.

The same has been done abroad in alternating-current circuits. For instance, on the Continent the Ganz & Co. machines are running in parallel, or in synchronism.

In this country parallel running of alternators has not found an extensive application, and frequently even the opinion has been expressed that the machines built in this country are not suitable for parallel working.

The result was that larger alternating-current stations have been built with a very elaborate system of switchboards, crossovers, etc., so as to avoid parallel running, and the service, as a result hereof, is not always very satisfactory.

To settle this question of parallel running of alternators, I made an exhaustive investigation of the subject, of which a few results may be of interest:

First—We may discard all the usual theoretical statements on parallel working relating to the effect of frequency, self-induction, etc., as wholly disproved by experience.

The use of artificial loads and sundry such relics of past ages of engineering, to assist in getting machines in step, are to-day hardly to be considered seriously.

With regard to frequency, I investigated experimentally the parallel working of alternators of a frequency as high as 125 cycles and of a frequency as low as 25 cycles per second, and found no difference whatever, and at the high frequency, as well as at very low frequencies, machines properly designed for these frequencies work perfectly in synchronism.

The self-induction of machines within the limits met in well-designed alternators has nothing to do with the success of synchronous running, and I had three phasers of very low armature self-induction running in parallel with each other and ironclad single phasers of high armature self-induction.

The theoretical conclusion that the condition of best synchronous running is a lag of 45 degrees in the alternating-current circuit, is, as probably generally known now, based on an error in its premises; that is, on a mistake of the external circuit for the cross-circuit between the two armatures. Corrected, this reasoning would mean that the armature inductance shall equal the armature resistance for best synchronous working. This condition is impracticable in commercial alternators, and would, if fulfilled, rather give the condition of a very unsuccessful parallel working.

As known, Mordey succeeded in running a 1,000-volt alternator in parallel with a 2,000-volt alternator. To show how far equality of potential of machines is necessary for parallel running, I made, amongst others, the following experiments:

Two 60-kw. ironclad high-frequency alternators, General Electric Company's standard machines, were driven at their normal speed, corresponding to 125 cycles per second. The fields of these machines were excited so as to give 1,000 volts at the terminals of each machine, and then without any further precautions both alternators were thrown in parallel, directly dropped into step and ran in synchronism with an interchange of current between both machines of 4 amperes only.

Then the experiment was repeated, but the voltage of one machine brought to 1,100 and that of the other to 900, so as to have a difference of 200 volts between the poten-

tials of the machines, and then the machines thrown in parallel.

The cross-current was slightly increased to 6.5 amperes, but the machines ran in parallel just the same. In this way gradually, in each following test, the voltage of one machine was increased and that of the other reduced by 100 volts, until at last the one machine was excited up to 2,000 volts, the other was left entirely unexcited at 0 volts, and both machines thrown in parallel, with a difference of potential of 2,000 volts. Still the machines ran in parallel, in this case with a considerable cross-current, however.

In the attached table and diagram the behavior of the two machines is shown when thrown in synchronism at the various potentials. As abscissae are given the differences between the potentials of the machines before throwing them in parallelism. The inclined lines I. and II. are the voltages of the machines before thrown in parallel; the line III. is the voltage at the common terminals of the machines after synchronizing. As seen, up to about 1,000 volts difference of potential between the machines, the resultant voltage is the average between the individual voltages of the machines. At a greater difference of potential the resultant voltage is somewhat higher, due to the approach of saturation in the first machine.

SYNCHRONOUS RUNNING OF TWO HIGH-FREQUENCY IRONCLAD ALTERNATORS.

60 Kw. 125 Cycles.					
E. M. F. of first alternator, before synchronizing.	E. M. F. of second alternator, before synchronizing.	Difference of the E. M. Fs. of the two machines, before synchronizing.	E. M. F. at the common terminals of both machines, after synchronizing.	Interchange of current between machines, after synchronizing.	Excess of momentary current at the instant of synchronizing over the cross current.
Volts.	Volts.	Volts.	Volts.	Amperes.	Amperes.
1,000	1,000	0	996	4.0	2.0
1,100	900	200	1,000	6.5	.5
1,200	800	400	1,000	13.0	3.0
1,300	700	600	1,000	18.0	4.0
1,400	600	800	1,026	24.0	6.0
1,500	500	1,000	1,010	28.0	6.0
1,600	400	1,200	1,010	39.0	3.0
1,700	300	1,400	1,046	44.0	5.0
1,800	200	1,600	1,060	50.0	6.0
1,900	100	1,800	1,066	56.5	5.5
1,000	0	2,000	1,075 $\pm$ 70	62.0	10.0
Full load current.....				25.0	

When the excitation of the second machine is brought down below 100 volts, while that of the other approaches 2,000 volts, the resultant voltage begins to get unstable and fluctuates about ± 70 volts; that is, the limit of synchronizing power of the machines was approached, and the machines alternately tend to drop out of step, and are brought back into synchronism again.

The curve IV. gives the cross-current flowing between the machines. Since 52 amperes is the full-load current, the interchange of currents between the machines reaches the full load value at a difference of potential of about 1,650 volts between the two machines.

This cross-current is obviously essentially a wattless current. To determine the momentary rush of current in the moment of throwing the machines in synchronism, a phase lamp was connected in and

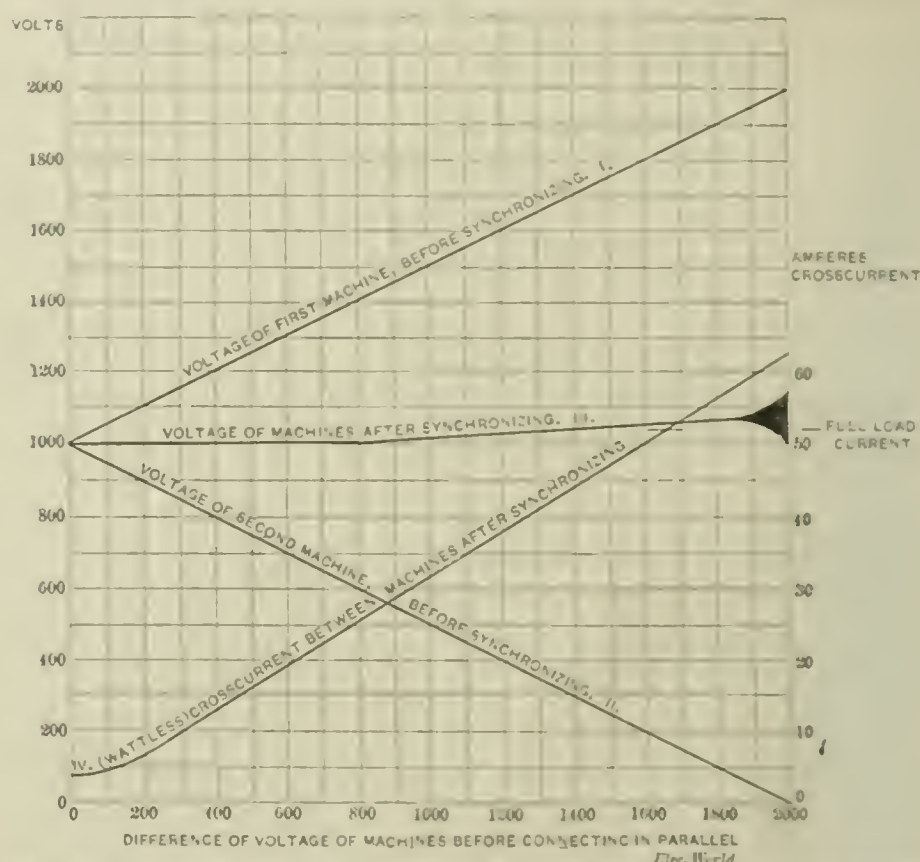
First—The synchronizing switch closed at the moment when the machines were in phase with each other.

In this case the momentary throw of current was from 0.5 to 6 amperes in excess of the stationary cross-current, according to the care of adjusting for equality of phase, or,

in other words, by adjusting the machines to an equality of phase when throwing them in parallel, an instantaneous rush of current is entirely avoided.

Second—The synchronizing switch was closed at the moment when both machines were just in opposition with each other, so as to short-circuit one of the machines by the other; then an instantaneous rush of current passed through the machines, which, however, subsided in a small fraction of a second, and the machine settled down into step.

The conclusions drawn from these and other tests are in complete agreement with the theory that with properly de-



PARALLEL WORKING OF TWO ALTERNATORS AT DIFFERENT VOLTAGES.

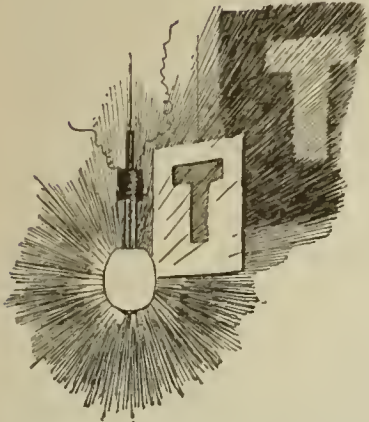
signed alternators, parallel running is perfectly successful, even under very extreme conditions of load and excitation, and no special or careful adjustment is required to throw two alternators which run at the same frequency into parallelism.

"Electricians in England Have Everything to Learn from America."

Mr. Preece, who was credited with having made the remark that "electricians in England had nothing to learn from America," refers to that supposed remark in the following terms in the conclusion of his recent interesting paper on his trip to the United States: "Interviewing is a feature of American journalism that, thank goodness, has not taken root here. I was surprised to read of interviews with myself, extending to two or three columns, that resulted from the passage of a few compliments; but I was more surprised to find that statements supposed to have been made by me to an interviewer were taken *en serio*. One irate functionary compared an official statement of our postmaster general with a mythical statement made by me and triumphantly pointed out such a glaring contradiction as a complete refutation of my fallacies. I even read that we electricians in England had nothing to learn from America. I have no recollection of ever having made any remark which could by any shorthand blundering have been construed into such an absurdity; but if I had done so, it would more likely have been one where 'nothing' was a telegraphic error for 'everything.' I cannot too gratefully speak of the attention and kindness I received from every one, and I certainly feel that I have personally profited from my visit very much indeed. A visit to the United States is something like charging an accumulator. It stores the visitor with energy. When I am discharged and my adverse criticisms are forgotten, I shall probably cross the Atlantic again."

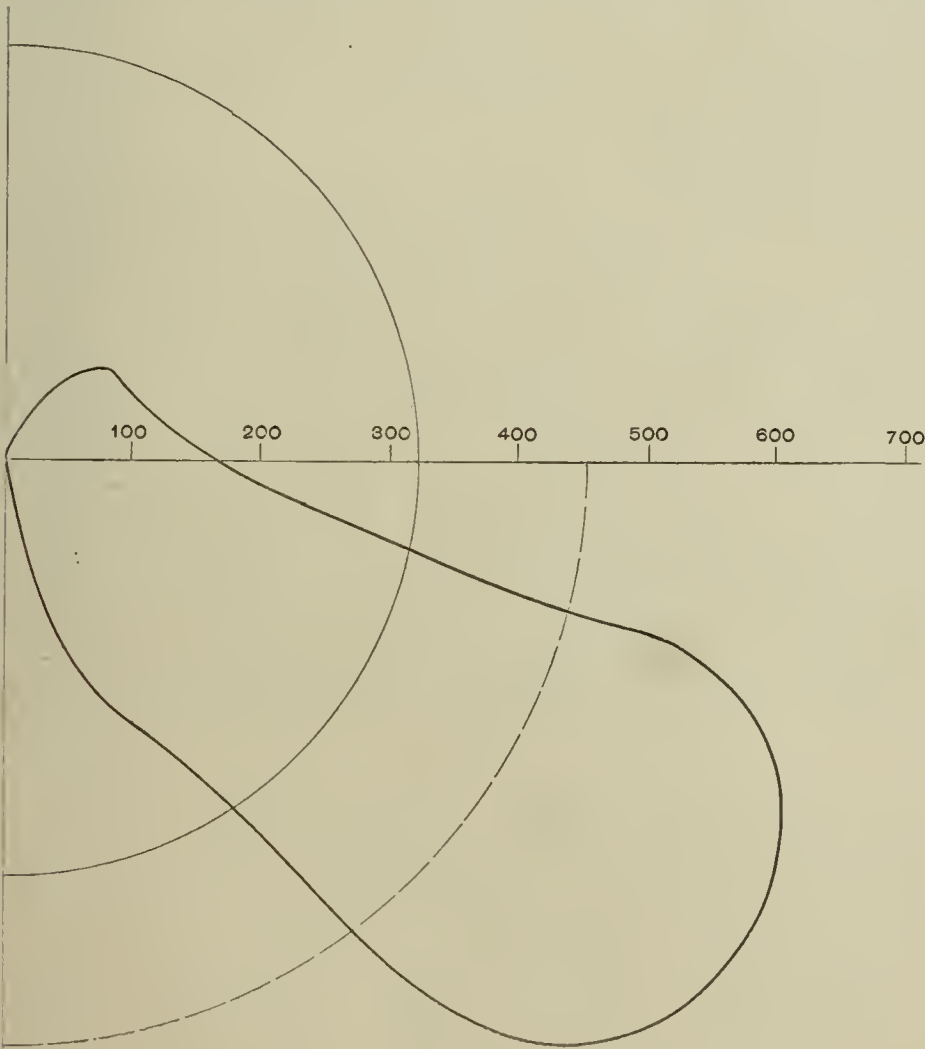
The Loss of Light from the Use of Globes with Arc Lamps.

BY GEORGE D. SHEPARDSON.



O the investigator, whether he be a student in the laboratory searching for new truths, or whether he be in charge of a central station or isolated plant, arc lighting presents many interesting problems. A renewal of interest in this important subject seems to have been arising during the past two or three years. The choice of dynamos, lamp mechanism, the size, shape and quality of carbons have been receiving a considerable amount of attention. Some thought also seems to have been given to the subject of globes. The importance of keeping these clean has long been recognized, but comparatively little attention seems to have been paid to the relative efficiency and desirability of different kinds.

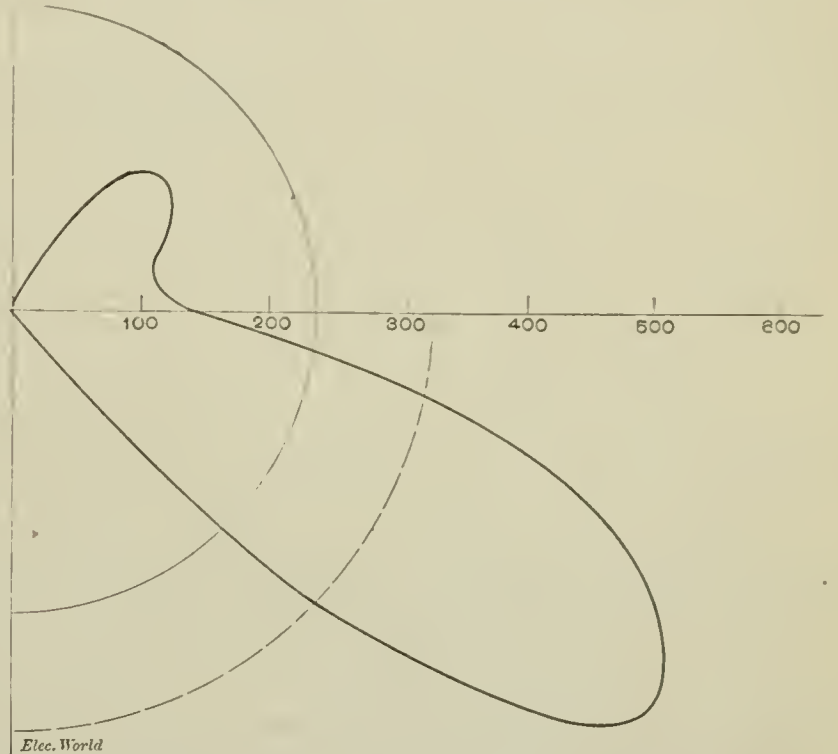
Believing the subject of arc lamp globes to be a fruitful field for investigation, Messrs. J. D. Guthrie and F. E. Reidhead, two of the seniors in the department of electrical engineering in the University of Minnesota, arranged a photometer for measuring the intensity and distribution of the light from an arc lamp with various globes and without any globe. In order to measure the light at different angles above and below the horizontal plane, the lamp was suspended from the end of a frame which could be rotated about



CANDLE POWER CURVE WITH BARE ARC.

an axis parallel to the photometer bar. A rotating mirror was placed on the photometer bar in such a position that by adjusting the mirror and the arm that carried the lamp the light in any direction from the arc would be reflected along the photometer bar, where it could be measured by a Bunsen photometer. The principal point of difference between this device and that usually found in laboratories for similar purposes is that the adjustable mirror was about 16 inches in diameter. The reason for having so large a mirror was that

the photometer might measure the light radiated from all parts of the globe and not merely that from the arc. A 16-c. p. 50-volt lamp was used as a standard, having been previously calibrated with great care. The Bunsen disc, with grease spot, gave fairly satisfactory readings of candle power after some practice. The arc lamp used was the Thomson-Houston ribbon feed type, adjusted to keep the potential as constant as possible. Current was supplied by a Thomson-Houston arc machine, regulated for 6.85 amperes. The standard incandescent lamp was shunted around a wire re-



CANDLE POWER CURVE WITH CLEAR GLASS GLOBE.

sistance in series with the arc lamp. This was found to give a very steady and satisfactory light. The potential around the arc lamp and the incandescent was measured by means of a standard voltmeter and a double-throw switch. The current was measured by an ammeter previously calibrated.

The photometer was arranged so that the standard lamp might be moved in order to keep the car at a sensitive position on the bar. For some readings it was necessary to use the original standard of one candle power. Reflection from the floor and walls was prevented by placing between the arc lamp and the car a large screen, through which a hole about one foot in diameter allowed the direct light to pass while cutting off all extraneous light. The plentiful use of dull black tailor's pattern paper reduced the stray light to a minimum.

Having taken these precautions, the light from the arc was measured in different directions,

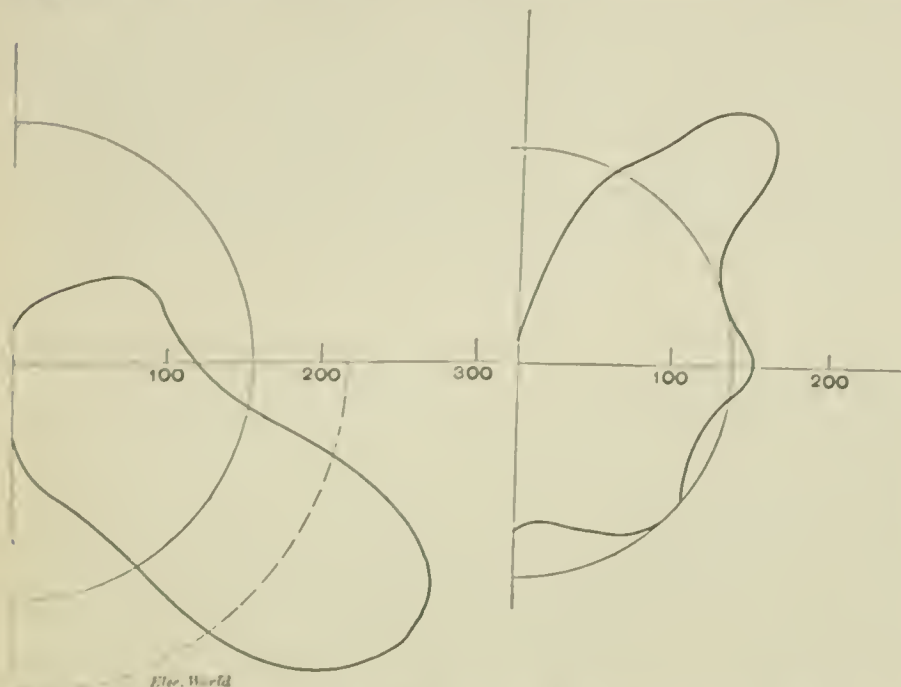
- (a) with no globe,
- (b) with a clear glass globe,
- (c) with a ground glass globe,
- (d) with an opal, or white, globe.

The average of ten readings of candle power for each position is given in the following table of results:

Direction.	Candle Power.			
	Bare arc.	Clear glass.	Ground glass.	Opal glass.
90° below.....	0	17	45	109
75° below.....	126	9	90	104
60° below.....	262	22	141	128
45° below.....	641	313	286	141
30° below.....	681	580	314	150
15° below.....	498	408	199	126
Horizontal.....	153	132	115	154
15° above.....	120	107	106	141
30° above.....	107	145	102	145
45° above.....	101	155	73	226
60° above.....	37	53	48	151
75° above.....	28	7	35	81
90° above.....	0	8	8	10
Mean spherical candle power.....	310	235	160	144
Mean hemispherical candle power.....	450	326	215	138
Average voltage.....	53.0	50.1	49.0	49.4
Per cent. spherical efficiency.....	100	53	23	19
Per cent. efficiency at maximum.....	100	82	47	33

These figures are not exactly comparable, because the voltage was somewhat different for some cause not determined.

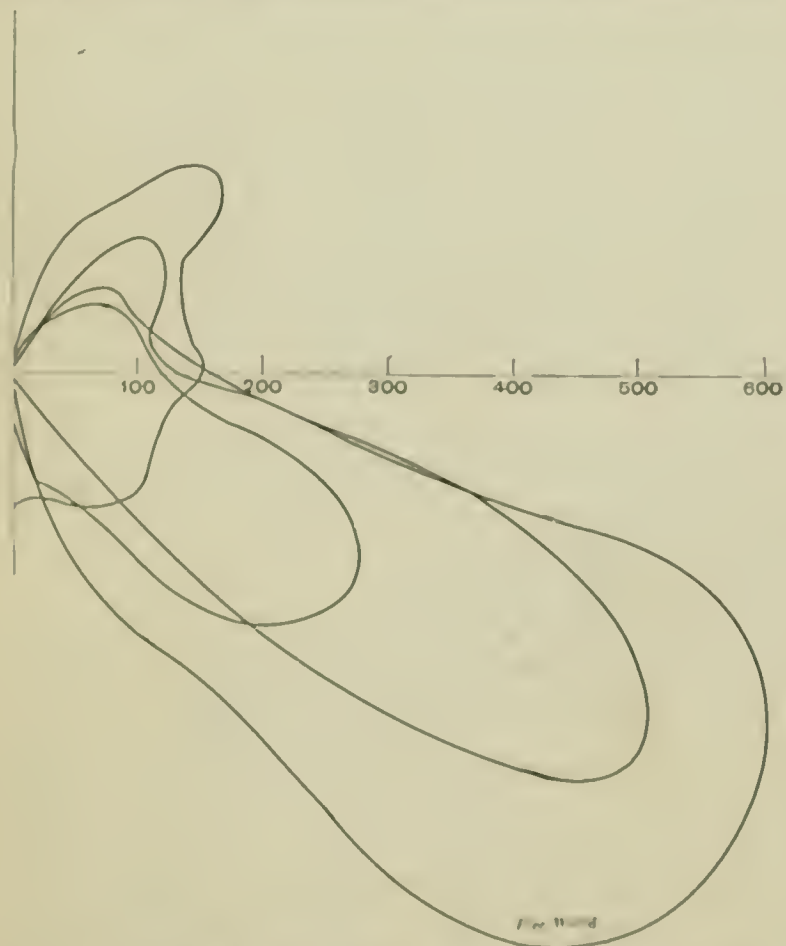
For obtaining the "mean spherical candle power," curves were plotted, showing the intensity of the light at various angles. The area of each curve was measured by a plani-



CANDLE POWER CURVES WITH GROUND GLASS AND OPAL GLOBES.

meter and a circle of equal area was drawn. The radius of this circle gives the value of the candle power if the light were equally distributed in all directions. Since, however, in most arc lighting the downward light only is used, or principally so, it is preferable to obtain the "mean hemispherical candle power," or the equivalent value of the light, if equally distributed in all directions below the horizontal. This latter statement would, of course, be modified in the case of interior lighting, especially if opal globes are used, or if the arcs are inverted so as to light by reflection from ceilings and walls.

The amount of light transmitted by the different globes is



CANDLE POWER CURVES ASSEMBLED.

given in percentages of the total amount given by the bare arc. The globes tested were obtained from the local lighting company through the courtesy of the secretary and manager, Mr. A. M. Robertson. These were taken from stock without any care to select good or poor ones.

The results of the test show that the amount of light absorbed by globes is no inconsiderable quantity. It is ex-

pected that this investigation will continue in order to determine the best kinds of glass to use, comparing various makes now on the market, and other problems. Interesting results are to be expected from a study of interior illumination by inverted arcs with and without metallic reflectors.

The above is to be considered only as a preliminary report of investigations upon an interesting and somewhat complicated problem.

Boilers for Small Central Stations.

BY REGINALD A. FESSENDEN.



It is a sufficiently difficult matter to design a large central station so that it shall give good results as regards economy in running, in labor, and as regards ease of extension. Smaller stations, however, it is generally admitted, call for far more exercise of ingenuity. Though the great majority of those qualified to speak on the subject have preferred to retain their experience for them-

selves, certain facts are well understood.

Such are, for instance, the necessity of choosing machines having an efficiency characteristic shaped with regard to the work to be done, or choosing units such that the machines shall always be working nearly at full load, and so that the reserve of power may be as small a percentage of the total power as possible, and of selecting machines capable of standing a considerable percentage of overload without undue heating, so that the different combinations of units may overlap one another.

In passing the writer may say in regard to the second subject—the choice of proper units—that the plan followed in some large central stations, where a number of machines are run in parallel, of using units in geometric ratio, i. e., of powers in the ratio, 1, 2, 4, 8, 16, etc., does not appear to be the best. In the first place the ratio of reserve to total power must be too great, and, secondly, too many spare parts must be carried in stock. A better method would appear to be what might be called the triple unit method (used with dynamos capable of standing 30 per cent. of overload for considerable times). In this system, if the lowest load were one-sixteenth of the maximum, the units used (with due regard to maker's standard sizes) would be in the ratio 1 — 2 — 4 — 4 — 4. The next addition would be an 8 unit, then two more 8s, a 16 and so on up, the final plant being 1 — 2 — 4 — 4 — 4 — 8 — 8 — 8 — 16 — 16 — 16 — 32, etc., the smaller sizes being, of course, discarded as the size of the station increased. It is believed that this system gives the best combinations as regards efficient running, and requires least percentage of reserve power, or of extra parts.

With regard to the boiler plant, however, not so much has been written. With the exception of the plan proposed by Mr. Raworth, and which has the inconvenience of requiring a distributing box for the exhaust steam, and pipes leading from it to half the tubes of the boiler, the writer is not aware of any attempts to prevent waste in this direction.

What the amount of this waste is may be shown from the following figures: On the average, a boiler will contain, with the water near the lowest gauge, from 60 to 120 pounds of water per horse power of rating (at 100 pounds pressure), the lower amount being for boilers of the marine type and the larger amount for water-tube boilers.

It is easily calculated that on closing down a boiler with 60 pounds of water per rated horse power no less than 5-h. p. hours are left in it in the heated water per horse power of rating, so that for a 100-h. p. boiler the total amount wasted would be 500-h. p. hours.

If, then, we start up a 100-h. p. boiler at 6 P. M. and run it till 9 P. M. at its full rated capacity, we leave in it nearly twice as much energy as it has supplied. It is true that the water may have been supplied from a feed-water heater, but ultimately the heat comes from the coal pile, and is wasted.

The most obvious means of lessening the waste is to use a boiler having less water capacity. Unfortunately, while this is all right where the load is constant, as on board ship, it will not answer with an electric light or power plant. Here the changes of load are so sudden that the steam pressure would fluctuate so much as to render the use of such a boiler impracticable.

This is upon the supposition that the draught of the grates is due to a tall chimney. Until lately this was the only means, if we except forced draughts from pressure in the stoke-hole. Thanks to the coking arch and the mechanical stoker, it is now possible to use short chimneys with power-driven exhaust fans. This also enables us to use fuel economizers. It would therefore seem as if, under these circumstances, a boiler having smaller water capacity might be used. If the power (electrical or steam) used to drive the exhaust fan were worked by a regulator, so as to speed up instantaneously upon the smallest fall in pressure, it is possible that good results could be obtained. With such a system, and the use of a fuel economizer, it would appear, theoretically at least, as if at least half the coal might be saved in the running of small central stations.

An idea of the type of boiler meant may be obtained from the following description of a boiler used by Mr. Maxim, which the writer had the pleasure of seeing in the former's workshop in Kent. This boiler, it may be remembered, is the one by means of which Mr. Maxim solved the problem of generating power for aerial navigation; the total weight of boiler, engines, condenser, water and oil supply, casing and supports for boilers being only 13 1-2 pounds per horse power, and 1 h. p. being able to lift 180 lbs.

The total weight of the boiler tubes is only 1 pound per horse power. Connecters, supports, etc., bring the total weight per horse power up to 3 pounds. This shows that the amount of heat necessary to heat the boiler fittings is very small.

The important point, however, in connection with our present subject is that instead of using 100 pounds of water in the boiler per horse power, the total weight of water in circulation in condenser, boiler and connections is less than 1 pound per horse power. Such a boiler can be started up in a few seconds, and on stopping the loss of heat would be negligible, less than 1 per cent. of that of present practice.

Mr. Maxim has never made any secret in regard to the construction of this wonderful piece of apparatus, and has published some of these figures in his papers in the periodicals, but the following particulars have not been given before, and may be of interest. (A general idea of the boiler may be got from the cut of the boilers of the Speedy, given in the "Scientific American Supplement," Dec. 16, 1893, or in the London "Engineer." The principal difference between Mr. Maxim's boiler and the cut is the replacement of the fire-box, etc., by a gas burner, and the use of small copper tubes, instead of iron.) No walls or casings are used, the only protection against radiation being a single sheet of asbestos laid over the outside tubes. The efficiency of the water-tube arrangement is so remarkable that under full steam the varnish on the smoke-stack (if it can be called so when there is no smoke) is not even charred. To make a rough estimate, considering the small size of the boiler for its rated capacity, 400 h. p., the efficiency must rise at least into the nineties.

The tubes used are of copper, about 1-4 inch diameter (all joints brazed), and the water is driven through them

with great velocity, and flashed into steam immediately after passing through one short section of tubing. The fuel used is a gas from light petroleum.

Now, it is not meant, of course, that such a boiler should be used in central stations, but it is merely given as an example of what can be done in the way of boiler making. The general principles for an economical boiler (not a boiler which is economical when run for a long time and steadily, but one which is economical under such conditions as are found in actual electric light and power stations) would seem to be as follows:

1. The use of an exhaust fan for draught, the velocity of the fan being governed by a regulator working through change of boiler pressure.

2. The use of small water tubes in conjunction with forced water circulation.

3. The use of a substance as fuel which is capable of combustion at a more rapid rate than coal is in its ordinary state. It is quite possible that coal (which, as is well known, forms an explosive mixture with air when in the form of dust) in the form of very fine powder could be used with an atomizer working with a screw feed.

4. The arrangement of the water tubes so that there is no necessity for brick walls, etc., the only material heated outside the boiler being a thin heat-insulating covering.

Should it prove possible to design such boilers, there is no doubt but that there would be a very considerable saving in their use over those of the ordinary form.

Incidentally it may be mentioned that the use of small tubes and the recent application of graphite as a cylinder lubricant would permit the employment of much higher pressures than have hitherto been possible. Mr. Maxim's tubes stand 500 pounds pressure per square inch with a large factor of safety.

A boiler resembling the one described above has recently been employed by Mr. Thornycroft on H. M. S. Speedy, as mentioned above. The results obtained were very satisfactory; 200 pounds of steam were generated in a 600-h. p. boiler in 25 minutes. A great saving in weight is reported (about 20 tons less than other boilers of the same capacity), due largely to the smaller amount of water carried in the boiler. Forced circulation does not seem to have been used, the fuel—coal—burning comparatively slowly, even with forced draught, so that this was not necessary, nor possible, on account of the great grate area necessary.

A New Monthly Magazine.

We have received the first number of "Elektron," a new monthly magazine devoted to electricity and its allied interests, and welcome the new addition to the electrical periodical press. The number contains a round dozen of articles on various electrical subjects, besides editorial and miscellaneous notes and a list of patents issued during the month of January, the size of page being that of the typical monthly magazine. Mr. John E. Talbot is editor, the price of subscription is \$3 per year and the place of publication is Boston.

Government Control of Electric Lighting.

In referring to this subject, Mr. Preece, in a recent address, remarked as follows: "It is all very well in the pioneer stage of any industry to let private enterprise have its full swing, but when an industry becomes a public necessity, and when the interests of the whole community are at stake, government, as the custodians of the public weal, must step in and assume the control. The accidents in the States are terrible in their number and fatality, and they strike the observant Englishman with dismay. The value of life there seems to be very much below par."

Comparative Value of Certain Wiring Plans and Some Wiring Pointers.

By L. P. ROBERTS.



THE statement is frequently made that the arrangement of wires, as shown in Fig. 8, gives the same potential at any point of the loop circuit, and that therefore it is the best arrangement, when considered from the standpoint of the lamp. That this is not a fact has, however, been shown, and that it is only true when the cross-section of the wire is made proportional to the current (as in Fig. 9) has also been demonstrated, although many "experts" are not acquainted with the fact. The writer has argued the case with a well-known and really first-class "expert," who, as an installer of apparatus, is one of the best in the country, and who claimed and still claims that Fig. 8 not only gives perfect distribution at any load, but takes the least possible copper for a given loss, and that its only disadvantage is that it is not convenient to test out same in case of trouble; also that the

ing R with C , but the increased C exists and the lamp is being strained—the latter is not being compensated.

It may be well to premise the working out of the examples by some general statements which contain truths often lost sight of. All electrical men are now acquainted with Thomson's law as to the economical size of conductors. Many understand how to use it; others, from lack of knowledge of how to determine the variable factors, consider it as of no practical bearing, but the point now desired to elucidate is that Thomson's law is based on the R of the circuit, being based on the energy lost, and that for a given weight of copper the energy wasted for a given amount used depends upon the distribution of the copper, and that by knowledge and careful planning one man can get far better results as to distribution and loss of energy than another, who either does not know, or care, or, knowing, will not take the time. Possibly the last man is not paid sufficiently; possibly the more material going in the better for him; possibly he considers it unnecessary labor, because it will never be appreciated.

Case first: The least amount of energy is wasted (commercially speaking) if the loss of potential be proportional to the lineal feet traveled.

If, in Fig. 7, we have four conductors of 10 B. & S. (1 ohm per M. feet) leading to a point 500 feet distant and



FIG. 1.

"theory" which can obtain the results tabulated below is "off," or the writer is. As the "theory" is Ohm's law, the writer suggested that the only error possible is in the application. The expert stated that he had erected a system, of the character shown by Fig. 8, and used two-thirds the copper required by Fig. 6, and a voltmeter showed that his statement was correct, and he did not care for any figures; he went by facts. This controversy furnished much food for thought, and could easily be made the text for an article; it is now only given, trusting that it will excite the reader to sufficient interest in the table to work out the results, and then, if he is a believer in the correctness of Ohm's law, he can judge for himself.

The method used for the calculation is the "drop of potential." In each case the same size wire is considered and, the R and C flow being known, the drop calculated. The C for each lamp is taken as constant, which, though not exactly correct, is sufficiently so. If the reader prefer, he can consider the translating devices, not as lamps, but of wire of constant R . The error, when lamps are considered, is toward compensation, as increased potential at any point increases C and lamp R decreases, but increased C cuts down potential. This must not be confused with distribution; the action is merely partly compensating for vary-

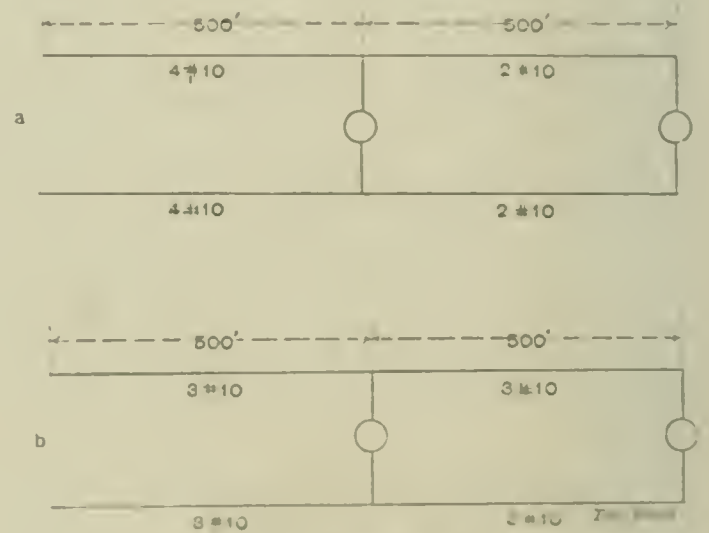


FIG. 2.

ing 10 amperes flow, and we connect up, as shown in *a*, *b*, *c* and *d*, we find that the drop and losses are as follows:

	<i>A</i>		<i>B</i>		<i>C</i>		<i>D</i>	
	P. D.	Watts.	P. D.	Watts.	P. D.	Watts.	P. D.	Watts.
1-2	1.15	.....	1.15	.....	1.15	.....	1.15	.....
2-3	1.25	.....	1.25	.....	1.25	.....	1.25	.....
4-3	1.85	.....	1.85	.....	1.85	.....	1.85	.....
5-3	1.35	.....	1.35	.....	1.35	.....	1.35	.....
1-3	2.40	.....	2.40	.....	2.40	.....	2.40	.....
4-3	1.10	.....	1.10	.....	1.10	.....	1.10	.....
Total,	10.	95.	10.	95.	10.	95.	10.	95.

Evidently a certain total number of pounds of copper can be used to better advantage in *a* than in *b*, *c* or *d*, and it is not an equivalent to run one size of wire a certain distance and piece out with another size, even if the total pounds be the same.

For the sake of simplifying calculations, No. 10 wire, and multiples thereof, is used in all the examples. Another way would be to consider the R per millimetre foot, and it is a simpler method for those who are used to using the same.

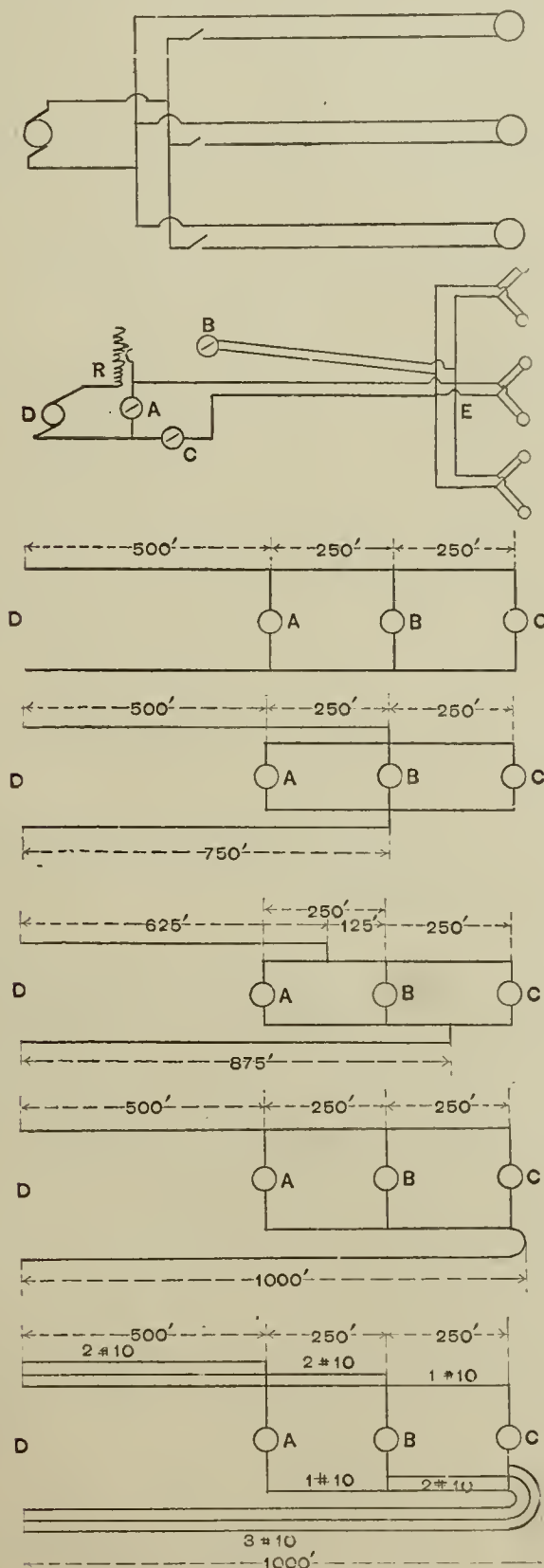
Another case: Fig. 2, *a* and *b*:

Losses in 1 and 4—				Losses in 2 and 3—				Total—			
Ohms	C	P. D.	Watts	Ohms	C	P. D.	Watts	P. D.	Watts	P. D.	Watts
1-2	25	2.5	31	2-3	25	2.5	31	5	62	5	62
Total (all)	100	10	124	Total	50	5	62	5	124	5	124

Note that although the drop from one end to the other is the same, there is nevertheless more energy wasted in *b* than in *a*, but also note that if incandescent lamps be the translating device used, *b*, would be better than *a*, be-

cause of better regulation. This does not affect the principles as to the least amount of energy lost, but shows that there may be more than one principle to consider.

It is generally known that the only way to obtain perfect regulation is to maintain constant P. D. at the dynamo, and to run a separate circuit to each set of devices, all of which must be "on" or "off" (Fig. 3). As this is generally impracticable, an effort is made to maintain constant P. D. as near the lamps as possible (see Fig. 4), where *D* represents a dynamo, *R* a resistance, so that P. D. at *E* can be controlled; (it may be controlled in other ways); *B* a voltmeter to indicate P. D. at *E*; a voltmeter, *A*, and ammeter, *C*, may be used, and the P. D. at *E* kept constant by knowing *R* from *D* to *E* and using Ohm's law. It may, however, be impossible to bring *E* very near the lamps, or the plant may be an isolated one, in which latter case compound wound machines are often depended upon for keeping the P. D. at the dynamo proportional to the current, and an effort be



FIGS. 3, 4, 5, 6, 7, 8 AND 9.

made (though probably it is not, and often cannot be made) to have circuits so divided as to all change load in about the same ratio. Whether there be a constant potential point at the dynamo, at some point along the leading wires or at some lamp, will only vary the conditions and results obtained, but the general deductions obtained from considering the following cases remain true.

Figs. 5, 6, 7, 8 and 9 show different methods of wiring for translating devices *A B C*. Each device to take 10 amperes.

First—If each is to have the same size wire throughout, consider No. 10, because of convenience, and use two wires for a conductor in Figs. 5, 6, 7 and 8, and in Fig. 9 taper off, as shown, making cross-sections proportional to *C*.

If potential be kept constant at 100 volts at *B* and full load, then

	5.	6.	7.	8.	9.
P. D. at <i>B</i>	100.0	100.0	100.000	100.00	100.0
P. D. at <i>A</i>	105.0	97.5	99.375	101.25	100.0
P. D. at <i>C</i>	97.5	97.5	99.375	101.25	100.0
P. D. at <i>D</i>	120.0	122.5	121.000	127.50	121.5
Total feet wire	4,000.0	5,000.0	5,000.000	5,000.00	6,000.0

If potential be kept constant 100 volts at *B*, and *B* be cut down to half load, *A* be fully loaded and *C* one-quarter loaded, then

	5.	6.	7.	8.	9.
P. D. at <i>B</i>	100.00	100.00	100.00	100.00	100.00
P. D. at <i>A</i>	101.87	97.50	98.59	100.31	98.44
P. D. at <i>C</i>	99.37	99.37	100.47	101.56	101.25
P. D. at <i>D</i>	110.62	113.12	114.53	115.94	111.56

If potential be kept as before at *B*, and *A* be at one-half load, *B* at one-quarter load and *C* at full load, then

	5.	6.	7.	8.	9.
P. D. at <i>B</i>	100.00	100.00	100.00	100.00	100.00
P. D. at <i>A</i>	103.12	98.75	99.84	100.94	100.31
P. D. at <i>C</i>	97.50	97.50	98.59	99.69	98.44
P. D. at <i>D</i>	111.87	112.12	114.37	115.62	111.25

Many other conditions might be assumed, such as maintaining the P. D. at *D* constant, and that necessary for full load, which (if *D* be the feeder end) is often done in central stations; or making P. D. at *D* proportional to *C*, which is the case when using an over-compound dynamo, and taking *D* as the dynamo; but enough has been stated to show that No. 7 is better than No. 8, not only in weight of copper and energy lost, but in regulation at full load, and for most variations under varying loads.

Economy of Incandescent Lamps.

BY W. STUART-SMITH.

Why does the economy of incandescent lamps fall so rapidly after they have been burning a few hours?

Every electrician has asked himself and others this question, and a vast amount of time has been spent and expense incurred trying to find out. The result is that every well-informed electrician will answer "that the filament undergoes a change in structure that seems to decrease its illuminating power." The resistance of the filament and current taken vary but little, while the light-giving powers fall through a wide range. A decrease in the illuminating power would seem to indicate a decreased temperature, which, with a nearly constant current, could only be caused by an increase in the specific heat produced by a structural change, and this explanation is the generally accepted one. It is the purpose of this article to show that such an assumption is entirely unnecessary, and that a very simple and familiar phenomenon is sufficient to account for the fall of efficiency.

Referring to Lieutenant Eyre's article on incandescent lamp economy (The Electrical World, Jan. 13, 1894), we see there three sets of curves given, and first it is seen that all three sets of curves rise rapidly for periods varying from 40 to 100 hours, depending upon the original candle power of the lamps. A maximum is soon reached, after which all the curves fall away.

The increase of the current at once indicates a decreased resistance, and this is probably caused by the filament becoming more dense under the action of the heat, just as a piece of porcelain will contract permanently if raised to a temperature higher than that at which it was fired. Although the filament may not be any hotter than it was at some points in its manufacture, yet the temperature is maintained much longer, and thus may have the effect of a higher temperature maintained for a short time.

The curves are shown as rising in a straight line from the origin to a maximum; it is probable that greater care in

plotting would show a concave portion near the origin, followed by a point of contrary flexure, and a convex portion passing through a horizontal at a maximum, then another point of contrary flexure, followed by a curve of large radius.

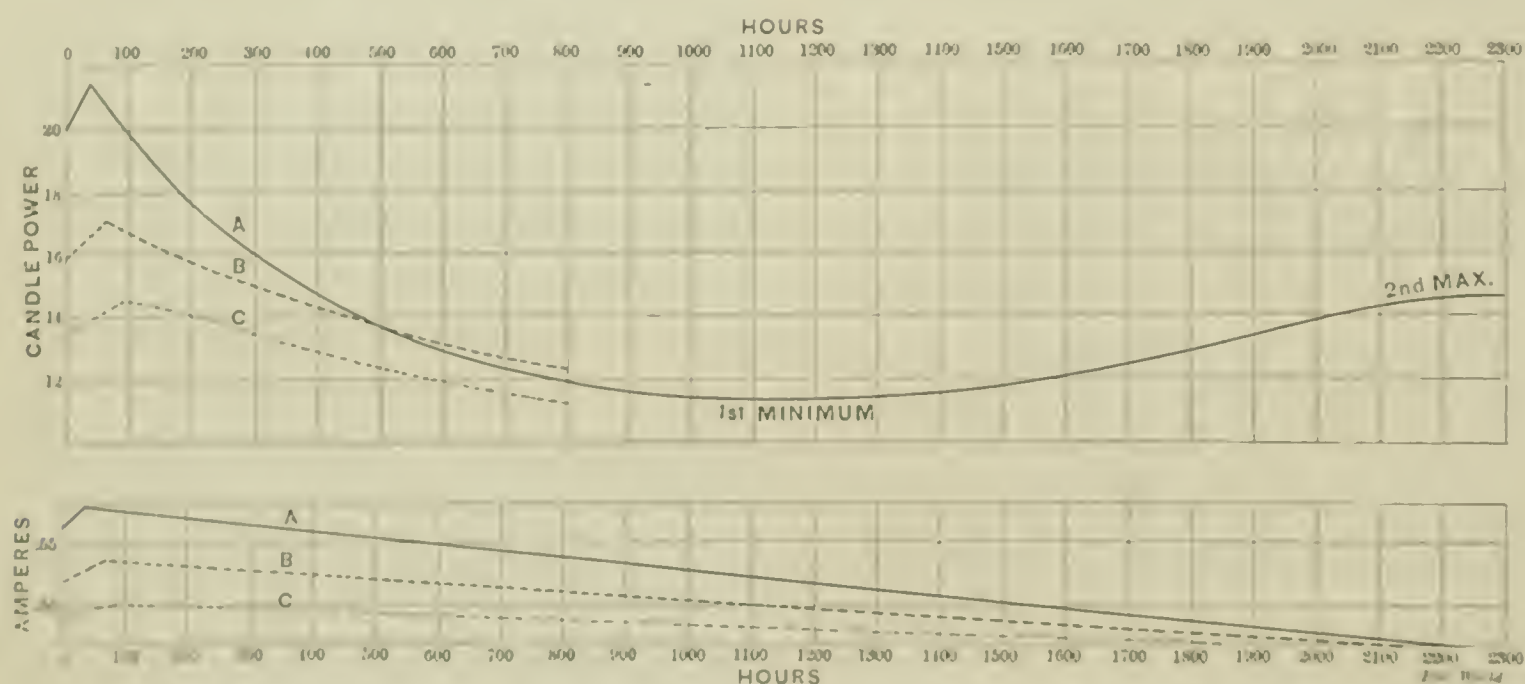
The candle-power curve rises much more rapidly from the origin than the current, due, of course, to the fact that at the higher temperature produced by the extra current a larger percentage of the total energy consists of light-giving rays.

After passing through a maximum the current falls slowly and steadily, the curve being very nearly a straight line. This is, no doubt, caused by the resistance increasing as the filament becomes smaller, through vaporization. As the curve is so nearly a straight line, the current decreases exactly in proportion to the volume of the filament, and the temperature should remain constant, unless there is an increase in the specific heat.

A further examination of the candle power and efficiency curves will show that the slope becomes less and less with time, and if continued they would probably reach the horizontal, pass through a point of minimum value and then rise again to another maximum of less value than the first. This last point is not evident from the curves, but, I think, can be shown.

The current curves, if prolonged, will be found to inter-

this occurs part of the light will be destroyed, with the result that the total illumination will begin to decrease. At first but few points will have the requisite depth for interference, and the diminution of light will be small, but as time goes on the number will greatly increase and interference will take place over the whole surface, and the effect will be greatly diminished illumination, due to the virtual decrease of illuminating surface. The effect will be the same as interference in the case of gratings, opals, Newton's rings, etc. Gratings, opals, etc., produce color effects, and it may be asked why, if this effect is the same, colors are not also produced. The answer is simple: Gratings, etc., are regular, and the results are even distribution of interference with consequent color effects, but in the case of the filaments, owing to non-homogeneity, the pittings and scorings will be very irregular, and the result will be that color effects from adjacent portions will be interspersed and the resulting effect will still be white light, though it will have less intensity than originally, on account of a portion of the light having been destroyed. If some color predominated, it would not show distinctly, but would be diffused throughout the mass of the illumination and give a general tint to the light, and it is well known that the color does change, becoming more red. Probably it also goes through other tints, but they are less



INCANDESCENT LAMP EFFICIENCY CURVES.

sect nearly in a point. If this is not accidental, it means that point when the filaments become so attenuated through vaporization that they become practically of no section. In practice they will break before reaching this point.

In my article on "Blackening of Incandescent Lamp Bulbs" (The Electrical World, Nov. 11, 1893) I suggested that the carbon filaments are not homogeneous, and that some portions volatilized more rapidly than others, and if this is true (as seems probable), a microscopic examination of filaments which have burned for some time will show them to have very irregular surfaces, being pitted and scored in every direction. During the early stages of illumination this would not have a deleterious effect, but, on the contrary, might add to the illuminating power by increasing the virtual surface, just as roughening the surface of a stove is beneficial by increasing the radiating surface. If this is true, then part of the increased illumination near the origin is due to this and part to the increased current, and the effects would be hard to separate. In any case, the effect of pitting would be small and would not prevent the point of maximum light-giving power coinciding with the point of maximum current. After a time, however, a totally different effect will occur. As the pittings and scorings increase in depth a point will be reached when the light emanating from the crests and hollows will be half a wave length apart, and when

noticeable, as the carbon deposit on the glass tends to absorb them and leave the red, which have the longest waves.

According to this view, the intensity of the illumination of every point of the filament remains the same as before, but the combined effect is less, owing to partial destruction just off the surface. Similar reasoning shows that the carbon is actually heated to the same temperature at all times during its life, but if the radiated heat should be measured it would be found to decrease, owing to interference as before. All this, of course, is independent of the effect of the carbon deposited on the glass. That is a mechanical interference and has nothing to do with the light-giving power of the filament. It is the filament which is being considered here and not the lamp as a whole.

It can now be seen why the slope of the curves decrease and approach a horizontal; in fact, why they must reach a minimum value, and then rise again to another maximum, to be followed by a second minimum, etc. As the pits and scores grow there comes a time when a maximum number have the right depth and size to produce a maximum interference, and at this point the virtual surface and consequent illumination will be a minimum, and the candle power and efficiency curves will both reach a horizontal. Beyond this point interference begins to decrease and the curves begin to rise, but at a less angle than that at which descent

was made, because as the filament wears away the current decreases. After a time the pits and scores will reach such a size that the virtual surface will be nearly that of the actual area of the carbon, and the candle power and illuminating curves will again pass through a maximum. This, however, will be less than before, because now the actual surface of the filament is less than originally, on account of the vaporization which has taken place. Theoretically, there should be a series of waves similar to sine curves, but having the part below the axis larger than the part above. They would be drawn about an oblique axis, to which they would tend to approach as the filament wore away. After the first wave they would tend to become complex, because the pits would then have considerable size and other pits would form within them and the effects would be superimposed. This recurrence of waves assumes, of course, that the carbons had so much section that they could stand the excessive scoring and pitting without breaking. In practice with lamps of high candle power and stout carbons, the second maximum might be reached, but probably nothing beyond that, and even this might not be noticed, on account of the blackening of the globes.

High candle-power lamps would feel the effect of this scoring and pitting sooner, because, owing to the greater size and consequent greater want of homogeneity, the pitting and scoring would be more rapid, and thus the more rapid falling off of illumination in high candle-power lamps is accounted for. It is even possible that with such lamps several maxima and minima might occur during the life, though, owing to the pitting within pits, as above explained, and the consequent superimposed curves, a steady illumination might take place, or, rather, the oblique axis might be reached by the candle-power curve. It could not become permanently horizontal, because the filament wears away and the current falls constantly. However, when the oblique axis was practically reached, the efficiency curve would become a horizontal line or a curve waving slightly above and below a horizontal. When this occurs, the efficiency should be nearly the original value because, though the illumination would be less, it would be practically proportional to the current.

The explanation given accounts for all the eccentricities of filaments, and points out the line to be followed in order to produce lamps that shall maintain high efficiency throughout their life.

The original cause is want of homogeneity, and probably this can never be overcome so long as organic, structural material is used for making filaments. It shows that a non-structural amorphous mass should be used as original material, and this must be chemically produced in such a manner as to be absolutely homogeneous. This being the case, the filaments will wear away evenly without pitting, and though the candle power will fall steadily as the filament wears away, it will still remain proportional to the current, and the efficiency will retain a constant value equal to the maximum near the origin.

Owing to the fact that experiments are made on lamps as a whole, the fall of efficiency and candle power observed are the combined effects of the lessened efficiency of the filament and increased absorption by the deposit on the globe. This absorption not only causes the curves to fall to a lower value and gives the oblique axis a greater inclination than it would otherwise have, but it also causes the minimum values of these curves to be reached at a later period, or the minima of the lamp are both lower and later than the minima of the filament.

Also, even if the filament had so much stock that after a time equilibrium in interference might be attained and the efficiency curve of the filament become a horizontal line, the continually increasing deposit would cause the curve for the lamp to slope downward.

Electricity in the Capitol City.



WASHINGTON was happily chosen as the convention city, for not only is it favorably located for the majority of the members of the National Electric Light Association, but it possesses attractions which no other city in the country can claim. While its chief features may already be familiar, a very brief glance at some of the principal points of interest from an electrical standpoint may prove of value.

PLAN OF THE CITY.

The Capitol is located at the geographical centre of the city. Commencing at the Capitol and running north, east and south are respectively North Capitol, East Capitol and South Capitol streets, which, with the government reservation known as the mall, running from the Capitol to the Executive Mansion on the west, divides the city into four sections or quarters. These are known as Northeast (N. E.), Southeast (S. E.), Northwest (N. W.) and Southwest (S. W.) The streets running east and west are designated by the letters of the alphabet, while those running north and south are numbered. Each block is assigned 100 numbers. Hence, to find any address requires but a moment's thought, as, for instance, wishing to locate 659 Eighth street, N. W., we know that it is between F and G streets (F being the sixth letter) on Eighth street in the northwest section of the city.

CONVENTION HEADQUARTERS.

The Ebbitt House, located at the southeast corner of 14th and F streets, N. W., has been chosen as convention headquarters. It is but natural that this selection was made, as it has been for years the headquarters for every prominent gathering at the National Capital. No better selection could possibly have been made, as it is very central, being but one square from the Treasury and Executive Mansion; two squares from the State, War, and Navy buildings and Corcoran Gallery of Art, and only one block from Grand Army Hall, where the convention will be held. The latter place is on Pennsylvania avenue, between 14th and 15th streets, N. W. Beautiful souvenirs of the city will be given to the visitors by the liberal management of this most excellent hotel. In these will be found half-tone engravings of the principal sights, together with a brief sketch of the interesting features of each. The red parlor on the first floor of the Ebbitt House will be thrown open for exhibitors. It is quite roomy, well lighted and should prove a very convenient location.

ELECTRICAL FEATURES.

A short description of the United States Electric Lighting Company's plant, located at the corner of 13 1-2 and B streets N. W., although by no means a model of modern plants, will perhaps be of interest.

The boiler plant of 3,450 h. p. is composed of eight 100-h. p. tubular boilers, two 200-h. p. Campbell & Zell water-tube boilers, and six 375-h. p. National water-tube boilers. As will be seen by the floor plan, Fig. 2, the engine room is arranged in the form of half of a hollow square, the boilers being placed in the central area. Steam is distributed through 14-inch mains having branches of the required sizes.

The power plant is made up as follows: Two 500-h. p. tandem compound Green engines belted direct to four 175-kw. Edison generators, one 250-h. p. tandem compound Green engine direct belted to four 50-arc Thomson-Houston generators. These engines are supplied with jet condensers, but owing to a lack of water supply the engines are run non-condensing; two 200-h. p. simple Green engines are direct belted to two 2,000-light Thomson-Houston alternators;

ing model constructed from the description and drawing in vol. XX. of "Sellman's Magazine"; Jacobi's motor, a working model of this motor of 1834 constructed from the earliest record of the same found in a translation of a description by Jacobi in "Sellman's Magazine"; Davenport's motor of 1837, the original Patent Office model filed with the application on which patent No. 132 was granted to him Feb. 25, 1837; the model shows the permanent magnets; a model of Stimpson's electromagnetic engine is also shown. Besides these there are many other models exhibited showing the patented ideas of Lillie, Neff, Page, Carpenter, Shepherd, Bergnes, Berloiz, Wilde, Lontin and D'Ireimois, Farmer, Sims, Paine, Gramme, Bishop, Fuller, Weston, Brush, Hursey, Ludwig, Edison, Thomson and Houston, Hochhausen, Griscom, Maxim, Van Depoele, Wood, Diehle, Lugo, Pfund, Little, Meyrowitz and Buchop, Heyer and Eckmeyer. Models of electric lighting patents are displayed covering the inventions of Collier and Baker, Gardiner and Blasson, Berloiz, Day, Wallace, Weston, Brush, Thomson-Houston, Edison, Sawyer, Maxim, Kieth, Van Depoele and Ward. Models of recently invented welding machines by Prof. Thomson are also shown. The telegraph and telephone are amply represented by many models of early inventions.

ELECTRICITY AT THE NAVY YARD.

Electricity has only recently made slight advances in its practical application to naval warfare. Under the able supervision of Lieutenant S. Morgan applied electricity as relating to gunnery is steadily advancing. He has already devised a very novel method of firing by electricity, which is as follows: With the case in question a closed box was built upon the web of the left-hand bed plate. In this box a 3-cell battery of Exeter dry cells is placed. One pole of the battery is connected to the body of the gun, while the other is connected into one pole of a plug cut-out. The other pole of this cut-out is connected to a bridge made of an alloy of platinum and iridium located within the shell and around which is wound a layer of gun cotton. After passing through the shell the wire makes electrical connection with the interior of the gun. A plug having a flexible cord of some 20 feet in length attached to it is provided at the opposite end



FIG. 3.—U. S. ELECTRIC LIGHTING CO.'S STATION.

with a handle which can be compressed by firmly grasping it. In compressing this handle the electrical circuit is completed and the charge exploded.

The electric motor, with screw power, is about to displace the ponderous hydraulic rams (and necessary piping) used in training and loading the guns.

The west gun shop is provided with portable electric drills, which have proven very advantageous for many kinds of

work. They were manufactured by Thomas H. Dallett & Co., Philadelphia. There is little else of an electrical nature to interest one outside of the 10-ton electric crane built by William Sellers & Co., Philadelphia. However, the entire works are exceedingly interesting and should be visited by all who can possibly find time to do so.

ELECTRIC RAILWAYS.

By cable from the Navy Yard one can be taken direct to Georgetown, D. C., where will be found the Tennallytown

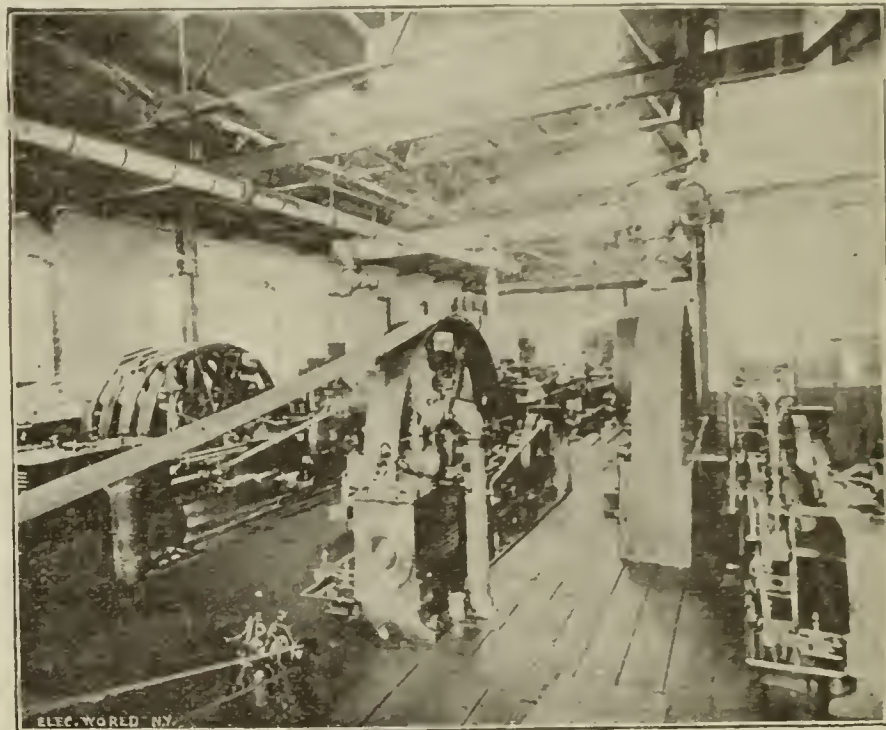


FIG. 4.—INTERIOR OF ELECTRIC LIGHTING COMPANY'S STATION.

and Washington Electric Railway. By crossing Aqueduct bridge a line of the Wheelless Underground Conduit Electric Railway may be found. Through financial difficulties the road has been shut down, but a move is now on foot which will probably again place it in operation. The U street line of the Rock Creek Railway, which is operated upon the Love system, should be visited. This line was fully described in The Electrical World of Jan. 14, 1893.

ELECTRICITY IN THE CENSUS OFFICE.

The honorable Commissioner of Labor, Mr. Carroll D. Wright, has forwarded to the secretary of the National Electric Light Association an invitation to visit the Census Office and witness the working of the Hollerith electric tabulating machines, so successfully used during the last census.

There is but little doubt that those who attend the convention will be amply repaid, for while the electrical features of Washington are few, there is so much else of historical value and interest that their time can be well occupied.

The Capitol, National Museum, Smithsonian Institution, Bureau of Engraving and Printing and Treasury are full of interesting sights and should be visited if possible.

Direct vs. Belt Driving.

Mr. Preece, in his recent paper on electricity in the United States, in referring to the subject of direct driving, states: "The reports of our performances in England are much sought after, and I think one influence of the Chicago gathering will be to convert American engineers to direct driving. The elastic character of direct driving engines, gradually increasing in number and capacity with the load, and the ability to shut down or turn on engine after engine as the load varies, are economical advantages of some value. The rapid regulation of small engines, the much smaller space occupied where space is so valuable, the smaller capital expenditure involved and the reduced working expenses, all give direct driving an advantage which should recommend itself to such eminently practical engineers as the Americans."

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE
PRINCIPAL FOREIGN
ELECTRICAL JOURNALS.
BY CARL HERING.

ELECTRO-PHYSICS.

Dielectrine.—The Lond. "Elec.," Feb. 9, states that Mr. Hurmuzescu described this material before the French Physical Society; it is a mixture of paraffine and sulphur, is harder and less easily melted than the former and less easily cracked and less hygroscopic than the latter.

MAGNETISM.

Magnetic Shielding.—The Lond. "Elec. Rev.," Feb. 9, in an editorial briefly abstracts the paper of Prof. Ruecker on this subject in the "Phil. Mag." for January, in which he discusses shields separated by air gaps, as distinguished from continuous masses of iron.

The Electromagnet.—A French translation of the article mentioned in the Digest Feb. 17 is begun in "La Lum. Elec.," Feb. 3.

Electromagnetic Synchronizing.—"La Lum. Elec.," Feb. 3, reprints a mathematical paper by Mr. Cornu on this subject.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Lord Kelvin's Amperemeter.—The Lond. "Elec. Rev.," Feb. 9, gives a short illustrated description, though not as complete as might be desired, of this instrument, called a current measurer; it is on the electro-dynamometer principle and is similar in construction to the one described in this paper some years ago; two small equal coils of fine wire are rigidly connected and suspended on modified knife edges, a pointer indicating their deflection; encircling these are two large fixed coils; the two coils of each pair are wound in opposite directions; the current is led to the movable coils through springs.

Instrument for Measuring Insulation.—In the "Elek. Zeit.," Feb. 1, Mr. Heim gives at considerable length an illustrated description of an instrument which he has devised for making insulation measurements at central stations. It is neither a coarse instrument for workmen nor a delicate laboratory one; it is for making reliable measurements up to a sufficient accuracy from 30 megohms to 1,000 ohms; it is a direct reading astatic galvanometer with a suspended needle.

Practical Unit of Self-Induction.—Mr. Whitwell, in the Lond. "Elec. Rev.," Feb. 9, endeavors to give briefly a clear notion of what the henry is; after a somewhat lengthy introduction he merely states that if the current increases by one absolute unit per second and also that the back E. M. F. of self-induction is one absolute unit of E. M. F., then the self-induction of the circuit will be one absolute unit of self-induction; he defines this absolute unit as follows: A circuit has one absolute unit of self-induction, if, when the current is uniformly increasing at the rate of one absolute unit per second, the back E. M. F. is one absolute unit; if the current increases at the rate of one ampere per second and the back E. M. F. is one volt, then the self-induction is one henry; he shows that the dimension of self-induction is a length.

Kruppin, a New Resistance Material.—A translation of the article mentioned in the Digest Jan. 6 is given in abstract in the Lond. "Elec. Rev.," Feb. 9, in which also a number of the tables are given.

DYNAMOS AND MOTORS.

Unipolar Machines.—The "Elek. Zeit.," Feb. 1, contains another article by Mr. Marcher, in which he discusses the subject at some length, giving illustrations of several inoperative machines and discussing certain principles; in conclusion, he infers that the construction of a unipolar machine is not impossible and that he merely wishes to point out useless directions of research.

Irregularities in the Action of Dynamos.—The article from the French, mentioned in the Digest, is continued in the Lond. "Elec. Rev.," Feb. 9.

TRANSFORMERS.

Ironclad Transformer.—The "Elek. Zeit.," Feb. 9, quotes from an Italian paper, dated October, 1871, a statement made by Pacinotti, in which he refers to Ruhmkorff coils and states that he added an armature with the object of making a complete closed magnetic circuit, stating that by this means a larger deflection was obtained in a galvanometer, and suggesting that such an addition might be of advantage also in large Ruhmkorff apparatus.

ARC AND INCANDESCENT LIGHTS.

Arc Lamp for Projecting Lanterns.—The Lond. "Elec.," Feb. 9, gives a short illustrated description of the Davenport lamp, in which the lower rod is fed up by a spring against a metallic stop near the arc and the upper one is moved by a rack and pinion by hand; it will burn five minutes without attention; the carbons are set at an angle; from two to three times the amount of light is obtained as from the lime light, with less risk of injuring gelatine slides by the heat.

Incandescent Lamps.—The well-illustrated serial of Mr. Richard, taken apparently from patent specifications, is continued in "La Lum. Elec.," Feb. 3.

ELECTRIC RAILWAYS.

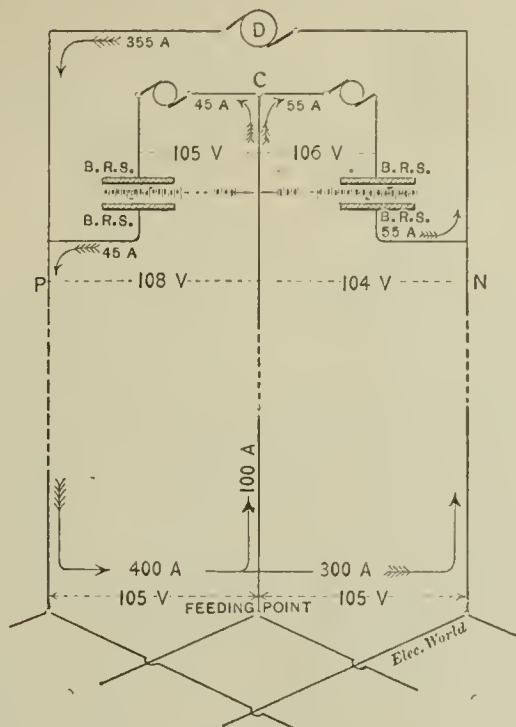
Railway Statistics for the United Kingdom.—The Lond. "Elec.," Feb. 9, publishes some tables of statistics and other information from the Board of Trade reports concerning street railways in general, no mention being made of electric railways in particular; the total number is 153, covering a length of almost 1,000 miles; the average total capital expended per mile is about \$73,500, that for municipal lines being considerably less than that for lines in the hands of companies; the traffic is about 600,000,000 per annum; the net receipts for the past year are about 5 1-2 per cent. of the total expenditure, which does not allow for depreciation; detailed data are given for four roads.

Mr. Preece on Electric Railways in America.—In his recent address he states that the progress made is the most wonderful instance of growth of the electrical industry in the United States; he describes in detail some of the larger plants; regarding the trolley wire, he states that when alone it is not unsightly, but when protected with three guard wires and when the feeders are overhead, it becomes hideous, and he is surprised that the American community submits to it.

Application of Electricity in Public Works.—The illustrated article in "La Lum. Elec.," describing the large traveling cranes used at Bilbao, is concluded in the issue of Feb. 3.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Three-Wire Compensating Device.—The following device is described in the Lond. "Elec. Rev.," Feb. 9, in an article on the Burnley station. The general arrangement is shown in the adjoining cut; the dynamo generates 230 volts and is



THREE-WIRE COMPENSATING DEVICE.

in connection with the central wire; the compensator consists of two armature coils wound on one drum, each for an output of 200 amperes and 110 volts (the output of the dynamo being 400 amperes); as shown, the compensator is connected to the outside wires through a battery of 120 accumulators of about 500 amperes each; the bars represent switches, by means of which a fewer or greater number of cells may be connected to either side; in this way it is possible to balance with only one engine and one dynamo.

Engines and Dynamos.—An editorial under this heading in the Lond. "Elec. Rev.," Feb. 9, discusses the subject of direct vs. indirect driving, claiming that there is no doubt that direct driving is best, having advantages in every respect, being cheaper in first cost, occupying less space, running cheaper, safer and at much less cost of maintenance; the only drawback being that it sometimes requires a large dynamo; it thinks there is a great future for the steam turbine; regarding single vs. double acting engines, it believes the former to be the better, and states that the single acting engine is running the largest amount of power in central stations in that country; it believes that about 75 per cent. of the electric lighting in that country and America is done by single acting engines; for direct coupling, gas engines have not been used with success.

Gas Engines in Central Stations.—Mr. Bourquin's article is concluded in "La Lum. Elec.," Feb. 3; he discusses at great length the advantages of using gas engines for generating electric light and particularly the combination of central stations and existing gas-producing plants, a system which he strongly advocates; he apparently gives nothing new. He also discusses the Van Rysselberghe hydraulic system, mentioned before in these columns, in which it is claimed to be more economical to transmit power hydraulically and transform it near the place of consumption into electricity; the chief argument is that the loss in hydraulic transmission is inversely proportional to the fifth power of the diameter, while in electric transmission it is inversely proportional to the square of the diameter; in the present paper it is argued that this system is no improvement; the same conclusion is arrived at regarding pneumatic transmission. In a former article he showed that a cubic metre of gas burned directly gives 91 candle-power hours, while with a gas engine and dynamo it can give 162 candle-power hours in incandescent lamps.

Double-Acting Gas Engines.—A communication to the Lond. "Elec.," Feb. 9, describes the Kilmarnock engine, which is claimed to be the only double-acting gas engine in England; a diagram is given for comparing the impulses at different loads for a number of different engines; it is started in a simple manner and at a moment's notice by a small boiler.

Mr. Preece on Electric Lighting in America.—In his recent address, mentioned elsewhere, Mr. Preece states that the accumulator in America has been a failure for electric lighting and that a very strong prejudice exists against its use. The feature which distinguishes American from English lighting is the persistent use of belting and countershafting, which in some stations is appalling to English eyes; he thinks that one influence of the Chicago gathering is to convert American engineers to direct driving. City work in such places as New York, Boston and Chicago, he says, is as solid and substantial as anything in England, but in country towns it is wretched; "if we are slower we do these things at least better in England." He states that when the industry becomes a public necessity and when the interests of the whole community are at stake, the government should assume control; the accidents in the United States, he claims, are terrible in their number, and strike the Englishman with dismay.

Average Output of Motors.—A note in the "Elek. Zeit.," Feb. 1, on the installation in a German town, gives a list of the motors and their power, from which it appears that out of 367 motors connected to that installation and representing a total of 87 h. p., 252 have 1-15 h. p., the next largest number being 32 of one h. p., while there are only four of more than 1 h. p.

Motive Power and Gearing.—Mr. Carter's serial is continued in the Lond. "Elec.," Feb. 9, in which he continues the discussion of the subject of fuel.

Self-Contained Condensing Plant.—The Lond. "Elec.," Feb. 9, gives a short illustrated description of the Allen engine, in which the condenser forms part of the machine, thus occupying much less space.

Burnley Station.—The Lond. "Elec. Rev.," Feb. 9, gives a brief illustrated description, showing the interior of the station and the switchboard; also a three-wire compensating device, for a description of which see the paragraph under that heading; the low tension three-wire system is used, the dynamos having the voltage of the outside mains, the load being balanced by means of the compensator.

Municipal Electrical Works.—The Lond. "Elec. Rev.," Feb. 9, abstracts briefly the same article which was mentioned in the Digest Jan. 27 on central stations in Germany.

Central Stations in Germany.—The "Elek. Zeit.," Feb. 1, publishes several communications concerning the article which was abstracted in the Digest Jan. 27.

Electric Lighting in London.—In a short article in the Lond. "Elec.," Feb. 9, curves are given showing the growth of various stations in London; the average rate of increase is about 10,000 lamps per year for each separate station.

Electric Lighting of London.—The Lond. "Elec. Eng.," Feb. 9, reprints the first part of a paper by Major General Webber, which is chiefly of local interest.

Kingston Station.—A well-illustrated description is published in the Lond. "Elec. Eng.," Feb. 9, the station being a small one, but said to be of very good design; it is a municipal undertaking; alternating currents are used.

Bordeaux.—"La Lum. Elec.," Feb. 3, gives a well-illustrated description of this railway, in which the Thomson-Houston apparatus is used.

Partnach.—The "Elek. Zeit.," Feb. 1, gives a brief illustrated description of this small alternating-current installa-

tion, driven by water power; it appears to involve nothing particularly interesting.

WIRES, WIRING AND CONDUITS.

Underground Mains in Glasgow.—The Lond. "Elec. Eng.," Feb. 9, reprints a paper by Mr. Lackie, in which he gives a good description of the electric mains in Glasgow. Bare copper strips one inch broad and 1-4 inch thick, of which two or more are laid together on top of each other, are run on insulators through troughs consisting of cast iron boxes laid in trenches 18 inches deep in the sidewalk; 15 men can lay 40 yards, completing the work entirely in one day; the troughs are jointed with red lead putty and are covered with iron covers cemented in the same way; a brick manhole, 4 feet square, is placed at the end of each length; like in this country, there are many cellars below the pavement, in which cases, as also in crossing streets, cast iron pipes are laid, through which insulated cables are pulled; the troughs are nearly, but not absolutely, water tight, and slope toward the manholes, where the water drains, or is drained off; the arc light circuits and the potential wires are carried alongside of the troughs in separate pipes; he states that the potential leads give more trouble than all the other mains put together; the mains have been in use for fully a year and a half, and have given no more trouble than insulated cables in pipes; he approves of the copper strips, but not of the iron culverts; he suggests covering the strips with a slight coating of some insulating material; he appears to prefer concrete or earthenware culverts; malleable iron pipes are led to the consumer's premises and the branch cables pulled through them. He is strongly in favor of corporations undertaking this work; in conclusion he discusses the recent explosions in these conduits.

Insulation Resistance.—In Mr. Guy's serial on "Electric Light and Power" in the Lond. "Elec. Eng.," Feb. 9, he discusses the subject of insulation resistance, giving three rules; in the first it is equal to the voltage divided by the current and multiplied by a constant, the value of which ranges from 500 to 100,000; the insulation is therefore a function of the total resistance of the conducting circuit and the reciprocal of the constant represents the leakage current, as a fractional part of the useful current; in the second rule it is equal to a constant divided by the number of 16 c. p. lamps, the constant for 100-volt circuits being from 100 to 10 megohms; for alternating currents it is customary to double the constant; in the third rule the constant is multiplied by the voltage and divided by the number of lamps.

Resistance of Stranded Cables.—Mr. Everett's article, mentioned in the Digest Feb. 17, is concluded in the Lond. "Elec. Eng.," Feb. 9; it is of a theoretical nature and the results do not appear to be of any very great practical value; a cable manufacturer informed him that the conductivity of a cable of a number of wires is not much less than that of the same number of straight wires whose length is equal to that of the cable.

Capacity of Cables.—In the Lond. "Elec. Rev.," Feb. 9, Mr. Appleyard discusses, with the aid of a number of illustrations, the statement that the capacity of a loop formed of two equal cables which are not earthed is half that of one of the cables using an earth return.

Networks of Conductors.—In an editorial on the miscalculation of mains in the Lond. "Elec.," Feb. 9, the nicety of the calculation of mains in Germany is contrasted with the methods used in England, in which shrewd judgment and experience rather than algebra are required in determining the section of a feeder; the editorial favors the former method.

Networks of Conductors.—The "Elek. Zeit.," Feb. 1, reprints at some length a mathematical discussion of the analytical treatment of the problem of the distribution of current

in networks of conductors; examples are worked out.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Bell with Pivoted Magnets.—Mr. Kohlfuerst in the "Elek. Zeit.," Feb. 1, describes and illustrates at considerable length an electric bell such as is used in Germany for giving loud railway signals; it has two electromagnets, one of which is pivoted and connected to the clapper, thus replacing the usual armature, the two electromagnets attracting each other.

Telegraphic Communication Between England and India.—The Lond. "Elec.," Feb. 9, publishes an article by Mr. Walker on this subject.

ELECTRO-CHEMISTRY.

Electrolysis of Alkaline Salts.—Mr. Blount, in the Lond. "Elec.," Feb. 9, discusses the nature of the reactions upon which electrolysis depends, basing his remarks on recent papers by Nourrison and Oettel; the energy required for the electrolysis of an equivalent of sodium chloride in aqueous solution is 470 calories, corresponding to 2.03 volts; that of sodium sulphate requires 2.15 volts; Nourrison arrives at the conclusion that the voltage required for the decomposition of all the alkali salts of the same acid have the same value, and that as the heat of neutralization of all the oxyacids is nearly identical, the critical voltage for the electrolysis of their salts is also nearly a constant quantity; after discussing the results obtained in practice he concludes that more than half of the electrical output of a plant for the manufacture of alkali and bleach is wasted by causes that cannot be considered altogether inevitable.

Purification of Sewage.—The reprint in the Lond. "Elec. Eng.," Feb. 9, in referring to the experiment at Havre, in which the refuse drains into the street gutters, states that when the electrolyzed seawater was used there was not only an absence of bad odor, but that the gutters, which formerly were always black and soiled, were beautifully bleached, even the curb and flagstones becoming nearly white. A report of a municipal committee is quoted from, giving some figures, as also a reply from Mr. Hermite, in which he states that the supply was not sufficient, as there should be 20 litres per inhabitant at 0.25 gramme of chlorine per litre; he guarantees one kilogramme of chlorine per hour for 12 h. p., equivalent to 48 cubic metres of disinfectant per day at double the above strength.

Chaliliez Accumulator.—"La Lum. Elec.," Feb. 3, gives a description of this accumulator as used in the station at Montmedy; the description is not sufficiently clear to be understood without an illustration, but the accumulator seems to differ from the general type.

MISCELLANEOUS.

Lightning Rods.—In an article by Mr. Hoho in "La Lum. Elec.," Feb. 3, he separates lightning rods into two classes: first those of Franklin and second those of Melsens, stating that the latter are unfortunately not well known. Regarding the first, he claims that it is absolutely wrong to suppose that it protects a definite zone, which, he claims, is very variable, and cannot be determined; after discussing Franklin's lightning rod, he describes that of Melsens, the principle of which is to envelop the building with a metallic network, particularly the prominent points, connecting it with the building, especially with the metallic parts, and making numerous connections with the earth; it is improved by attaching numerous needle points to it, the advantages of which have been proven by experiments. The difference between the two systems, he states, is that the first provokes lightning, while the second protects the building; the second system is not based on any hypotheses, but on perfectly well-established principles; it does not increase the probabilities of a bolt of lightning; it has no influence on neighboring buildings; it is much cheaper, a better connection with the ground is obtained and the attention it requires is next to

nothing; buildings thus protected have never been known to have been struck; the system has been adopted in the principal public buildings in Belgium, was recommended by the French Academy of Sciences, especially for powder magazines, and was also adopted by the English Navy. He states that the statistics show that the accidents caused by lightning have lately increased in a nearly geometric progression, and that the probable causes of this are the disappearance of the forests and the increased use of metals in the construction of buildings.

Cooking.—Mr. Binswanger, in the Lond. "Elec.," Feb. 9, states that the method proposed by Mr. Fessenden in the Electrical World, in which the heat losses are reduced by reflecting surfaces, is not new, as he has used it for some time; he finds practical difficulties exist, which reduce the advantages, but adds that bright and smooth surfaces should be used as much as possible in electrically-heated ovens, as the loss from the usual surfaces is so great as to make the oven practically useless; he gives the results of an experiment, and finds that 950 watts for ten minutes raised the temperature from 60° to 330° Fahrenheit when the outside was bright polished brass and the inside enameled, while 970 watts for ten minutes raised the temperature from 59° to 165° Fahrenheit when the outside was blackened and the inside ordinary sheet iron.

Electricity in the United States.—Mr. Preece's paper, mentioned in the Digest Feb. 17, is continued in the Lond. "Elec. Eng.," Feb. 2; the first part is also given in the Lond. "Elec.," Feb. 2. The telephone systems and details are described at some length, but few comparisons being made between the two countries, and few opinions being expressed; regarding trunk working, he states that it is wonderfully well done; regarding long-distance working, he states that he tested the circuits and found their working remarkably good, "it was difficult to say that it was better or worse than the working of our London-Paris line." A section is devoted to the congress, in which, however, no opinions are expressed, it being merely descriptive. In the section on the exhibition he speaks of it in glowing terms. In the section on electric lighting he states that it has not made the rapid progress during the past nine years which was expected from the very great rate of growth during the previous four years; incandescent lighting, he states, is more general in public places than it is in England, but in private houses it is not used as generally as in England; the cost of production of electric energy differs very little from that in England; it is diminishing and will certainly far exceed in economy the production of gas; the incandescent lamps are better than those in England.

Blowpipe.—The Lond. "Elec.," Feb. 9, calls attention to a description in the "Chemical News" by Mr. Warren, of a blowpipe made of a water voltameter arranged so that the electrolytic gases pass up through a couple of tubes to an oxyhydrogen blowpipe; if 50 of these in series are connected to central station mains, it is thought that the apparatus ought to maintain a long, steady flame of intense temperature.

The Electrical Industry in the United States.—A series of articles by Mr. Brunswick is begun in "La Lum. Elec.," Jan. 27, based on an official report to the French Minister of Commerce. In the first chapter the industrial conditions in France and America are discussed; the second chapter deals with the electric light.

Keely Reminiscences.—In a communication to the Lond. "Elec. Rev.," Feb. 2, Prof. Elihu Thomson describes some observations made by himself at Keely's exhibitions.

Heinrich Hertz and His Work.—"La Lum. Elec.," Feb. 3, publishes an article by Mr. Brunhes, describing Hertz's researches.

Street Railway Storage Traction.

BY J. K. PUMPELTY.

Mr. Albert Stetson, in his paper read before the American Institute of Electrical Engineers on the practicability of electric conduit railways, makes some very surprising criticisms on the use of storage batteries for electric roads, which, although true to a certain extent, are in the main unjust. When he states that the experiments of "the Electric Power Storage Company in England and those of the Julien company in this country exhaust the possibilities, under commercial conditions, and that we have seen no better batteries than theirs," the criticism is far too broad. Mr. Stetson may be right in his opinion as to general commercial results, but the same might well be said of cable traction in many cities, where the commercial conditions are such that no dividends have been paid, but still not prove that large ones are not paid on some cable roads.

Under the improvements of these later days made on the old Plante process accumulators have been put to practical work in several instances and to such a successful purpose that the old Faure process of applied oxides, such as used in the systems cited by Mr. Stetson, must be relegated to a past age. It is pretty well known by men who have studied the subject undoubtedly quite as much as Mr. Stetson, that there are now on the market more efficient and more desirable storage batteries than any referred to by him in his paper. A battery, properly formed on the improved Plante process, in which the plates or electrodes are made of rolled lead integral in all its parts, with no joints or soldering, is so efficient and so evenly balanced in its electrochemical action that large discharges, even to 100 amperes from a 38-pound battery, can be sustained for some time in practical work; that is, 198 watts can be drawn from such cells for 25 minutes without any damaging effects, the batteries still performing their normal work, notwithstanding that the most economical output would be 10 per cent. of the rated capacity of the battery for 10 hours; that is, 20 ampere discharges instead of 100. Conservative battery makers to-day do not claim that storage battery traction is the ideal traction for all city railways, but that a good battery, such as above mentioned, would often fill the gap where a franchise for an electric road depends on the entire route through the city being electric traction, but forbids the use of the trolley along the crowded streets. Conserved and condensed energy in convenient or transportable form has certain advantages, such as compressed air or gas; at the same time the loss in conversion counts heavily against this method. Even coal, with all its possibilities of latent energy, is subject to tremendous loss in conversion to useful kinetic force. Thus, notwithstanding the horsepower energy of 1,200,000 foot pounds in one small storage battery may only equal the stored energy in 1 1-2 ounces of coal, it would be a very inconvenient matter to carry about a boiler and engine, however small, with water sufficient to generate the steam to produce this 1,200,000 foot pounds of energy. Stored energy in an accumulator, or rather converted energy, has advantages over other forms of portable energy, in that we can obtain from it light and kinetic force at the same time. As for the great weight of the battery, much depends in this respect on the work to be performed and the length of time allowed for doing it. This weight can be adapted to the length of the trip and the convenience of charging. However, this is hardly a point to be argued; it has all been tried in many ways, and found to have many objections, the principal one being weakness of the battery plates. As Mr. Stetson puts it in commercial parlance, "It don't pay," unless, as I have said before, there is no other way to carry out an electric road franchise. The writer does not care to wave the red flag before the eyes of the enraged

investors who have lost money by attempting the use of storage batteries on short roads, or of apologizing for what they have not done. Unfortunately, thus far, most money has been spent and lost in experimenting with the weakest form of batteries, in this country, at least. I could hardly say this had I not been constantly at work for six years in making storage batteries, in improving them and trying to overcome weak points in their mechanical and chemical construction. To return to the subject referred to above—the possibility of using the accumulator when the demand of the city authorities is for an electric road, the trolley wire being allowed to within a certain distance of the centre of city traffic, but denied in the more crowded streets—what were best to be done in such a case, since digging up of streets for sub-conduits is also assumed impossible? Cannot accumulators be made useful and commercial by so arranging the system that cars could leave the trolley wire at the outside of the city, and by the aid of storage batteries continue the trip through the city, around the loop and back to the trolley, when the connection with the battery car would put them in a position to be charged from the trolley wire? This, I think, could be done by using locomotive cars to carry the batteries and act as haulers of the passenger cars as trailers. To do this, 200 batteries placed on a short, compact car, half the length of the present grip car and carrying a 25 or 30 h. p. motor, could not only be charged from the 500-volt current through proper resistance on each car, but would drive the 500-volt motor after leaving the main wire with sufficiently reduced speed to suit the demands in the crowded streets. One motor could be on the locomotive car, or a motor could be on each passenger car, as now, receiving its current from the battery car. In systematizing such a plan as this, the batteries need be of no greater size and weight than would be necessary to make the loop trip, say 40 minutes. A motor to do this work, driven by 400 volts from 200 batteries, once again the voltage used on battery cars would not call for a greater output of current from the batteries than they would bear, if made in the way I have before mentioned. There would be one marked advantage on the generator line; that is, the batteries would be charged from the spare current while doing their regular work on the road, and hence the dynamo and engine would have a steady load at the maximum point when consumption of coal per horse power would be the most economical. The system should be so arranged that if the estimated travel demanded 40 cars to make the full number of trips, 20 would be on the trolley all the time and 20 on the loop free from the trolley. The plan in itself is not impracticable nor lacking in economy, providing a system adapted for it is thoroughly carried out. Much would depend on the accuracy of estimated work and load and time occupied. I think the plan has never been tried, although the system of storage battery locomotives is patented.

Storage Battery Traction.

The largest installation in the world for operating street cars by accumulators is in Paris, 25 cars being now in service, and this number is to be increased to 75 in the near future. The two roads using this system extend from the Ronde-Pont de Picardie, at St. Denis, the one to the Madeleine and the other to the Opera; a third line, about three miles long, from St. Ouen to Neuilly, is also soon to be operated in the same manner.

The battery used is the chloride accumulator, which in America is manufactured by the Electric Storage Battery Company, Drexel Building, Philadelphia, Pa. The first trials date from the month of February, 1892, and electric traction has been regularly employed on a portion of the two lines outside of the city walls of Paris since June 1. Horse

cars have been entirely done away with on the Madeleine line since Oct. 1, and will soon be taken off the Opera line.

The car employed is illustrated with a trailer attached and has a capacity for 50 passengers. The speed, with full car, is seven and a half miles per hour, or of ten miles an hour outside of Paris, and a minimum rate of three and three-quarter miles on the heaviest grades, which are about 4 per cent. The company has the right of attaching another car, is seven and a half miles per hour, or ten miles an hour at least sixty-five miles. Finally, the weight of the accumulators, including all accessories, does not exceed 6,000 pounds.

A motor is attached to each axle by double reduction gear wheels, the ratio between motor and axle being twelve to one. The gears are in an iron casing, the first pair completely immersed in oil. The electric motors are bipolar, of the Manchester type, with Gramme armature, series wound. The brushes are four carbon blocks. Each motor will develop, with a speed of 1,350, a power of 10,000 watts, with a difference of potential of 200 volts. Under these conditions the efficiency between motor and axle is 73 per cent.

The accumulators, as remarked before, are of the chloride type, manufactured by the Societe pour le Travail Electrique des Metaux, in France, and the Electric Storage Battery Company, in Philadelphia, and are placed under the seats of the car. There are one hundred and eight elements of eleven plates each contained in hard rubber boxes. The plates are seven and three-quarters inches by seven and three-quarters inches by a quarter-inch thick. The weight of an element is thirty-eight and a half pounds. These one hundred and eight batteries are divided into twelve groups of nine batteries each, contained in twelve wooden boxes, six on each side of the car, the batteries of each group being connected in series, and the two terminals attached to copper strips fastened to one of the partitions of the wooden box. The sets of accumulators are charged in parallel, with a constant electromotive force of 260 volts, and are left charging until they have absorbed a number of ampere hours, equal to that which they have rendered in service, plus an increase, on a basis of 85 per cent. efficiency. The number of ampere hours required to operate each line has been experimentally determined by means of a registering ammeter placed on a trial car. The duration of the charge is six hours for a battery which has furnished all its capacity of 230 ampere hours, or 52 h. p. hours. The yield in energy of the batteries is as high as 70 per cent., the batteries in service, with an electromotive force of upward of 200 volts, giving a discharge which on grades reaches 70 amperes, or nearly two amperes per pound of element. The average output on the level is about 35 amperes, which increases to 55 amperes on grades of 2 1-2 per cent. One charge of the batteries will run the car about forty miles on grooved rails and about seventy-five miles on ordinary T rails. In order to operate the car at the various speeds required in service the coupling of the cells of battery is changeable. In the car the batteries are divided into four parts or sub-batteries, each of 27 cells in series, which give, on closed circuit, about 50 volts. By means of a regulating switch, placed at the disposition of the driver, the three following couplings of batteries may be obtained: First, the four sub-batteries in parallel—E. M. F.—50 volts; second, two sub-batteries in series, two in parallel—E. M. F.—100 volts; third, four sub-batteries in series—E. M. F.—200 volts.

The speed of car is doubled in passing from one coupling to the other. The motors of the car are usually connected in series, but, by means of a switch, may be placed in parallel when greater speed or power is required, although this last combination is seldom used. This second switch also reverses the direction of running of the car by reversing the current in motor armatures, and by it also a motor may be cut out of service in case of damage by short circuiting it on the series combination. A single motor is sufficient to

run the car with a slightly reduced speed. The switch for altering the coupling of the sub-batteries consists of a barrel of non-conducting material, carrying three sets of copper strips, corresponding to the three couplings or combinations of the batteries. These strips become connected when the barrel is revolved on its axis between the metallic brushes, communicating with the sub-batteries. In passing from one position to another the current is broken before the strips are released from between the brushes, the break being made on special strips supplied with blocks of carbon, so arranged as to be easily replaced. The rapid deterioration of the metallic strips by sparking is thus avoided. The barrel is revolved by means of a lever. The switch or regulator which changes the couplings of the motors is composed of three commutators, operated by separate cranks, which are so interlocked that they cannot be operated except when the current is broken by the battery switch.

The daily service of the Madeleine route consists of 104 trips, or 52 round trips. Seven cars are operated on this line, some making eight and others nine trips, about 92 and 103 miles, while horse cars make not much more than 60 miles. Each car is operated with two sets of batteries, making from four to six consecutive trips, 46 to 69 miles, without recharge. The running time between terminals is fifty-five



STORAGE BATTERY CAR.

minutes, including stops. The weight of a full car is about 29,000 pounds, of which 5,700 pounds are for the batteries and their accessories and 7,700 pounds for the passengers. The mean tractile force is about 26 1-2 pounds per ton. The average results of operation on the Madeleine line for October, November and December, 1892, per car mile, are as follows, reduced to a basis of pounds of coal: Ampere hours, charged, 6.2 pounds; horse power hours, generated, 2.2 pounds; coal consumed, 9.2 pounds. The averages for a whole year would be lower, as the average for the three months considered is relatively high in consequence of the heavy condition of the road, due to mud, snow and ice. The service has been very regular and the receipts per car mile have increased to a marked degree. The favor of the public has been instantly won by the new, comfortable cars lighted by electricity. Encouraged by the good results obtained, the street car company has determined to introduce storage battery traction on all their lines. On the new cars which are to be built a system of regulation is to be employed whereby, in stopping the cars and in running down grades, the motors will become generators, and a portion of the energy previously given out by the accumulators restored.

The Leonard System of Control for Electric Elevators

Elevators operated on the Leonard system have now been running for over two years without, it is claimed, any failure in the service, any expense for repairs, or the necessity of any attention beyond the oiling of the bearings. The Leonard system of control of electric motors differs essentially from other methods in that the regulation is effected entirely by varying the strength and direction of the current applied to the field of the generator, and not in the motor itself. In a well designed generator of moderate size the current of the field is perhaps one and one-half to two per cent. of its total output, so that the current varied is extremely small, and consequently the control is very small and sparkless. The system is applicable to any electric motor made without alterations. Another point of advantage claimed for this system is that the speed of the motor is practically independent of the load, or, in other words, that there is at command an infinite number of automatic speeds. A motor running slowly under only frictional loss can pick up its full load without slowing down appreciably, and when running slowly under full load its speed is not materially affected if the entire load is removed instantly. It is also

claimed that the motor can be reversed when running under full load and the load quickly and smoothly retarded and then accelerated in the opposite direction without jar or sparking.

In the ordinary method of control by placing a rheostat in the path of the entire current more or less sparking at the contacts is inevitable, but in the Leonard system there are no contacts, except at the brushes and on the controller of the car. A flexible cable of No. 16 B. & S. gauge can be used between the motor and the controller, and in the case of an elevator constructed

for handling 2,000 pounds the current carried by the cable for ordinary speeds is less than one ampere and sparking entirely avoided.

No mechanical brake is required for this system, as the retardation of the load is accomplished by causing the motor to become a generator, which feeds back current to the system. This not only saves the loss in friction of the ordinary mechanical brake, but is an actual gain. Another important point in the Leonard system is that the current drawn from the supply system in starting the elevator is the least used instead of being the maximum, as in the case of the ordinary system, and the current is gradually and automatically increased in proportion to the speed of the elevator, so that the most perfect efficiency is realized even at the lowest speed.

The system is very simple, as there are no rheostats, dash pots, solenoids, indicators, mechanical brakes, automatic switches, pilot motors, or other similar devices. Among the companies licensed to use the Leonard system are Otis Brothers & Co., Crane Brothers, Hale & Co., Stokes & Parrish and the Whittier Machine Company, all well-known manufacturers of elevators.

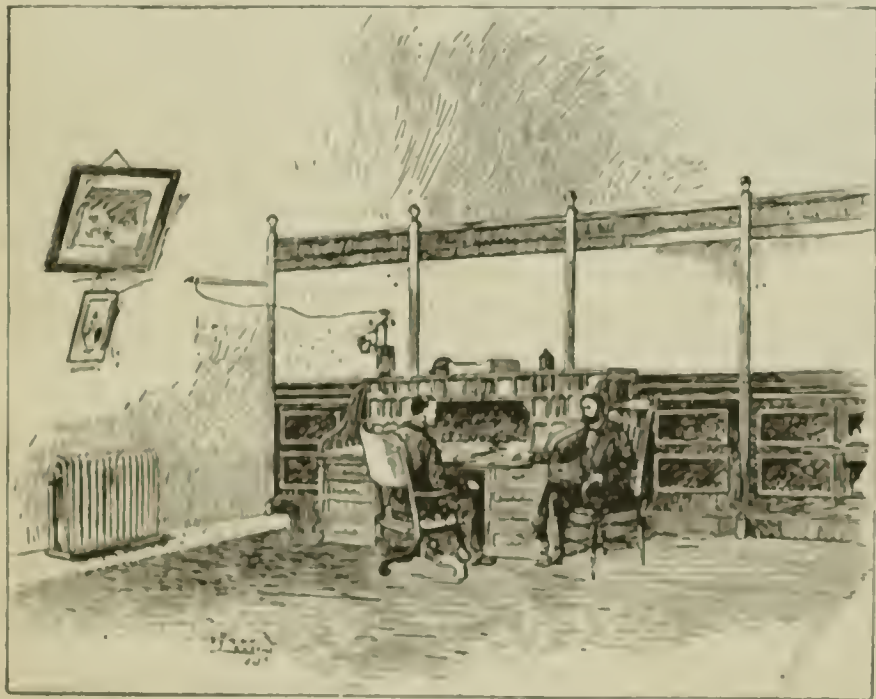
The Metropolitan Electric Company.

In its new quarters at 186-188 Fifth avenue, Chicago, Ill., the Metropolitan Electric Company now possesses every advantage for carrying on its large and growing business. In the face of the financial distress of the past year this company, under the able management of Mr. W. H. McKinlock, president, and Mr. Walter C. McKinlock, secretary, made such progress that it entirely outgrew its old quarters and was obliged to seek new quarters where it could have the advantages of combined offices, salesrooms, storeroom and



GENERAL OFFICES.

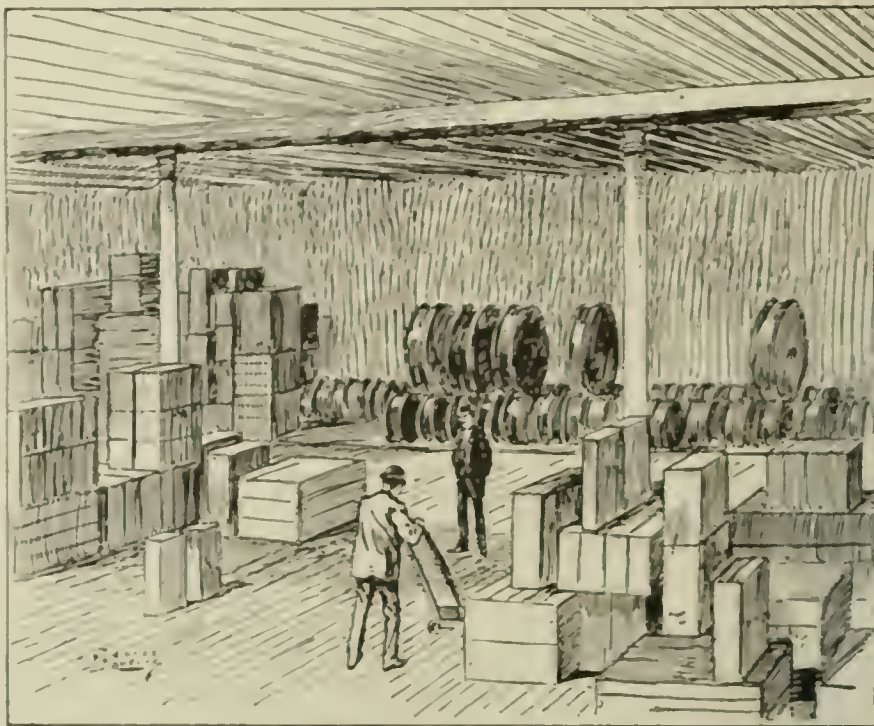
shipping department, and about the first of the year it settled in the large store at the above address. The accompanying illustrations will show how well fitted its new quarters are for the conduct of its business. On the ground floor, which consists of a room 50 feet by 150 feet, are the general offices, private offices of the president, the cashier's and stenographers' department, and shipping room and sales department. The front of the store is mostly of glass, which gives plenty of light on every part of the floor. As there is no partition between the salesroom and the shipping room,



PRESIDENT'S OFFICE.

the salesman is always able to have personal supervision of the packing of goods. A basement under the salesroom, 50x110 feet in dimensions, is used as a storeroom, extending out under the sidewalk and affording ample room for the storage of inflammable material in accordance with the underwriters' rules. Here the N. I. R. insulated wires and cables, P. & B. compounds, incandescent lamps and various other supplies which this company handles may be seen in large quantities. The Metropolitan company is the general Western agent for the National India rubber wire, which is

now made in all lines of insulated wires and cables, including telephone twin wire, lamp cord, electrolite wire, rubber tubing and concentric wire, as well as the more familiar forms. The Metropolitan incandescent lamp, which has been recently placed before the public, is claimed to possess unusual merits and is manufactured in all the standard candle powers. The well-known "Mac" tape is also handled by this company,



BASEMENT.

and the Paiste specialties, as well as the Standard Paint Company's P. & B. compounds, occupy a prominent place in this list. The Metropolitan transformer is a new piece of apparatus, which the company expects to place upon the market immediately, and which no doubt will meet with success.

The Metropolitan company has been fortunate in securing as manager Mr. J. J. Nate, whose long experience in the tele-



STORE ROOM.

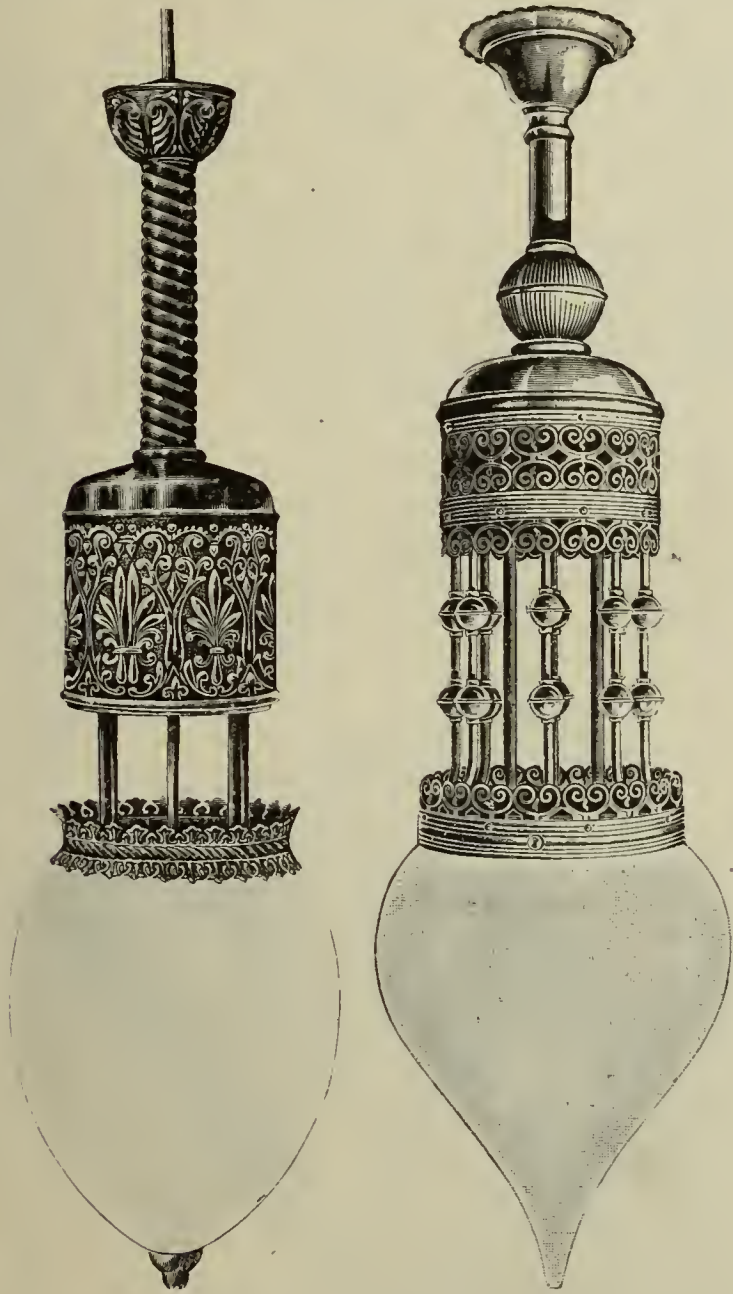
phone business and whose personal qualities render him particularly well qualified to fill this position.

A Loss to England.

We are informed that Mr. Gisbert Kapp, who has done such good work in England during the last twelve years, has accepted an appointment with the "Verband Deutscher Electrotechniker" in Berlin.

Ornamental Arc Lamps.

The arc lamps illustrated herewith, manufactured by the Clark Electric Company, 192 Broadway, New York, can be used with the high tension arc current or on low tension incandescent or alternating circuits. For alternating work especial claims are made. No extra appliances are required to be attached for this use, and the arcs do not make the "singing" or disagreeable noise generally associated with alternating arc lamps. This is a most important feature and weight is given to the claims by the great number of these lamps now employed for interior lighting with the most satisfactory results to the users. This, with the steady white light given by the Clark lamps and the entire absence of hissing, have given it an enviable reputation. In addition to the ornamental types illustrated the same company makes a



ORNAMENTAL ARC LAMPS.

lamp for exterior illumination that contains the same features as those illustrated, and is so constructed as to require no hood.

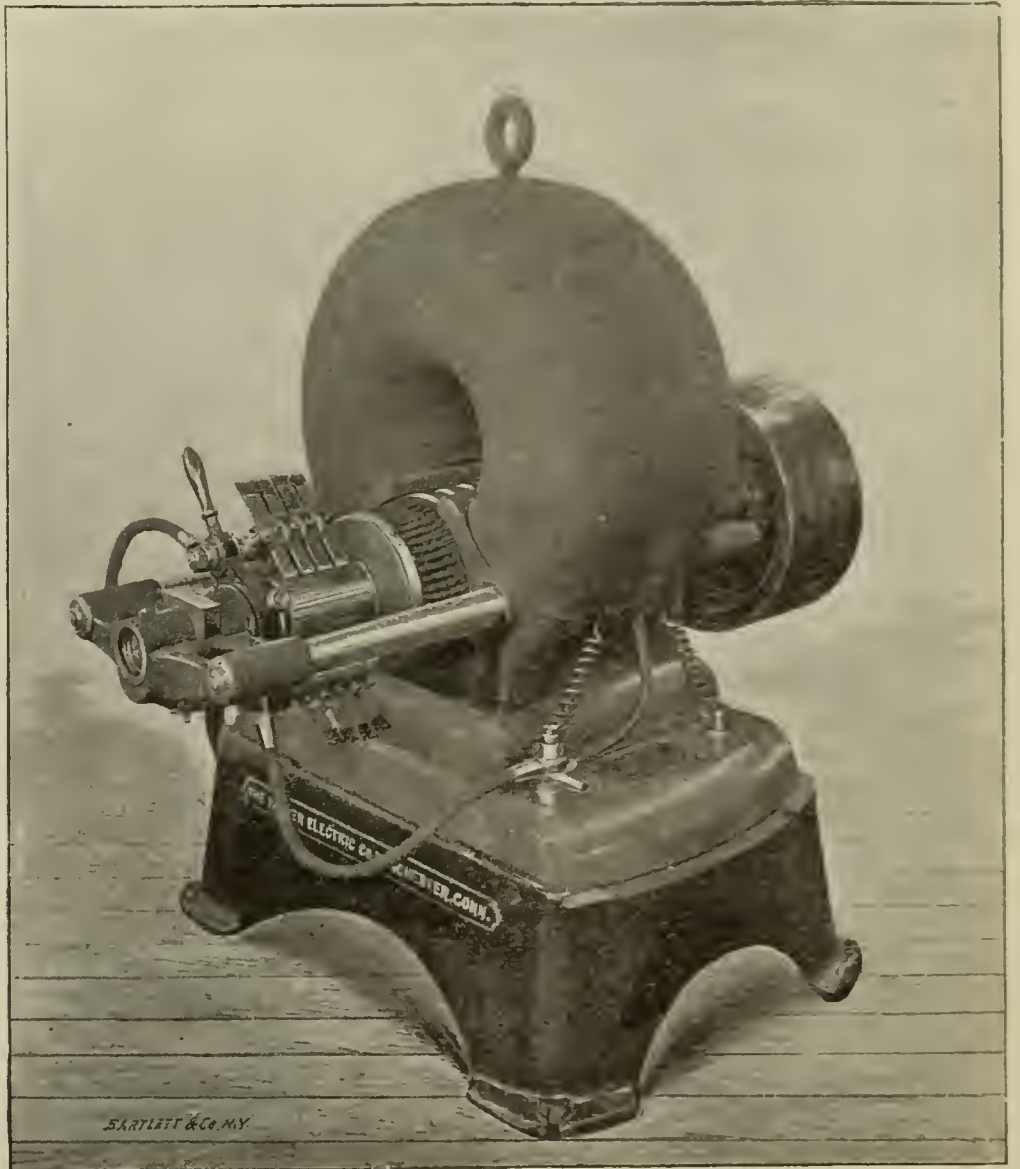
New Mather Dynamo.

A new form of dynamo shown in the accompanying illustration has recently been placed upon the market by the Mather Electric Company, Manchester, Conn. The Mather type of machine has long been familiar to the electrical public, but this latest addition to the Mather generators possesses some new features which add to its efficiency and value. The field of this machine is made of cast steel, thus reducing its size and weight and increasing its permeability. Another important feature is the new self-oiling bearing, which is also provided with a device which shows at any moment just how much oil the bearing contains. The other details of this dynamo are similar to those of its predecessors.

One of the claims of the Mather company is that the fields of their machines, being closely wound, are much less likely to burn out or be injured than those of the ordinary type. The workmanship, mechanical and electrical efficiency of these generators is of the highest. The machine shown in the illustration has a capacity of 31 kw., or between 450 and 500 incandescent lights.

Voltmeters for Direct and Alternating Circuits.

The Cardew, Ayrton and other "hot water" voltmeters in which the expansion of the heated conductor records or indicates its amount by means of an index moving over a suitably graduated scale, have been largely used in commercial work, the former being for a number of years the only direct reading instrument capable of measuring alternating current and E. M. F. Such an instrument if standardized in any way for direct current measurements, will give exactly the same re-



NEW MATHER DYNAMO.

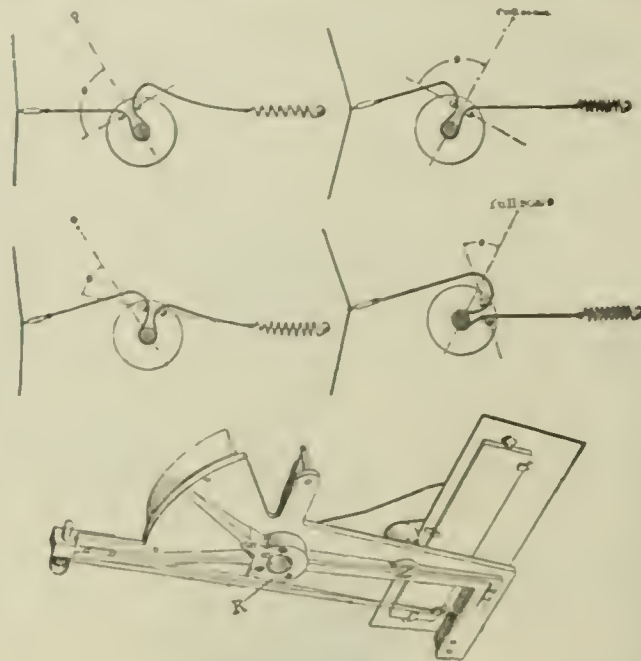
sults when used on an alternating circuit, provided, of course, the circuit be wound non-inductively, since in either case the heating is proportional to the mean square of the current flow without other factors entering. Such an instrument, furthermore, can have no magnetic lag nor can it be influenced by neighboring magnetic fields or circuits, since the magnetic quality of its circuit has no part in the operation of the instrument.

Messrs. Queen & Co., of Philadelphia, commenced two years ago, through their electrician, Mr. Willyoung, a thorough study of "hot-wire" instruments with the object of developing a complete series of voltmeters, which is now practically complete, and includes portable and laboratory instruments of all ranges from 1 to 3,000 volts, both single and double scale; switchboard voltmeters for isolated plants and central stations, with or without illuminated dials, and recording voltmeters of marked advance over existing types. All of these instruments are direct reading on either

direct or alternating circuits of any frequency, and are dead beat in action. The entire line of "hot-wire" instruments has been designated the "Acme" series, a name already associated with Queen & Co.'s specialties, such as testing sets and microscopes.

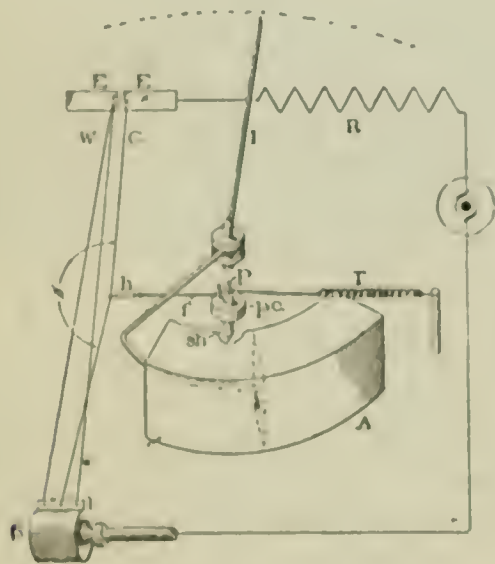
Fig. 1 illustrates, diagrammatically, the essential working parts of the instrument. The "hot" or working wire, C , extends from a fixed support, E , to a spirally wound phosphor bronze spring, S . Midway of its length it is connected to the extremity of a phosphor bronze filament or strip f which passes around the index shaft sh , engaging as it goes with two small pins p ; the other extremity of the filament f is attached to a spiral "take-up" spring T , whose outer end is fixed. It is obvious that for a very small linear expansion of the working wire C there will be caused a many times magnified movement of the middle point in line of the filament f , which movement being taken up by T results in the carrying of the index I over the scale. The wires W are two or more in number, each of the same or nearly the same cross-section as C and attached at one end to the fixed plate E' similar to E but insulated from it, and at the other end to the spring S , to which it is attached. These wires, not carrying any current, serve to restrain S from taking up the expansion of C when current is passing, but being affected by general changes of temperature, such as room temperature, etc., to the same degree as C , let out S just enough for such changes to take up the linear expansion of C , due to the same changes, thus preventing any change of zero of the pointer for varying temperatures. It should also be observed that this compensation is effected instantly, no matter how varied the changes of temperature, since the wires W are of the same, or nearly the same, cross-section as C . In the "Acme" instruments absolutely no variation in reading can be detected whether the current be on for a second, a moment, or an hour, and the readings going to any point from zero are exactly the same as when dropping to the same current value from a higher one. The spiral spring S is used in preference to an elongated spring, on account of the fact that in an instrument in which the forces involved

The filament f is attached to the wire C by means of a minute glass connector, h , provided at each end with equally minute hooks of platinum wire. The purpose of this glass connector is to interpose between the wire C and the filament f an effective insulation, thus avoiding any risk of accidental short circuits in other portions of the instrument. The platinum hook which engages with the wire C is fixed in position by a special cement studied out for the purpose and which but holds more firmly the more it is heated.



FIGS. 2, 3 AND 4.

An important function in this instrument is performed by the filament f and the collar $p c$, with its pins, p , which arrangement was devised to secure a fairly uniform scale



FIGS. 1 AND 5.—ACME "HOT WIRE" VOLTMETER.

are so small as in the "Acme" the effect of gravity upon a long spring would be considerable and would cause the readings to be less or greater, according as the spring were lower or higher than the other end of the wires, and small changes of level would, therefore, have to be guarded against. Upon the form of spring used gravity has no effect, and the readings are therefore not appreciably affected by very considerable differences of level; this freedom from level error is greatly assisted by the fact that the index is very exactly made and balanced so as to have its centre of gravity in its axis.

throughout the whole range of the instrument, so that readings at a low point of the scale can be made with not greatly larger errors of reading than at high, and it performs its duty admirably. The manner of its operation may best be seen by inspection of Fig. 2, a and b , and Fig. 3, a and b , which represent enlarged diagrammatic views of the arrangement at zero and full scale deflection for two different positions of the collar $p c$ with reference to the pinion sh . The collar, $p c$, carrying the two pins p , it must be understood, can be set upon the pinion sh so that the angle between the pins p , and the pointer may be made anything desired. Referring

now to Fig. 2, *a*, we see that the collar *p c* has been so set as to make $\Phi = 90^\circ$. This causes the bend in the left-hand side of the filament to be very little at the zero point, and hence the effective radius of action of this part of the filament upon the shaft *s h* to be very short; a very small movement of the working wire is, therefore, considerably magnified by the index. At this position *b*, of the same figure, however, the bend in the filament has become great and the effective lever arm long. Consequently the scale divisions, which would be proportional to C^2 did the filament simply wrap about a cylindrical shaft, are greatly shortened, and the general tendency of the whole is to even up the scale throughout its entire range. Fig. 3, *a* and *b*, shows the character of the filament bends for $\Phi = 45^\circ$; here the early divisions are closed more, the result being a scale somewhat crowded at each extremity and most open in the middle. By using other values Φ the scale may be made to vary in still different ways. In practice a value of $\Phi = 135^\circ$ has given the best results, the scales so produced opening more and more from the beginning to the end of the scale, but not nearly so rapidly as if the C^2R law only were operative. The filament *f* is of tempered phosphor bronze, rolled flat from a wire 0.0015 inch in diameter. After rolling it is subjected to a careful course of treatment in order to age it and provide against changes of elasticity taking place with time.

To avoid any trouble from the instrument changing its reading or its zero when the containing case becomes strained mechanically in any way, either through handling or by the expansion and contraction coincident with general changes of temperature, the entire operative structure of the "Acme" instrument is supported upon a ribbed and very strong aluminium casting, which is itself attached to the containing case at but one point, shown clearly in Fig. 4.

As shown in Fig. 1, the "working" portion of the instrument is the wire *C*. This wire is about 0.0012 inch in diameter and 6 1-2 inches long; it is drawn from a special alloy of high specific resistance and great tensile strength, and is practically non-oxidizable. It requires to be heated to 150°C . to carry the index *I* over the whole scale, and this is effected with 7.5 volts and 1-15 ampere. This wire does not change its resistance for change of temperature, so that to make the instrument applicable to any range of E. M. F. desired, it is only necessary to employ a suitable amount of extra resistance of the same alloy in the shape of a multiplier. To avoid any error being produced by heat radiated from this extra resistance upon the working wire, the former is thoroughly partitioned off and arranged so that its heat radiation takes place to the external atmosphere.

Fig. 5 shows one of the perfected forms of this voltmeter, being the style intended for inspectors, engineers and others having accurate testing to do in various places. An extra resistance is supplied wound (for all ranges above 75 volts) in sections, in coil form and non-inductively, of double covered silk wire thoroughly soaked and baked in shellac. No two neighboring wires can have, therefore, more than 75 volts difference of E. M. F. In order to use as fine a wire for this extra resistance as possible and thus diminish bulk and weight, the extra resistance coil is clamped between two aluminium plates made part of the lid of the instrument, as shown in Fig. 5, a pair of small flexible leads connecting it with the working wire. Another form of this instrument has been designed for laboratory use and for those engineers who prefer an instrument without a hinged lid. In this form the extra resistance is contained in a metal box located between the binding posts and contact key. By means of a switch a portion of the resistance may be cut out and a reading thus obtained for any desired fraction of the indicated voltage, the instrument lending itself readily to this "double scale" arrangement.

Instruments of the form illustrated are not adapted for

higher E. M. Fs. than 600 volts, owing to the impossibility of securing in such small compass sufficient insulation and heat radiating surface for greater potentials. Accordingly a separate series of boxes has been designed to contain the extra resistance when high range instruments are desired and the scale of the instrument is made to indicate the E. M. F. actually at its own terminals. When the separate extra resistance is put in series with the instrument, then scale readings must be multiplied by some factor, depending, of course, upon the amount of multiplying resistance used.

A special plug has been devised equally applicable to the Edison, Thomson-Houston or Westinghouse sockets, so that the Acme instruments can be readily connected to incandescent lamp circuits for resting purposes.

Referring again to Fig. 1, the pointer carries a dasher which moves in an air chamber or dash pot, *A*. This makes the instrument extremely dead beat in its action, the pointer not swinging more than a small fraction of an inch beyond its proper position even when the maximum potential is thrown on. Consequently, accurate readings can be taken on railway and other circuits where the voltage changes rapidly. The extreme sensibility of the instrument to the most minute changes of current is obtained partly by the use of the very fine working wire (0.0012 inch in diameter, as previously mentioned), thus causing the temperature of the wire to change instantly for a change of current and partly by the great care taken to secure accurately pointed and polished pivots and correctly shaped and constructed bearings. These bearings are of selected sapphire cut to a carefully determined curve and very highly polished. In the "Acme" instruments the strains upon the working wire are extremely small as compared with the strains which the instrument can stand. Thus, the entire movable system, including, of course, the dasher, weighs but 6.25 grains, being made of hard drawn or rolled aluminium. The tensile strain produced in the wire by the take-up spring *T* is only 15 grammes at a maximum, whereas a tensile strain of 120 grammes is required to break the wire.

Owing principally to the fact that the elasticity of the take-up spring *T* of Fig. 1 changes necessarily with changes of the temperature, the instrument has a temperature correction. This correction is exceedingly small, and is not a percentage correction, but a constant for each instrument: approximately 2-10 volt for each 5°F in a 100-volt instrument and correspondingly greater or less in higher or lower range instruments. This constant must be added to the readings for a rise of temperature and subtracted for a fall of temperature. A thermometer graduated from 30° to 100°F is placed above the contact key, as shown in Fig. 5, so that this correction can be quickly applied. As to accuracy, it is claimed by the makers that results can be obtained with this instrument well within 1-4 of 1 per cent. on either direct or alternating currents of any frequency, and this, on alternating circuits, much more quickly than with any other instrument known. No difference can be detected reading up or down the scale, nor is the voltmeter affected by magnetic fields or heavy currents in its vicinity.

An Automatic Electric Light Switch.

The Secrist automatic switch we illustrate, manufactured for the Central Electric Company, Chicago, is especially adapted for controlling incandescent lights in private residences. In that capacity alone it gives a great range of possibilities for convenience and comfort, besides being adapted for a number of other uses, among which are the controlling of electric bells, lights for railway signaling, etc. By means of this device a person may have absolute control of any or all of the lights in the house from any part of the house. A person in moving about a house in any direction, by means of

it, is always able to turn on the light ahead and at the same time turn off the lights from that part of the house which he has just left. Coming home at night, he presses a button outside, which turns on the porch light, enabling him to readily unlock the front door. Immediately on opening the door, the hall, parlor, library or dining room lights may be turned on or off, and the system can in the same manner be indefinitely extended.

The mechanism of the switch is shown in Fig. 1, being simply a locking and releasing device, operated by means of two electromagnets and enclosed by a neat case, not shown. There are no adjusting screws or complicated parts to get out of order. The electric circuit is attached to the switch the same as to any common switch, while the wires from the

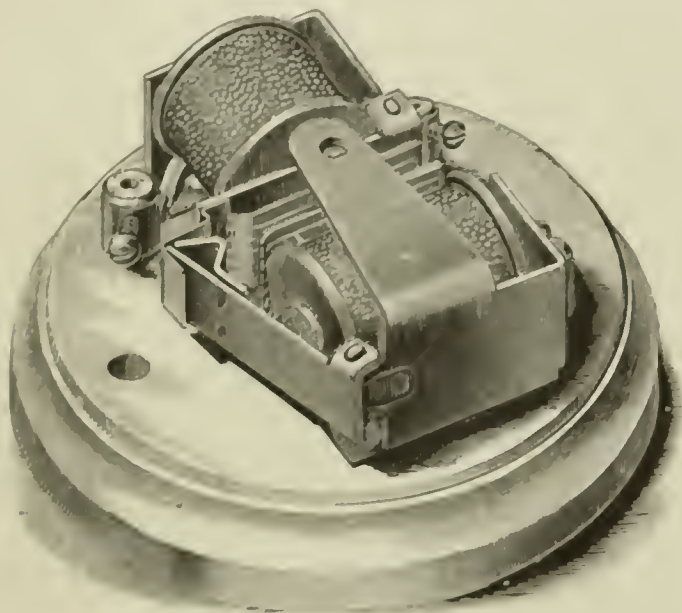


FIG. 1.—AUTOMATIC LIGHTING SWITCH.

magnet spools, which are common bell wires, run to the different push buttons from where the switch is to be controlled. The switch may be operated either by an ordinary battery or by means of the electric light current.

The method of running the wires and connecting them to the automatic switch may be readily understood by referring in Fig. 2, where *A* represents the back of switch; *B*, a group of lights controlled; *S*, an ordinary switch loop con-

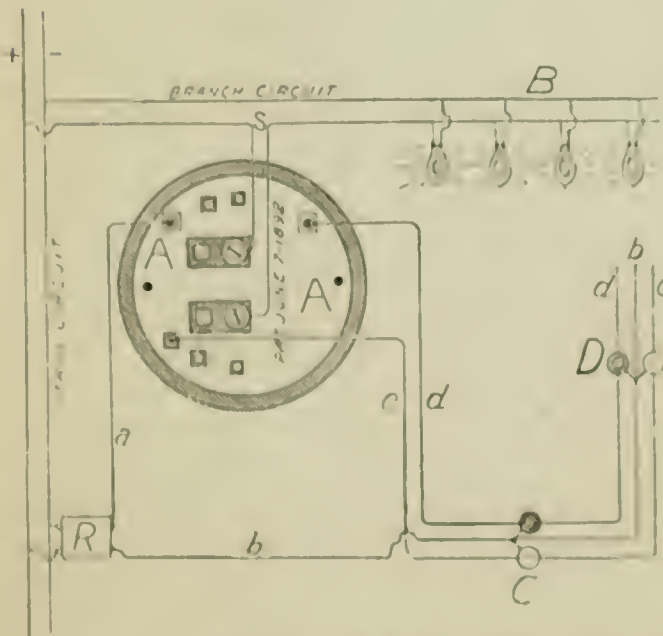


FIG. 2.—AUTOMATIC LIGHTING SWITCH.

nected to the switch; *a b* are wires supplying the reduced current to operate the switch; *b, c, d* are ordinary bell wires, which run to the different push buttons from where it is desired to control the lights. *C D* are two sets of buttons similar to those used in electric gas lighting, and controlling the automatic switch *A A*. It is evident that any number of push buttons may be connected to the wires *b, c* and *d*. One resistance box for reducing the strength of the electric

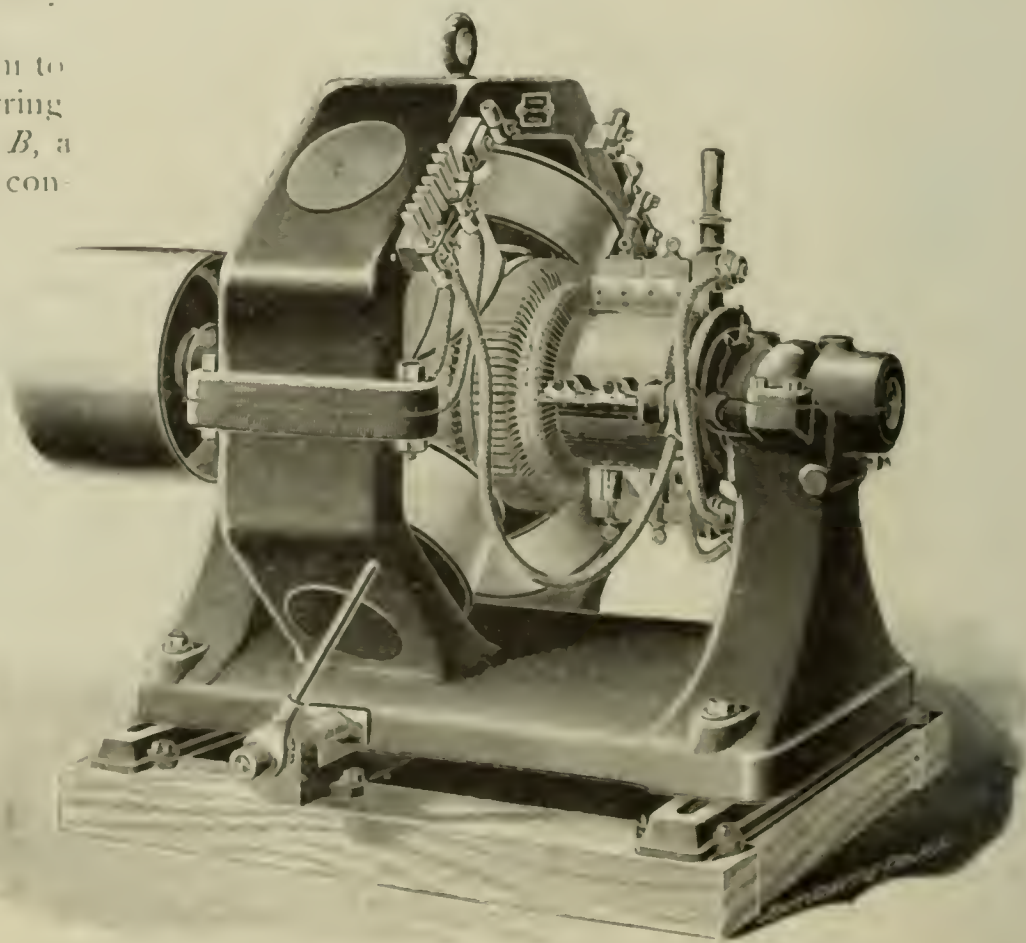
light current operating the switch may be used to supply current for any number of automatic switches. To operate the switch by means of a battery instead of the electric light current, a battery is substituted in place of *R*.

Crocker-Wheeler Standard Multipolar Machines.

Since moving to their new works at Ampere, N. J., the Crocker-Wheeler Company has been very busy perfecting a line of larger sizes of dynamos and motors, and we have an opportunity of illustrating one of the first of these.

The detail of these motors and dynamos represents the work of their entire engineering staff the past year. As will be readily seen by the illustration, great care has been given to produce an artistic design, a solidity of construction and a close adjustment of proportions electrically within the machine.

In the multipolar type illustrated the steel magnets are turned to gauge and set into the yoke, the outer end of the holes for the fields being covered by a thin circular plate. The pillow block standards are cast in one piece with the base, and the armature is rendered accessible by removing the caps of the bearings and the upper half of the magnet frame, thus permitting of the armature being lifted vertically out of the bearings, when the upper half of the magnet frame is thus removed. The rocker arm is made in halves, held together by wing nuts, and travels upon a grooved ring attached to the pillow block standard, and slotted, the grooved ring being cut away through the upper side wide enough to permit the shaft to be lifted out. No solder is used in any part of these machines, and besides being built to stand 25 per cent. overload without undue heating, they will stand an altogether unusual degree of heating without injury.



IMPROVED MULTIPOLAR DYNAMO.

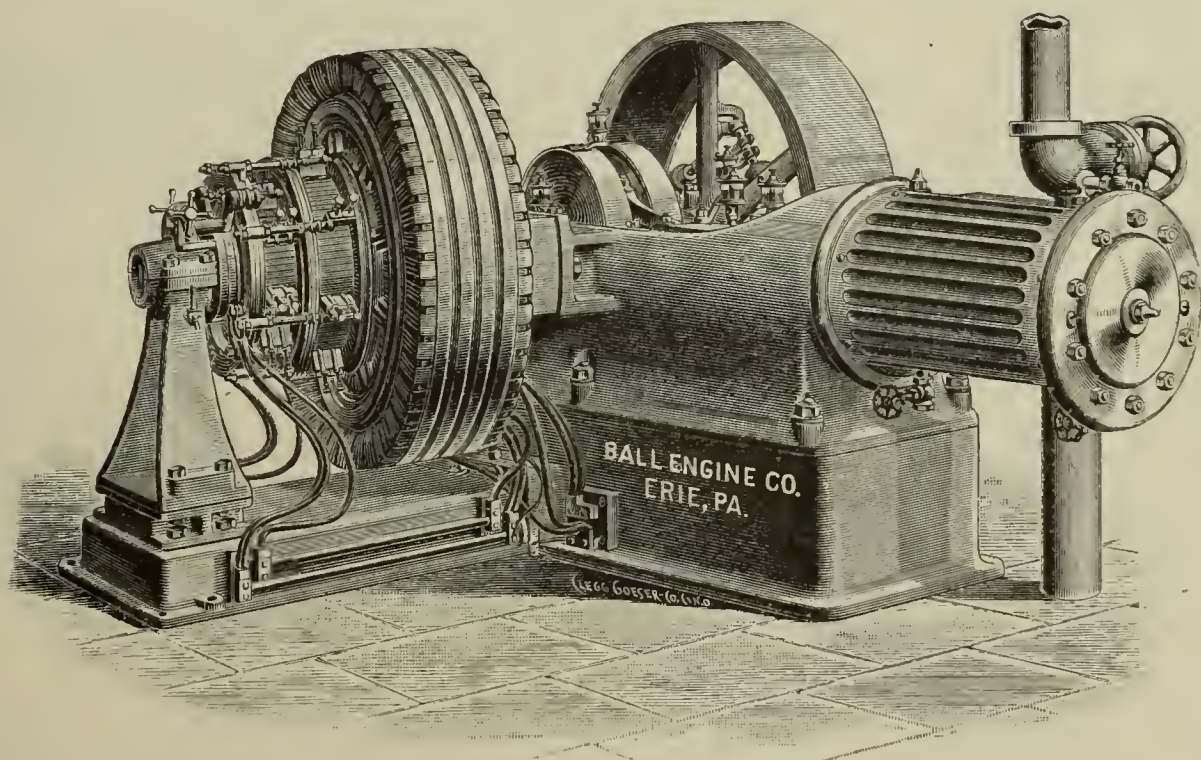
The multipolar types above 25 h. p. (20 kw.) for 110 volts have armature conductors of rectangular copper bars riveted together by means of strip copper and connectors in place of the ordinary wire windings. The armatures thus wound, although for multipolar machines, have but two circuits, and may therefore be operated with one set of brushes instead of two sets, because of the novel cross connections within the armature. The common practice in multipolar armature

winding heretofore employed renders one portion of the armature liable to short circuit the other portions if there is any inequality in the strength of the fields. This construction is an improved form on that formerly followed by the Standard Electric Company, of St. Johnsbury, Vt., of whom the Crocker-Wheeler Company is the successor in this business. This form of armature was the invention of Mr. C. S. Bradley, and was the prototype of all of the bar wound armatures now commonly made in large sizes, such as for railway generators, etc.

In the new line of standard machines being brought out by this company, besides a high efficiency, the necessary losses are evenly distributed in the various parts of the machine, so that the heat produced by these losses may be evenly distributed, and thus permit the machines to stand the greatest abuse without any one part suffering in excess. We may add as a hint that this point of distribution of the efficiency losses seems to be the direction in which to look for improvement, and is a matter about which engineers of the company are very wide awake. For the equipment of the modern industrial power plants this higher class of apparatus is particularly appreciated. One plant furnished by the Crocker-Wheeler Company already amounts to about 500 h. p. in motors alone, to which additions are being frequently made.

Direct-Connected Engines.

The progress toward ultimate perfection of electrical machinery is manifested in many ways, but in no way more clearly than in the present use of engines directly connected to dynamos. This arrangement of engine and dynamo has a two-fold advantage. The first of these is the small floor



DIRECT-CONNECTED ENGINE.

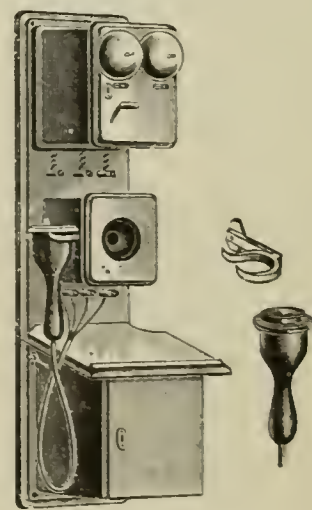
space occupied. This is an important consideration for central stations, hotels and office buildings in large cities, where there is a steadily increasing demand for economy in this direction. Another advantage is in the elimination of wastes of energy by transmission through belts and counter-shafting. With the direct connected engine the frictional losses due to outside causes entirely disappear, leaving nothing but the internal friction of the engine to be accounted for.

The accompanying illustration represents an 80-h. p. Ball engine, directly connected to a Waddell-Entz dynamo. It shows the armature mounted on the engine crank shaft, which is supported on the end by an out-board bearing resting on an extended sub-base. This is a remarkably compact, durable and efficient arrangement, and has given the greatest satisfaction in practice.

The distinctive features of this well-known engine are beauty of design, simplicity and compactness, solidity and strength of frame, large bearings and wearing surfaces, excellence of materials and workmanship. The engine, therefore, is economical and durable, and being perfectly balanced, will run quietly and smoothly under the heaviest and widest varying loads. The regulation is so perfect that the engine will not vary to exceed 1 per cent. in speed. Every detail of construction receives the most careful inspection, and every engine is thoroughly tested before shipment is made.

New Telephonic Apparatus.

Among the various telephones now offered the public, we illustrate in this issue one based on a unique principle, constructed under patents which have been granted to Mr. S. D. McKelvey, Canton, Ohio. The general appearance of this telephone is the same as the well-known form now in use, which form, however, will be modified for the purpose it is intended to be used. The illustration herewith shows a telephone intended for exchange purposes and for private lines. Mr. McKelvey has also secured letters patent on a system designed especially for use in factories, stores, hotels and other large buildings, which is so arranged that any sub-station may communicate with any other sub-station without employing a central office, and is also the patentee of an effective auxiliary telephone, which is designed to be used in connection with sub-stations. The auxiliary consists of a specially constructed chair; the back of the chair is so made that it will act as a transmitter, so that a conversation may be carried on with perfect ease while the operator is seated in the chair. The principle on which this patent operates is the vibrations produced in the body of the speaker, which



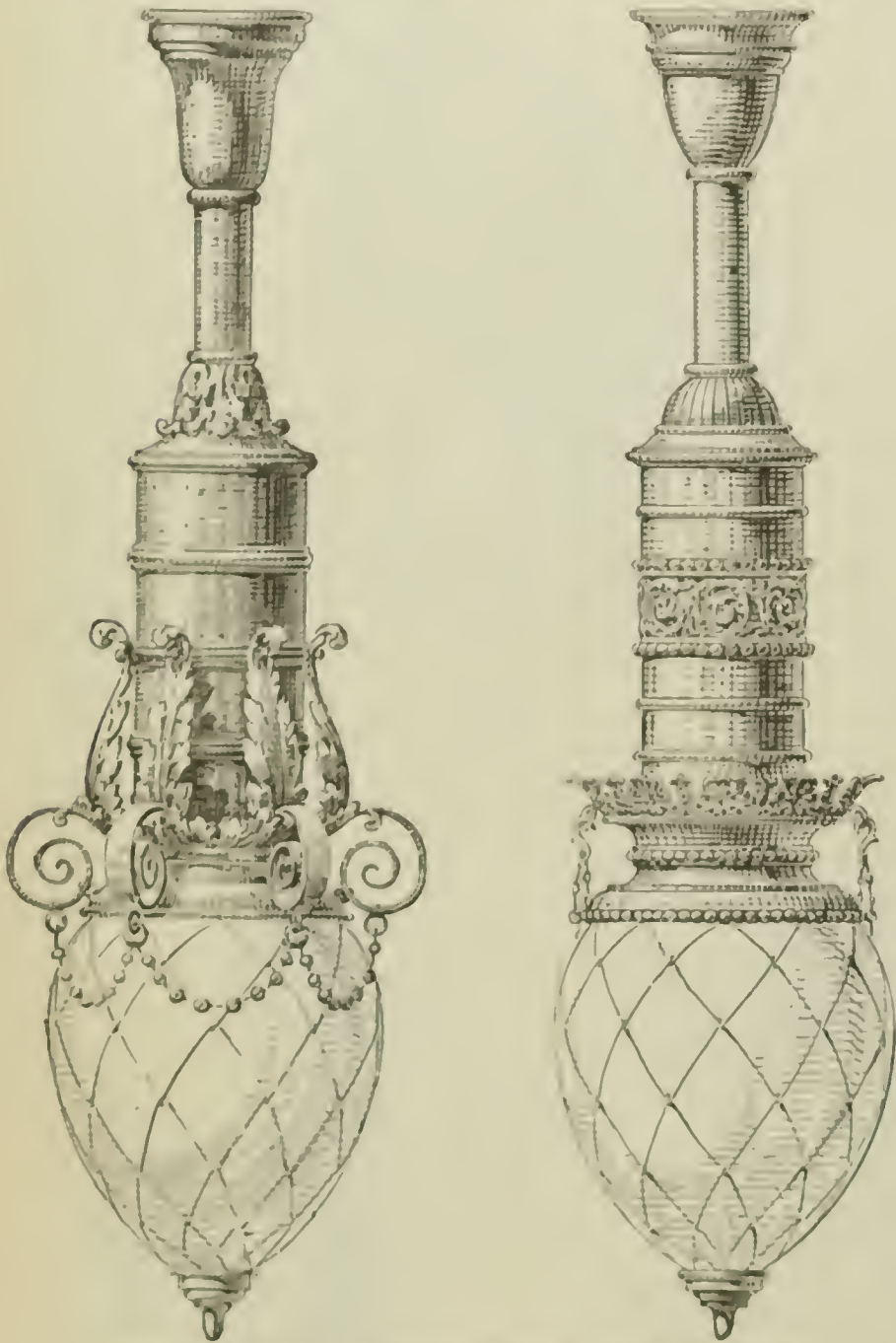
A NEW TELEPHONE.

are transmitted to the chair back, and thence over the line in the usual manner. This chair telephone is so designed that the chair will answer the purpose of an ordinary office chair. Mr. McKelvey is now making experiments with a view of putting this attachment to any ordinary chair now in use. In devising this telephone Mr. McKelvey has departed from the usual paths followed by inventors, and has proceeded along new lines, employing a bipole non-metallic diaphragm in the receiver, a compound induction coil, the tertiary coil of which is connected in series, and an amplifying magnet located immediately behind the diaphragm in the transmitter. This telephone has been successfully worked over 115 miles of telegraph wire with earth return, and it is believed that when further experiments are made that a distance much greater than this can be successfully worked.

Among the various other telephonic apparatus brought out by Mr. McKelvey is a dry battery for telephone and open circuit work, and which has been tested in all the various open circuits with the most satisfactory results. These batteries have been in use on an experimental telephone line constructed by Mr. McKelvey for the past eighteen months, and are giving the same satisfactory results to-day that they did when the line was first constructed.

A New Alternating Current Arc Lamp.

During the past year electric lighting by means of arc lamps on alternating current circuits has made marked progress, and the General Incandescent Arc Light Company, 572-578 First avenue, New York City, has recognized this fact by



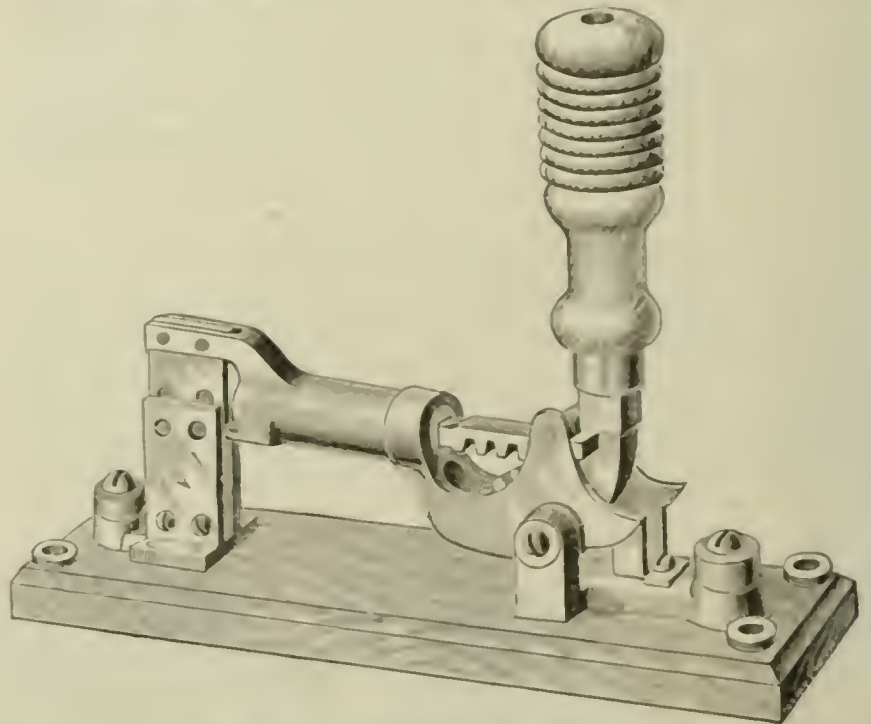
ORNAMENTAL ALTERNATING ARC LAMPS.

placing upon the market a new alternating current incandescent arc lamp of the same high standard of workmanship which has characterized its continuous current lamps. The company manufactures this new lamp in various styles and degrees of ornamentation from the plainest "standard" lamp of simple and neat design to the most elaborate creation of the metal worker's art. The accompanying illustrations give some idea of the attractive form in which these lamps have been gotten up. The General Incandescent Arc Light Company, however, does not rest its claims upon external appearance, but the operation of the lamp itself is said to be equal, if not superior, to the company's direct current lamp, which has attained such success. The lamps burn steadily, give as pleasing a light as the direct current lamp, and have given excellent satisfaction. Simplicity of mechanism, first class workmanship, absolute steadiness without adjustment, ease of trimming, protection from dust and weather, starting at less than the normal current, no

waste of current in resistance, large range of candle power and improved carbon holders are some of the claims for superiority which are made for this lamp.

Pneumatic Quick Break Switch.

The accompanying illustration of the pneumatic quick break switch, manufactured by the Ohio Brass Company, Mansfield, Ohio, shows it in normal position, when the circuit is closed. The action of the switch when opening the circuit is as follows: On drawing down the handle, a toothed segment engages with the rack shown on the end of the plunger rod, carries the plunger from the front to the rear end of the cylinder and compressing a coiled spring on the inside of it until the small projecting pieces on the movable arm strike against the shoulders on the body of the switch. The contact lips are then separated and the movable arm is drawn upward by the force of the compressed cylinder spring, giving a quick, wide break. At the mo-



PNEUMATIC QUICK BREAK SWITCH.

ment the separation is made a jet of air is thrown against the arc, if any is formed, by the forward movement of the plunger in the cylinder, making it impossible for the current to carry over. The metal parts of this switch are made of polished brass, mounted on a slate base. They are made in single, double and triple pole types, ranging in capacity from 100 amperes upward. The contact lips are separable and reversible.

New Book.

ENGLISH METHODS OF STREET RAILWAY TRACK CONSTRUCTION. By James More and Alexander McCallum. New York: Street Railway Publishing Company. 26 pages, 10 illustrations. Price, 35 cents.

This is a small pamphlet reprinted from the columns of the "Street Railway Journal," and, as indicated by the title, is on the methods of street railway track construction as carried out in Great Britain. The authors claim that in many respects English construction is superior to American, but aside from this claim, much information can be obtained from the pamphlet that will be of value to American street railway engineers.

Not Honest—On Sundays.

The editor of our bright London contemporary, "Lightning," calls attention to the fact that on Sundays the penny-in-the-slot cigarette machines will receive and keep the pennies but will not give any cigarettes in return.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, Feb. 23, 1894.

THE ELECTRICAL STOCK MARKET has made further progress towards higher quotations. In this it is but reflecting the improved condition of business, a feeling that all commercial circuits are participating in.

GENERAL ELECTRIC has been unusually strong this week. There has been any amount of bull talk on the property. It has been well known that the short interest existing for some time has been very apprehensive of late, and there is good ground for believing that a good deal of it has been scared to cover this week. There are semi-official reports that the company has paid off its floating debt, that it has numerous orders on hand, which, without any new business, is sufficient to pay the fixed charges and the preferred stock dividend and leave a 4 per cent. surplus applicable to dividends on the common stock. The Drexel-Morgan people still put in a good word for the stock, and there are indications of inside buying. The officials say the volume of business this year will be about \$20,000,000, and the dividend on the preferred stock will undoubtedly be resumed at the end of the current quarter. There is no prospect, however, of an early recuperation of dividends on the common stock. The best thing has been the strong demand for the bonds; the 5s closed to-day at 80 $\frac{1}{4}$, a rise of about 5 points for the week.

WESTINGHOUSE ELECTRIC issues continue strong. From Pittsburgh comes the report that the company will at once become a very active competitor in the direct current arc light business. The company has perfected, it is said, a generator which has very great advantages over any of the forms now in use. Its efficiency is said to be some 10 per cent. higher than the average of generators now sold. The Westinghouse company intends to establish rates for this arc lighting apparatus on a purely commercial basis, so it will, therefore, be hereafter one of the most active competitors for a class of business heretofore almost exclusively enjoyed by the General Electric Company and its allied concerns.

THE POSTAL TELEGRAPH COMPANY and the American Bell Telephone Company will, according to a just published report, enter into a deal to consolidate their interests. The proposed increase of capital by the Bell company is supposed to have a bearing on the matter. The Postal company is understood to be earning a dividend now. No details of the proposed merger are known, but it will be a combination of vast importance.

WESTERN UNION TELEGRAPH has shared in the week's strength. It continues to command inside support, and the smaller shorts have become very uneasy over the scarcity of the stock in the loan market. The Goulds are openly bullish on all their properties and Western Union will be taken care of with the rest.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES' trustees invite proposals for the sale to them of another \$110,000 of the outstanding preferred stock. The \$70,000 previously called has been cancelled, the average price being \$82.90 per share. The range of stock accepted under the first call was about 80 to 84. There were tenders as high as 110, the maximum price at which it can be purchased for cancellation. Bids of 10 are made for the common stock, one small sale at 10½ being reported.

THE BELL TELEPHONE COMPANY of Canada reports for the year ending Dec. 31, 1893, gross earnings of \$961,174, operating expenses of \$236,383 and net earnings of \$724,791. The paid up capital is only \$2,421,000, so that the net earnings equal about 30 per cent. on the capital.

THE ELECTRIC ILLUMINATING AND POWER COMPANY, of Long Island City, has been incorporated at Albany with a capital of \$50,000. The directors are H. H. Hollister, E. A. Maher, R. T. McCabe, John Stewart, Cord Meyer, Charles Hoffman and D. H. Valentine, of Brooklyn.

THE COMMERCIAL CABLE COMPANY'S new cable between Nova Scotia and Ireland will be commenced May 1; it will be 2,200 miles long. The stock is now quoted at 145 asked.

THE ALLENTOWN ELECTRIC RAILWAY, it is reported, has been sold for \$300,000 by the Industrial Improvement Company, of Boston, to the Johnstown Company, of Allentown.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York.....	50	20	35
Detroit Electrical Works.....	10	2	3
Cleveland General Electric Co.....	—	\$5	90
East River Electric Light.....	100	—	65
Electric Con. & Supply Co., pref.....	15	15	16
" " " com.....	15	15	17½
Edison Electric Ill., New York.....	100	96	98
" " " 1sts.....	—	105¾	105¾
Edison Electric Ill., Brooklyn.....	100	99	102
" " " Boston.....	160	112	115
" " " Chicago.....	100	145	150
" " " Philadelphia.....	100	115	120
Edison Electric Light of Europe.....	—	—	3
" Bonds.....	—	80	85
" Ore Milling.....	—	5	12
Fort Wayne Electric.....	—	4½	6½
General Electric Company.....	100	38¼	38½
" " deb. 5's.....	—	80	80½
Interior Conduit and Ins. Co.....	100	20	30
Mount Morris Electric.....	—	—	65
Westinghouse Consolidated.....	50	45	47
" " pref.....	50	26½	27½
Western Union Telegraph.....	—	83¾	84

New Incorporations.

THE AMERICAN ELECTRIC BATTERY COMPANY, Des Moines, Iowa, capital stock \$250,000, has been formed to manufacture all kinds of electrical machinery, appliances and supplies. F. D. Goode, J. B. Cann, F. G. Curtis, H. B. Church and L. W. Goode are interested.

THE MADISON MILLING COMPANY, Madison, Minn., capital stock \$50,000, has been formed to own and operate a mill and to furnish power for electric light and waterworks in that village. E. O. Berg, J. F. Jacobson, G. Herriges, N. Herriges and P. G. Jacobson, all of Madison, are interested.

THE PALMYRA ELECTRIC LIGHT AND POWER COMPANY, Palmyra, N. Y., capital stock \$10,000, has been formed to do electric lighting, heating and to supply power. W. J. Morrison, Syracuse, N. Y.; B. H. Davis and S. P. Nichols, Palmyra, N. Y., are interested.

THE WAUKEGAN ELECTRIC RAILWAY COMPANY, capital stock \$500,000, has been formed to construct, purchase and operate street railways, electric light, power and gas plants; also waterworks. M. C. Van Fleet, B. L. Jones and C. W. Plamer are the promoters.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
41 Park Row, New York, Feb. 23, 1894.

CAPTAIN WILLARD L. CANDEE AND GEORGE T. MANSON will, as usual, be on hand at the convention to represent the Okonite Company, Ltd. The popularity of these gentlemen is only equalled by that of the Okonite specialties themselves.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY, 572-578 First avenue, New York city, will be represented at the Convention by its general sales agent, Mr. S. A. Douglas, who will explain the details and show the excellent points of the new incandescent arc lamps which the company has just placed upon the market.

E. F. GENNERT, who has been connected with the E. P. Gleason Manufacturing Company for nearly 22 years as superintendent and vice president, severed his connection Jan. 1 with this firm and is now general manager of the William Lang Company, manufacturers of metal goods, 123-139 Middleton street, Brooklyn, N. Y., which is contemplating going into the electrical supply business.

W. D. HOLMES AND GEORGE W. WALKER, manufacturers' agents, 136 Liberty street, New York, are placing on the market a new and novel electric shade which is light, durable and cheap. The shade is made of celluloid and has a fixture attached which will be suitable for any socket, and they are in all colors, from a dark bottle green to a plain white, are unbreakable and can be washed the same as porcelain. A cheaper shade is made of paper, which will be in great demand for central station and factory work.

THE COMPLETE ELECTRIC CONSTRUCTION COMPANY, of 121 Liberty street, New York, recently closed contracts for the following: With the Brush Electric Company, of Philadelphia, for a 10-mile subway, and with the Lakeside Railway Company for a complete electric railway from Mahanoy City to Shenandoah, Pa., to consist of a Westinghouse equipment with 260-h. p. generator and engine, and 70-T. R. bracket construction. Mr. J. A. Seeley is the president of the company and C. O. Baker, Jr., secretary and treasurer.

CUTTING DOWN WIRES.—The work of cutting down overhead wires is proceeding under the direction of Chief Inspector Brown, of the Board of Electrical Control. The start was made on the roof of the Fifth Avenue Hotel, and the men will work down as far as Twelfth street at once. The district is between Fourth and Sixth avenues. Mr. Brown said that he would leave a few wires overhead, belonging to people who have permits from the Board of Electrical Control, and added that the work will be the most extensive of its kind ever undertaken in this city. The work of cutting the wires will be continued until the men reach the Battery.

MR. THOMAS C. PERKINS, vice president of the Mather Electric Company, Manchester, Conn., was in the city last week and reported plenty of business, with bright prospects for the future. The Mather company, having been thoroughly reorganized, is now better than ever equipped for the line of work for which it has long been well known. It also intends to pay special attention to constructing railway generators. The company proposes in the future to deal directly with contractors as agents in various parts of the country, instead of establishing numerous local branches or offices. G. M. Anger, 116 Bedford street, Boston, Mass., is the contractor for the Mather apparatus in New England.

English Notes.

(From our own Correspondent.)

LONDON, Feb. 14, 1894.

TRAMWAY STATISTICS.—The latest Board of Trade returns show that whilst in Scotland the net earnings are on the average £1,100 per mile, the same figure for England and Ireland is respectively £800 and £600. The municipallization of the tramways, as well as the electric light, is proceeding apace, but has not as yet attained very large dimensions. Only three local authorities, viz., of Blackpool, Huddersfield and Plymouth, are at the present moment actually working their tramways. Of the total tramways in the United Kingdom one-fourth are owned by local authorities, and it is interesting to note that whilst the average total expenditure per mile in the case of the municipally constructed lines amounts to a little over £11,000, the same figure for the lines constructed by private enterprise aggregates £16,000, the average for the United Kingdom being about £15,000.

TELEGRAPHIC COMMUNICATION BETWEEN INDIA AND ENGLAND.—Mr. E. O. Walker, late of the Indian telegraph service, will read to-morrow an interesting paper at the Imperial Institute on the subject of the present condition and future prospects of telegraphic communication between England and India. The most important points brought out by Mr. Walker are: (1) That the time has now arrived when, in the interest of the commercial community, the present 4s. word tariff should be gradually reduced to 1s. (2) That the present prosperous financial condition of the telegraph companies concerned permits of their gradually reducing their tariff without much danger of a diminished return to their shareholders. (3) That whilst the early land lines across Turkey, Prussia, Russia, etc., were constantly interrupted, experience has taught us how to obtain from them almost as regular a service as from submarine cables. (4) That falling reasonable reduction in tariffs on the part of the companies, the Indian Government would do well to run a line on its own account from the Indian frontiers across Afghanistan, Persia, the Merv, Russia and Prussia to the North Sea, and then by cable to England.

THE LAMP CONNECTIONS OF THE METROPOLITAN ELECTRIC LIGHT COMPANIES.—Whenever the rapid increase in the lamp connections of our metropolitan electric light companies is brought to the notice of the gas interest, the gas journals almost invariably console themselves by prophesying that the present rate of increase will not be kept up very much longer. However that may be, if one goes to the trouble of plotting the (lampage) curves, it cannot be said that those relating to the leading and largest companies show any signs of saturation. For instance, the Kensington and Knightsbridge company has increased its lamp connections during the past twelve months by 35 per cent., and has just paid a dividend to its ordinary shareholders of 5 per cent.

News of the Week.

Electric Light and Power.

LEADVILLE, COL., has organized a second electric lighting company.

LYNCHBURG, VA.—Lynchburg is to have its own electric lighting plant.

HAMILTON, OHIO.—Bids for the proposed electric lighting plant will be received by Council till March 17.

ONTONAGON, MICH.—The city will vote March 12 on an issue of \$30,000 in bonds for electric light and waterworks.

WHITEHALL, N. Y.—T. S. McLaghlin will incorporate an electric company to take over his electric lighting plant.

WASHINGTON, N. J.—Rutherford Stuyvenant will build another electric lighting plant on the Tranquillity farms.

CONNERSVILLE, WIS.—F. T. Roots is corresponding in the matter of changing from his present water power to electricity.

HOUGHTON, MICH.—The Peninsula Electric Light Company will duplicate its plant at Houghton during the coming summer.

VICTORIA, TEX.—Jas. Koyer has bought a controlling interest in the electric lighting plant, and will make many improvements.

SPRINGFIELD, ILL.—The City Council committee on lighting has decided to reject the propositions of the gas and electric light companies.

PROVIDENCE, R. I.—Mr. John J. Moore has succeeded Mr. Marsden Perry as superintendent of the Narragansett Electric Light Company.

WILMINGTON, N. C.—Sealed proposals will be received till March 16 for lighting the city with electric lights. S. H. Fishblate is mayor.

YORK, PA.—The ordinance authorizing an appropriation of \$40,000 for an electric lighting plant was reported negatively from the ways and means committee.

ENFIELD, CONN.—The Enfield Electric Light and Power Company will extend its plant as far as the First Congregational Church, and will wire same for electric lighting.

SANDWICH, ILL.—At a Council meeting the bids for the steam portion of the electric lighting plant were rejected, and the specifications will be revised and resubmitted for bids.

THE HOME ELECTRIC COMPANY, of Tyrone, Pa., has just added a large boiler to its plant, and also a new switchboard designed by the superintendent, Mr. S. H. Stauffer.

SAN DIEGO, CAL.—Sealed proposals will be received to March 22 for lighting the streets and parks with electricity for one year from the 1st of April, 1894. S. W. Belding will give details.

NIAGARA FALLS, N. Y.—The Niagara Falls Electric Light Company is making arrangements to extend its wires and build a new plant, likely to be located near the old Wesley Park.

WOODSTOWN, N. J.—A strong effort is being made to establish an electric lighting plant in Woodstown. It is proposed first to light the business places in the middle of the city and then the entire city.

PORTLAND, ME.—C. B. Dalton offers for sale or lease two water powers of 5,000 and 2,500 h. p., respectively, and 18 and 20 miles distant from Portland, Me. Mr. Dalton calls attention to the fact that the city pays \$33,000 per year for lighting the streets alone.

MONTCLAIR, N. J.—Paul Wilcox and other local capitalists applied to the township committee of Montclair, N. J., for an electric lighting franchise. The application was referred to the street lighting committee, of which M. N. Baker is chairman. From 500 to 800 incandescent lamps would be required to cover the town.

The Electric Railway.

SOUTH NORWALK, CONN.—The tramway company proposes to extend to Roton Point and Five Mile River.

GAYSPORT, PA.—The Logan Valley Electric Company has been granted right of way through GaySPORT.

ROCKVILLE, MD.—The extension of the Bethesda Electric Railroad Company to Rockville is being agitated.

ENGLEWOOD, N. J.—Judge Phelps is said to be interested in a proposed trolley line between Englewood and Hackensack.

MIDDLETOWN, PA.—The Hon. J. W. Rife has been refused an extension of time in which to begin work on his proposed electric railway.

YOUNGSTOWN, OHIO.—Bids will be received to March 3 for operation of an electric street railway. J. Howard Edwards is city clerk.

ASHLAND, WIS.—The Ashland Lighting and Street Railway Company will issue \$250,000 in bonds to pay off indebtedness and make improvements.

ANN ARBOR, MICH.—The Ann Arbor Electric Street Car Company and the Ypsilanti motor line have decided to consolidate and run the whole line by electricity.

HOLYOKE, MASS.—The Board of Aldermen of Holyoke will give a hearing March 6, at 8 P. M., on the petition of the Holyoke Street Railway Company for leave to extend its lines.

WARREN, OHIO.—A corporation with \$10,000 capital has been organized to construct a railroad between Kinsman and Farmdale. D. N. Yeomans, E. R. Brackin and J. A. Russell are interested.

PHILADELPHIA, PA.—The Philadelphia "Record" states that property on Delaware avenue, near Laurel street, has been purchased as a site for a mammoth power house for the Electric Traction Company.

PHILADELPHIA, PA.—The contract to build the trolley road of the Lehigh Traction Company from Harleigh to Freeland, seven miles, has been awarded to the Westlake Electric Company, of Philadelphia.

HORNELLSVILLE, N. Y.—Residents of Howard, about eight miles from Hornellsville, are agitating for an electric railway to connect the town with Hornellsville or Canisteo, to be used for both passengers and freight.

GAITHERSBURG, MD.—Upton Darby, president of the bank, is corresponding with northern capitalists with a view to constructing an electric railway from the intersection of Seneca with the Potomac River to Gaithersburg.

ELKHART, IND.—The Elkhart electric railway has been sold to C. N. Lambert for \$21,000. An effort will be made to consolidate with the Goshen railway, and work will soon be commenced to complete the line between the two cities.

KINSMAN, OHIO.—The Kinsman-Farmdale Electric Railway Company is incorporated, with a capital of \$10,000, to build a street railway to connect the towns of Kinsman and Farmdale. D. M. Yeoman, E. R. Brackman and J. A. Russell are interested.

STAMFORD, ONT., CANADA.—Two applications for electric railway franchises have been received by the Stamford Council, one from Mr. Black and another from B. Lundy, in connection with E. A. C. Pew. Both applications were placed on file.

TOWANDA, PA.—A project is being pushed to connect Towanda and Wellsboro, by way of Troy, Sylvania and Mansfield, by an electric railroad. Most of the right of way from Troy to Mansfield has been obtained. Charles Card, of Sylvania, is interested.

NIAGARA FALLS, N. Y.—Burt Van Horn, Jr., representing the Niagara Whirlpool and Northern Railroad Company, has given notice that he will apply for a franchise for an electric road on Main and other streets, and Common Council will pass upon same March 5.

LA CROSSE, WIS.—The La Crosse and Oskaloosa Street Railway Company will increase its capital from \$30,000 to \$50,000, and will equip its line with electricity. Work will be begun as soon as the weather permits. J. B. Canterbury is president, and E. B. McGill is secretary.

KINGSTON, N. Y.—The Kingston "Leader" states that the company which proposes to build an electric line between Kingston and Ellenville will be called the Rondout Valley Electric Railway Company, and that it will light the villages through which it passes by electricity.

DIXON, ILL.—The Rock River Electric Railway Company has been incorporated and will extend via Grand Detour, Oregon and Byron to Rockford. The president of the new company, James H. Ticknor, of Rockford, has already over ten miles of electric railway in the city of Rockford.

STOWE, VT.—The Mount Mansfield Electric Railway Company has been incorporated, with a capital of \$50,000, to build an electric road from Stowe to Waterbury, a distance of ten miles. E. D. Blackwell, of Montpelier; O. E. Luce, of Stowe, and L. A. Pike and L. C. Moody, of Stowe, are directors and will give details.

ELIZABETH, N. J.—Articles of incorporation of the Suburban Railway and Electric Company, \$750,000, were filed in the office of the county clerk in Elizabeth, and its principal office will be here. The incorporators are James B. McGiffert, of Roselle; W. B. Hosmer, of Boston; John S. Bartlett and Charles H. Newhall, of Lynn, Mass.

HOMESTEAD, PA.—The Homestead Borough Council has granted right of way to four companies to operate electric roads in their streets—the Homestead and Highland Railway Company, the Pittsburg and Homestead Railway Company, the Homestead Street Railway Company and the Second Avenue Railway Company.

BURLINGTON, VT.—The proposed electric road from Burlington is now assured. Hon. Isaiah Dow, C. G. Peck, Albert Reed Ray, Perry Reed and H. M. Hull, of Hinesburg, and C. W. Brownell and Frank O. Sinclair, of Burlington, are interested. The latter is engineer for the project. C. G. Peck, of Hinesburg, will shortly address a mass meeting.

SCHUYLERVILLE, N. Y.—Dennis B. Hill, of Greenwich, N. Y., has obtained permission from the commissioners of the town of Saratoga to erect poles and string wires along the highway leading from Northumberland through Schuylerville and Grangeville to Saratoga Springs. It is the object of Mr. Hill to furnish power from the plant now being installed at Clark's Mills for an electric railway.

NORFOLK, VA.—A bill was introduced at Richmond to incorporate the South Norfolk Street Railway Company, and it was opposed by the existing street railway officials, who claim that they are just beginning to see financial daylight, and that there is not traffic enough for two roads, and, further, that they have made arrangements to extend their road and equip with electricity. Notwithstanding the protest, the bill was reported favorably.

PLAISTOW, N. H.—Residents have issued an ultimatum to the projectors of the New Hampshire electric railway system that if Plaistow is not included in the route they will oppose the scheme. It is stated that prominent residents of Plaistow are interested in the scheme to build an electric road from there through South Kingston, Kingston Plains and thence to Brentwood, and that plans have been drawn and the road will soon be incorporated.

ITHACA, N. Y.—The Cayuga Lake Electric Railroad Company has filed articles for incorporation, the principal office to be at Ithaca, N. Y., to operate an electric railway, length not to exceed two miles, and the capital stock to be \$25,000. The names and addresses of the incorporators are Alfred Hand, Horace E. Hand and E. L. Fuller, of Scranton, Pa.; De F. Van Vleet, Herman Bergholtz and E. P. Fuller, of Ithaca, N. Y.; Charles W. Hand and Henry S. Hand, of Brooklyn, and Fred W. Spender, of Staten Island.

WASHINGTON, D. C.—On the calendar of the Senate District committee are the following railway bills: The Washington and Arlington Street Railway Company, W. H. Randle, J. S. Lawrence and Beriah Wilkins; the Washington and Benning Street Railway Company, introduced by Senator Gibson—Levi Woodbury, Caleb S. Willard, Robert Downing; the Washington Central Railway Company, John H. Knight, Henry H. Rand, Perry W. Boyd, Michael I. Weller and Nathaniel McKay; the Washington, Alexandria and Mount Vernon Company applies for right to use electricity as motive power.

Personal Notes.

THE NATIONAL ELECTRIC LIGHT ASSOCIATION is so intimately associated with the names of George F. Porter and



and Cyrus O. Baker that its annual gatherings could hardly be counted a success if they were not present. Mr. Porter, the secretary of the association, has yet some time this side of the forties, having been born in Pittsburgh, Pa., on March 12, 1855, where his childhood was spent, and from whose public schools he graduated. In early life he practiced civil and mechanical engineering, later entering the iron business, in which he remained until 1883, with the exception of an excursion into the electrical and railroad field from 1875 to 1877. During Mr. Huntley's term as president of the National Electric Light Association Mr. Porter became its

secretary, to which position he has been twice reappointed. Mr. Baker, the master of transportation, has become such an indispensable adjunct to electric light gatherings that his absence on such occasions would be considered almost a calamity. Mr.

Baker was born in Newark, N. J., on the 12th of October, 1857. For many years past he has been connected with the firm of Baker & Co., of Newark, who are the only refiners of crude platinum in America, and who, with Johnson, Mathey & Co., of England, are known the world over as the principal workers in this refractory metal. Besides his connection with this business, which has had such a close association with the electrical industries since the discovery of the incandescent lamp, Mr. Baker is financially interested in a number of electrical matters, including an electric lighting plant at Newtown, L. I., of which he is president and Mr. Porter is secretary and treasurer. He has presided over the transportation department since its foundation in 1886, and in a manner as efficient as his attention to his charges is genial.



Miscellaneous Notes.

THE FRANKLIN INSTITUTE has awarded, subject to objection, until April 1, the Elliott-Cresson medal to Nikola Tesla for his "Researches in High Frequency Phenomena."

THE CITIZEN'S TELEPHONE COMPANY, St. Joseph, Mo., will start a telephone exchange and has been very successful in its canvass for subscribers. Mr. M. M. Riggs is president.

BOSTON, MASS.—The Drawbaugh Telephone Company has petitioned for incorporation with a capital of not less than \$1,000,000 nor more than \$10,000,000. Fred O. Prince is at the head of the company.

PROF. F. B. CROCKER delivered a lecture on electric lighting at Cooper Institute on Feb. 14, being one of the course of University Extension lectures. While the lecture mainly dealt with the more elementary features of electric lighting, several points of importance were enlarged upon, as the candle power of arc and incandescent lamps and the economics of the latter.

THE ELECTRICAL ENGINEERING LABORATORY at Purdue University, Lafayette, Ind., we are informed, was not damaged in the recent disastrous fire which destroyed portions of the shops and the mechanical engineering laboratory. A large generator was lost in the fire, but with this exception the electrical equipment was uninjured, and the work in this line is progressing as usual.

ANOTHER PENNOCK.—An impostor named Fred. L. Schupp recently gulled some simpletons in Manayunk, Pa., to the extent of \$1,000, through claims that an idiot should have suspected. By means of a device he exhibited, which could be placed in the woodwork of a door or house, he claimed that with a simple chemical battery he could light a house on the same principle "that electricity is utilized to ring door bells." A house was wired, a small "nickel-plated, clock-like machine" placed in the vestibule, and the stockholders asked to be present to witness the test. At the last moment Schupp disappeared, and it was discovered that he had meant to connect the house with a trolley wire passing the house, but was scared off by the discovery that he was being watched.

SOME THEORIES.—A recent pamphlet contains the following: "By decomposing zinc with an acid, its stored energy, its chemical affinity, is released and comes forth in the form of electricity. But suppose you try decomposing iron or steel with this acid, and its energy comes out in the form of heat, with no electricity about it. The reason zinc gives forth electricity is because of its extraordinary chemical constitution, which no other material possesses. To come right to the point, it is undoubtedly a fact that the mode of the atomical motion brought about by the decomposition of zinc is altogether different from that of other materials, and this mode of motion happens to be the same as that brought about in the coils of a dynamo by the magnets passing them. Heat is evidently a simple reciprocating atomical motion, while in the case of electricity we have the best of evidence by its manifestations, if not positive proof, that it consists in a rotary reciprocating motion of polarized atoms on an axis."

Trade and Industrial Notes

THE HOWARD SYSTEM of arc lighting will be presented to the N. E. L. A. Convention at Washington, D. C., by Mr. Charles R. Huntley, of the Buffalo General Electric Company. Mr. Huntley has made an exhaustive test of the system on his circuits in Buffalo.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., has furnished the iron roofs for the new electric light station for the Citizen's Electric Light, Heat and Power Company, at Lancaster, Pa., and the dye house of George C. Hetzel & Co., Chester, Pa.

JAMES LEFFEL & CO., Springfield, Ohio, direct the attention of electrical engineers to their "Samson turbine" water wheel. This wheel is furnished in a number of styles on upright and horizontal shafts, and is specially designed and adapted for driving electric lighting and power plants.

C. B. DALTON, 7 Preble street, Portland, Me., offers for sale or lease two water powers of 5,000 and 2,500 h. p., and 18 and 20 miles, respectively, from Portland. That city is now paying \$33,000 per year for street lighting alone, and the lowest price of steam horse power is quoted at \$75 per year.

THE W. D. GRAVES ELECTRICAL AND MACHINE WORKS, Cleveland, Ohio, has issued a catalogue of the various arc-lighting apparatus manufactured by it, as well as of the Graves transformer. The Graves arc lamp received an award at the Chicago Fair, and continues to meet with success.

THE WESTON standard voltmeters and ammeters are theoretically correct in principle, accurate throughout their entire range, simple in construction and economical to operate. Their popularity is an established fact, and the Weston Electrical Instrument Company, of Newark, N. J., is a busy concern.

THE GOUBERT MANUFACTURING COMPANY, 32 Cortlandt street, New York City, manufactures two steam specialties well worthy of the careful investigation of every member of the National Electric Light Association. We refer to the Goubert feed water heater and Stratton steam separator, of both of which it is the sole manufacturer.

THE AMERICAN SILK MANUFACTURING COMPANY, manufacturer of silk wipers, Philadelphia, Pa., has just received a very flattering testimonial as to the merits of its wipers from Mr. J. A. Turpley, chief engineer of the United Electric Railway Company, of Nashville, Tenn., in which he states that the wipers are the best he has ever tried.

MR. H. I. HADAWAY, who is well known throughout Kentucky, Indiana and Ohio from his long connection with George Cutter's specialty line, has opened an electrical supply house at 503 Third street, Louisville, Ky. He expects to carry an assortment of both electric light and house goods, and has the best wishes of a host of friends with him in this undertaking.

THE PARAGON PITCH COMPANY, Cleveland, Ohio, is making a new insulating pitch, which has proved very satisfactory in all tests so far made, several manufacturers already consuming large quantities of it. A representative of the company is expected to be at the convention, in Washington, when those interested will do well to examine into the merits of the new material.

THE AMERICAN RUBEROID AND RUBBER MANUFACTURING COMPANY, 206 Centre street, New York, has placed on the market a line of ruberoid tubing for electrical purposes, which has been approved by the New York Board of Underwriters. The tubing, while almost as hard as ordinary hard rubber tube, is flexible, and in large sizes can be bent to a right angle with a small radius.

THE WAKEFIELD ELECTRICAL ENGINEERING COMPANY, 731 Reading Terminal, Philadelphia, Pa., has secured a contract for a seven-mile extension of the Lehigh Traction Company, Hazleton, Pa. The road is to be built in a very substantial manner, and graded according to the best steam road practice, and will also include several large trestles. Work will be in charge of Mr. A. W. Gilbert, constructing engineer for the company.

THE ABENDROTH AND ROOT MANUFACTURING COMPANY, 28 Cliff street, New York City, reports a brisk demand for its Root improved water-tube steam boiler, with recent orders of 248 h. p. for Para (Brazil) Electric Light Company; 2,000 h. p. for tunnel plant of Baltimore and Ohio Railroad Company, at Baltimore, Md.; 4,000 h. p. for Cincinnati Street Railway Company, and two large boilers for the Flatbush Gas Company, Flatbush, L. I., N. Y.

MESSRS. D. L. BATES & CO., Dayton, Ohio, are meeting with flattering success with the Bates fan and motor, which is claimed to be indispensable to hotels, cafes, restaurants, etc., where a thoroughly reliable and ornamental fan motor is required. It runs with a minimum amount of cost and expenditure of energy. These fans can be run on any direct-current incandescent light or street railway circuit, and are made for 110, 220 and 500-volt circuits and also for 10-ampere arc circuits.

THE ELECTRIC LIGHT EQUIPMENT of the large addition to the Chicago post office has been made very complete in every respect, every cabinet and desk being equipped with the most effective kind of electric and combination fixtures. The contract for furnishing these fixtures has just been completed by the Electric Appliance Company. The contract was secured only after considerable competition, and the Electric Appliance Company feels considerably elated at their success.

THE BALL ENGINE COMPANY, of Erie, Pa., has made a number of installations of direct connected engines in connection with various types of dynamos; among late ones are two 200-h. p. cross compound engines, directly connected to Siemens & Halske dynamos in the Lumber Exchange Building, Minneapolis, Minn.; one 125-h. p. Simplex engine, in connection with Waddell-Entz dynamo, in the store building of Willoughby, Hill & Co., Chicago; one 80-h. p. engine in connection with Waddell-Entz dynamo, in the building of Cumner, Craig & Co., Boston, Mass.

THE TAYLOR BATTERY COMPANY has issued an illustrated catalogue, in which it claims that the Taylor battery has been perfected, and the statement verified by those who use it practically, as well as by scientific men. Among the new features we notice the following: Prepayment of freight, out of town customers furnished with formula of the depolarizer, a modification of the Minotto cell for all-summer work on fan motors, slow-speed motors for boats, motor castings, novelties in telephones and estimates for small electric lighting plants. The battery is renewed without disconnecting or removal of jars.

THE PAGE BELTING COMPANY, of Concord, N. H., at the present time is making three wide belts for the Suburban Electric Company, Elizabeth, N. J.; a 54-inch double for the Union Railway Company, New York, and for a large New England manufacturing concern a wide three-ply belt of construction similar to the large tandem belts which it exhibited at the World's Fair, running on the Allis engine. All these large belts are the famous "Crown" brand, for which it received at the Columbian Exposition "The Highest Award." As is well known, this company was enterprising enough to be the first to publish a copy of this award and a reproduction of the Columbian medal of award, as designed by St. Gaudens, which has created such a stir. Besides these orders it has recently shipped to Japan a very large order of single belting, the third received from that country since the first of the month.

THE WASHINGTON CARBON COMPANY, of Pittsburgh, Pa., has been at work for the last two years perfecting a cored carbon, and now announces that it will be ready to place the new carbon on the market about March 20. To Mr. L. B. Marks, well known not only for his work in the carbon line, but also in connection with the Howard system of arc lighting, is due the success in developing the new carbon. Mr. J. S. Humbird, the president of the Washington Carbon Company, says he believes that this carbon will give as good satisfaction as foreign makes, and he hopes even better. The company's selling agents in Boston, New York, Philadelphia, Chicago and St. Louis are now prepared to fill orders for the carbon.

THOMAS C. WARLEY & CO., 11 South Ninth street, Philadelphia, Pa., manufacturers of boilers cleansing compounds, have had a greater sale of their products during the months of November and December of the past year, and January of this year. This firm has been before American steam users for several years past, and now numbers amongst its customers some of the largest railway and lighting plants in this country and Canada. The universal satisfaction given by their compound, as a preventive and remover of scale, to the many who have used it commends it to those who have not availed themselves of its sterling qualities, and, as the item of boiler repairs is a very important one, the managers of power plants will be more than convinced of the merits of this article by investigating it. A representative will be at the electric light convention with a sample of the article manufactured, and proof of the work done.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

The Electrical World.

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NEW YORK, MARCH 10, 1894.

No. 10.

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In the growth of the paper in circulation, size and general improvement, the value of its columns for reaching those engaged in electrical pursuits has not failed to be appreciated by advertisers. The following table shows its steady onward march in this department of business. The first issue of

1880 contained 25 different adv'ts.	1887 contained 154 different adv'ts.
1881 " 28 " "	1888 " 175 " "
1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 289 " "
1884 " 82 " "	1891 " 325 " "
1885 " 100 " "	1892 " 316 " "
1886 " 138 " "	1893 " 317 " "

The first issue of 1894 contained 320 different Advertisements.

No announcements of the Publisher are included in this list.

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MR. PREECE ON AMERICA.

It is with no little satisfaction that we are able to say that Mr. Preece, of London, denies very positively having ever made the remark credited to him that "electricians in England have nothing to learn from America." He refers to it in some remarks, which we published last week, in concluding his very interesting description of his recent trip to the United States. Those who have attributed this remark to him, as also those who felt the injustice of it, will do well to read what Mr. Preece himself has to say about it, as also the complimentary statements which he makes. By this denial and by his honest acknowledgement of what he found to admire here, Mr. Preece has gained the respect of Americans, which they so willingly grant to the appreciative and fair-minded foreigner.

INSTITUTE POLITICS AND ITS EFFECTS.

Referring to a remarkable paper read at the late convention of the National Electric Light Association, one of the speakers, in congratulating the meeting upon having had first laid before it a paper of such great scientific and practical importance, remarked that "a year or two ago it would, undoubtedly, have first been presented to the American Institute of Electrical Engineers." A writer, in referring recently to an undignified squabble, compared it to "a family row in the A. I. E. E." In view of the course of the Institute during the last year or so, these remarks are full of significance. The character of many of the papers accepted by the latter body during that period and the petty politics by means of which some of them were foisted into the transactions, as well as other occurrences, have not had a beneficial effect on the standing of the Institute. It is to be most sincerely hoped that the coming election will place that body on a truly national and professional basis, and free it from the petty influences that have, it cannot be denied, already grievously affected its standing.

CENTRAL STATION STORAGE BATTERIES.

We have frequently called attention in our columns to the extensive employment of storage batteries in Europe in connection with electric lighting, and pointed out the advantages claimed to be derived from such use. Our central station managers have been slow to take up the subject, but recently, however, they have shown a disposition to investigate it. The discussion before the convention at Washington, an abstract of which we print elsewhere, will undoubtedly have the effect of concentrating attention on the matter, and it may not be long before we shall outstrip our European brethren in this field, as we have in others relating to electrical applications. The prevalent opinion in this country in regard to storage batteries has been largely formed with reference to those employed for traction and other purposes where light weight is a requisite, which implies a sacrifice in durability. With batteries of less plates, and yet weighing ten or more times as much as those with which we have heretofore been acquainted, it is evident that the former grounds of criticism do not apply. One of the speakers stated that he knows of no company that will not give a guarantee at least as good as 10 per cent., and another said that his firm could build a battery with a guarantee that it would last one hundred years—which statements illustrate the wide differences referred to. The advice of Mr. Salom as to the methods to be pursued pre-

liminary to deciding in regard to the introduction of the storage battery is timely, as more harm to the storage battery industry than good would be caused by the addition of this adjunct where the conditions that would render its use profitable are not present. The description by Mr. Appleton of the first station in this country to use a storage battery of American manufacture will be found not only of interest but of direct value as illustrating a case in which the conditions requisite to its profitable operation were present, and the same may be said of the remarks of Mr. Barstow. For use where a central station carries only a moderate day load, or where the current has a large maximum for a small period, there can be no doubt of the advantage to be derived from a storage battery. There are also other cases in which its use has been found profitable, and it would be well for every central station manager to make an examination of his special conditions to determine if he could not by this promising adjunct increase his dividends.

MR. SCOTT'S PAPER.

By far the most important contribution to the proceedings of the Electric Light Convention was the paper by Mr. C. F. Scott on "Polyphase Transmission," which, owing to an unfortunate delay in the cuts, we are unable to print in this issue. The paper is in two parts, the first being an admirable exposition of the principles and phenomena encountered in alternate current working. The second part, which has little or no real connection with the matter that precedes, is an account of a new polyphased current system, which was pronounced by no less an authority than Prof. Rowland to be "one of the finest inventions that has come out in recent years in this country," and as marking "an era in the science of the polyphase system." The expository portion of the paper will be a boon to the central station man, as it is written from his point of view and explains in simple terms, without the use of any mathematics, the various alternating current phenomena in regard to which a practical man desires information. The new polyphased current system described is claimed to combine the advantages of both the two and three phased systems. As shown recently in these columns, the three-phased system, to transmit a given power with a given insulation stress, requires much less copper than its two-phased rival, and Mr. Scott points out that it also has the additional advantage of less self-induction, and entails a less cost of installation in insulators and pole construction, as well as involving reduced leakage, etc., on account of having three instead of four wires, as in the other system. On the other hand, the two-phased system has the advantage of better regulation, requires a less number of transformers, and is more simple of installation. The importance of a system that contains all of the good qualities thus enumerated and discards the undesirable ones is evident, and the reader will recognize the justice of Prof. Rowland's remarks, which were to a great extent corroborated by those of Prof. Forbes. The principle involved in the system is the transformation of the phases of currents by means of converters. The currents of a two-phased generator are led to two converters, whose secondary coils are so proportioned and interconnected that the three secondary currents leading from them differ 120 degrees in phase. At the end of the transmission the currents may be used to operate three-phased apparatus, or to supply lamps, or they may be converted again into two-phased currents by means of converters similar to those at the generating station. When the loads on the different branch circuits can be balanced, there may be no material advantage in reconverting to two-phased currents, but in the reverse case, as with motor circuits, the inherent regulation of the latter system may be secured by converting again to two phases. One of the valuable points of the new system

is that such unbalanced loads do not affect the balance of the transmission line nor of the station converters. Owing to the remarkable theoretical advantages the system presents, it will doubtless not be long before it is put to the crucial test of practice, and all of those interested in the progress of electrical science will heartily wish to see realized the great promise it contains.

THE ELECTRIC LIGHT CONVENTION.

The Washington meeting of the National Electric Light Association again demonstrated the usefulness of this institution and showed that it has lost little of the vigor which has been its characteristic from the beginning. While the papers read and the discussions have a sufficient value in themselves to justify the time and money expended by those in attendance, of no less value are the occasions for personal comparisons of experience and the opportunities offered by electrical manufacturers for the inspection of the latest improvements in apparatus and material. As was expected from the recent tendency toward municipal ownership of electric lighting plants, this subject occupied a prominent place at the convention. The position taken, that it is not only unjust but absolutely dishonest for municipal bodies to institute plants with no regard to the private interests thereby affected, will meet with the approval of all fair-minded men, and cannot in any sense be construed into an extreme view. This is aside from the principle of municipal ownership itself, and is rather a question whether the public should deliberately rob private citizens of the fruits of their enterprise in developing at an unknown risk a new industry. While it has been argued that the private investments in electric lighting were made with expectations of good returns, this furnishes no excuse for the confiscation of the results of years of hard work in establishing a new industry on a stable basis, but, on the contrary, its recognition would have a most blighting influence on public enterprise. The necessity of organization for the defense of the rights threatened is imperative, and the members of the Association were naturally somewhat severe in their reflections on the executives for their dereliction on this score in the past. The proposition to secure the services of an attorney in order that timely information of adverse legislation may be thereby given was eminently wise, and should lead to good results. The discussion on the subject of the most economical size of arc dynamos was a timely one, and the almost unanimous opinion expressed in favor of units of 100 and even more lights for large stations will doubtless lessen the effect of the opposition that their adoption has met in certain quarters, notably at Detroit. One of the most valuable achievements of the convention was the settlement of the vexed question in regard to the rating of arc lamps. We were among the first to advocate that the rating of arc lamps should be in terms of watts, and, therefore, are especially gratified at the step taken, although we regret that the definition of a normal 1,200-c. p. arc as one produced by 300 watts was not included. As the principle, however, is now established, its application is easy of extension, and, above all, we shall hear no more of the farcical photometric measurements of arcs that brought disrepute on electrical engineering. The report of the committee on data is of more importance than seemed to be realized, as it shows that there is enormous room for improvement in the steam plants of central and power stations. It is about time that attention should be directed to the great saving that may be made in this respect, and it would be a policy of wisdom for all station managers to subject their plants to exact tests in order that they may obtain definite data showing in what directions improvements should be made. With the necessary data, it may be found that even radical changes in very many sta-

tions would be profitable through the decrease in coal consumption, and it is even possible that there may be cases in which there would be a saving by the adoption of economical machinery, even if that at present in use had to be disposed of as old metal. The discussion on the new form of arc lamp thoroughly introduced this novel device to those most interested in the subject, and the favorable account of it given by Mr. Huntly was not lost on the enterprising gentlemen composing the Association. The papers and discussions on fuses and magnetic cut-outs, metallic circuits for electric railways, central station switchboards, meters vs. flat rates, rules for safe wiring, and arc lamps on incandescent circuits, while interesting, developed nothing particularly new, with the exception of the description in the latter of a high voltage arc lamp, which promises an important addition to lighting apparatus. The striking paper of Mr. Scott and the discussion of storage batteries we reserve for separate comment.

A Current Without a Difference of Potential.

BY W. A. ANTHONY.

In an article in *The Electrical World* Feb. 17, 1894, in relation to "A Current Without Difference of Potential," Mr. Stern asks what direction the current would flow in the ring referred to in my note published in *The Electrical World* of Feb. 3. The current would flow in the direction of the E. M. F. generated in the ring by cutting the magnetic lines. If the north pole of the magnet were thrust into the ring from the observer, a current would flow counter clockwise. But there is no difference of potential in the ring, because there is no disturbance of the electrical equilibrium, no accumulation of electricity at one point at the expense of another point, no force of electrostatic attraction or repulsion, and these, and not electric currents, are the tests of electrical difference of potential.

Vineland, N. J., Feb. 26, 1894.

Refuse Utilizer.

The London "Electrician" of Feb. 16 had a number of illustrations of the boiler used in the Livet system, of which a trial is being made at Halifax, in Yorkshire; the ratio of the total useful heating surface to the grate area is said to be 50, as against 30 and 35 in the usual boilers; the so-called "coal storage" system is used, in which the refuse is mixed with coal slack in varying proportions, as occasion may require; when the load is great the proportion of coal is great, and when small no coal is used; the article states that this system has neither the elasticity nor the durability which is required, as it is not capable of dealing with long periods of idleness nor short periods of great activity, nor is it competent to cope with any large sudden change in the load, but combined with other systems of storage it might be found to answer well enough; it is stated that 13.13 pounds of water were evaporated per pound of coal in this boiler, but the results are questioned. The Lond. "Elec. Eng." in a note refers to these trials of this system, stating that the average quantity of rubbish burned per hour on each square foot of grate surface was 33 pounds, and that four separate tests showed that 4.08 pounds of water were evaporated per pound of rubbish consumed. The Lond. "Elec. Rev.," Feb. 16, also refers to these so-called tests, which its representatives witnessed and which they claim were no tests at all, and are therefore quite misleading. "Ind. and Iron," Feb. 16, also refers to this system, giving a somewhat more detailed description of the boiler and the results of some of the tests; it quotes from a circular in which it is stated that 170 h. p. per hour was obtained from the combustion of 10.17 tons of refuse in 24 hours.

Alternate Current Working.—IV.

BY HARRIS J. RYAN.



THE ordinates of the curve E_{RL} , in Fig. 11, are the sum of the corresponding ordinates of E_R and E_L . For example, the point at c on the curve E_{RL} was determined by subtracting from the ordinate td a length $d = a$. This subtraction is made because td is negative and a is positive at this particular instant t . When both values are either positive or negative their ordinates are added to form the corresponding ordinates of the resultant curve.

At t the values of E_R and E_L are positive, and are equal to each other, since the two curves intersect. The ordinate for the resultant curve E_{RL} , therefore, at $t' = 2t' b = t' e$. A sufficient number of points at different intervals on the curve E_{RL} are thus determined to enable the curve to be located and drawn. We now come to the interesting fact that the maximum of the resistance curve E_{RL} is equal to the diagonal of the parallelogram erected on the radii that develop E_R and E_L . Fig. 11 gives graphic proof of this relation. $E_{Rmax.}$ and $E_{Lmax.}$ are the developing radii upon which the parallelogram is erected. The diagonal obtained is $E_{RLmax.}$. Rotating this diagonal into the vertical, we find it to have a value equal to that of the maximum of the resultant curve E_{RL} . Again the angular position of this diagonal is just right for developing the curve E_{RL} . This will be found to be true upon further inspection of the diagram. Consider for a moment the values E_R , E_L and E_{RL} at the instant t'' . The value of E_R at this instant equals $t'' f$, which is equal to the developing radius $E_{Rmax.}$; the value of $E_L = 0$, equals the vertical projection of $E_{Lmax.}$, and the value of $E_{RL} = t'' f$, the vertical projection of the diagonal $E_{RLmax.}$. In this same manner many other points on E_{RL} may be determined by using this diagonal as a developing radius. The ordinates for the curve thus determined will be found to be equal to the algebraic sum of the corresponding ordinates of E_R and E_L . The reader should note that in using this construction the developing radii must always be separated from each other by the same angles, and that each developing radius must make one complete revolution per

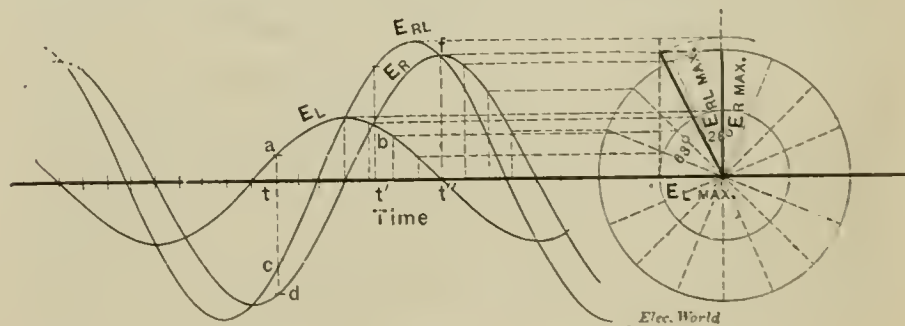


FIG. 11.

complete cycle of variation of E. M. F. or current. It is usual to use the impressed E. M. F. as the time position of reference for fixing the relative time positions of other alternating quantities connected with the same circuit. E_{RL} is the impressed E. M. F. for this circuit, the positions of the E. M. Fs. E_R and E_L are, therefore, referred to it. We see that the relative angular positions of the developing radii correspond to the relative time positions of the curves that they develop. In all these cases then where the alternating E. M. Fs. and currents may be assumed to have the form of curves of sines it is not necessary in expressing graphically values and relative time positions to plot the curves for a complete cycle or even a part of it. The developing radius

located in its proper angular position is sufficient for all purposes. Through the adoption of this method it has become customary to designate the time positions of alternating E. M. Fs. and currents by the angles between the developing radii and the developing radius of the curve of impressed E. M. F. The number of degrees in any one of these angles divided by 360, will give the corresponding fractional part of a complete period or cycle that exists between the actual curves. In Fig. 11 $E_{K \max}$ is 27° behind and $E_{L \max}$ is 63° ahead of $E_{K \max}$, while E_L is 90° ahead of E_K . Corresponding parts of a complete period are:

$$27^\circ = \frac{27}{360} = .075;$$

$$63^\circ = \frac{63}{360} = .175;$$

$$90^\circ = \frac{90}{360} = 1/4.$$

We have seen that the ratio of the $\sqrt{\text{mean}^2}$ value to the maximum value of an E. M. F., or current, is the constant for each form of curve, and that this constant is .707, gen-

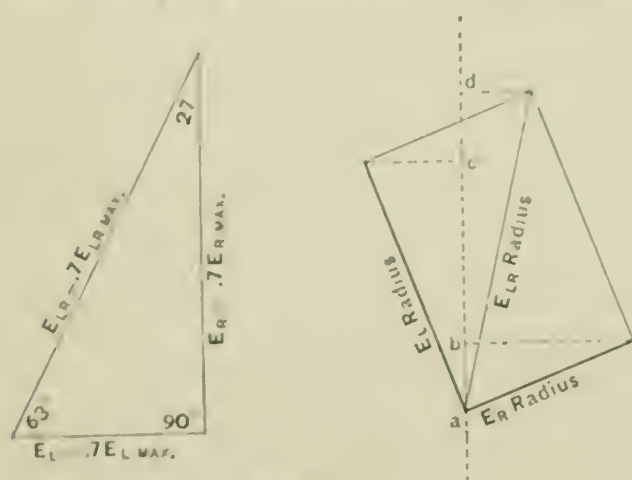


FIG. 12.

erally used as .7 for sine curves. In these alternate-current diagrams one may substitute the $\sqrt{\text{mean}^2}$ values for the developing radii values, preserving, however, their angular positions. The diagonals of the parallelograms formed on the $\sqrt{\text{mean}^2}$ values will be the $\sqrt{\text{mean}^2}$ values of the resultants. This method for obtaining resultant values is usually adopted: Where a single resultant of but two values is to be determined, as is often the case, the value of the resultant is obtained by completing the triangle (see Fig. 12), for which the values producing the resultant form two sides. The line that completes this triangle has the same length as the diagonal of the parallelogram erected on the values that form the resultant.

The more general proof that the diagonal of the parallelogram formed on the radii that develop the E. M. F. or current curves is found in Fig. 13. The radii are designated as E_L , E_R and $E_{R \perp}$. As these radii rotate their vertical projections develop the corresponding curves. For any particular position of these radii the vertical projections equal the instantaneous values of the corresponding curves. In Fig. 13 ab is the vertical projection of E_R , ac for E_L , ad for $E_{R \perp}$. By construction $ab = cd$, therefore, $ad = ac + ab$, which means that the instantaneous values of the diagonal $E_{R \perp}$ equal the sum of the instantaneous values of E_R and E_L . $E_{R \perp}$ is, therefore, the true resultant.

(To be continued.)

Simple Mathematics.

A foreign contemporary facetiously calls attention to a recent article in which the author uses the word "simple," "simplified," etc., frequently, but gives equations which, in the ordinary type, are two yards long, each equation occupying two pages of the journal, and, what is worse, the equations are only approximate! It is needless to say that it was a French journal.

Photometry.

BY A. W. CLAPP.



METHODS used for comparing the intensities of sources of lights are treated of in that branch of optics called photometry, as indicated by the name. These being based on a geometrical law, no practical method has been found, up to the present time, by which mathematical accuracy can be obtained.

The difference in colors which are greatly observed in lights that are being tested gives another difficulty. In the particular case of electric lights the difference in luminous value—often very large—between the standard and the lamp to be tested still further makes the experiment more difficult, and increases the uncertainty of the test. Apart from all various methods, which have but little value, the process employed by all experts in these tests consists in replacing a direct estimate of the luminous source by an indirect comparison with a given standard. It will be seen that the test consists of substituting for a difference of luminous emission at the same distance an equal amount of light at different distances.

Kepler, the astronomer, enunciated this law, called the law of the square of distances. When a luminous source is placed successively at various distances from a screen which is illuminated the quantities of light received on this sur-

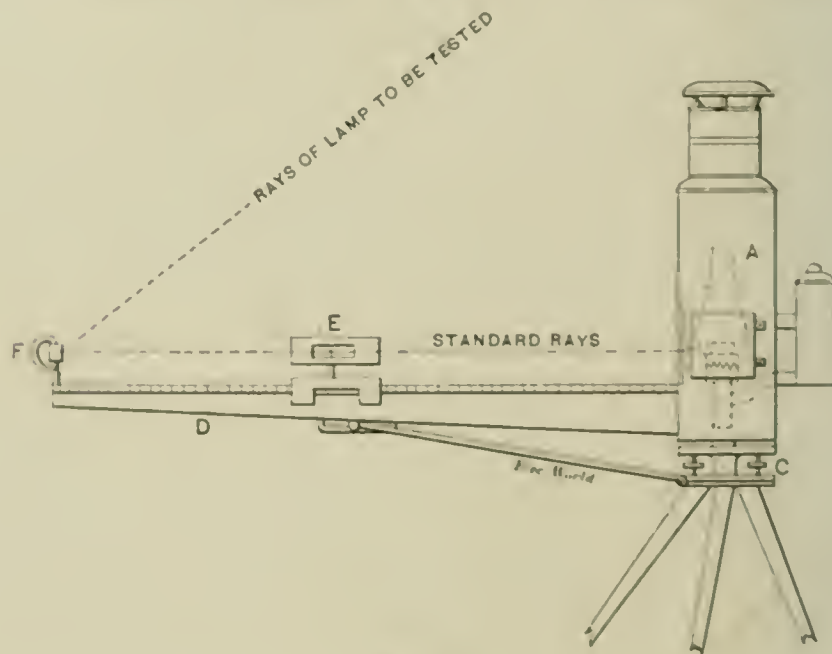


FIG. 1.

face vary in an inverse ratio with the squares of the successive distances of the luminous source from the screen. So, if the distance is doubled, the intensity of light will be four times less; it will be nine times feebler if the distance is trebled, etc.

I have already said that it is very difficult for the eye to estimate the relative values in the intensities of two different luminous sources, but it can, on the other hand, judge with more accuracy when the two surfaces brought near each other are lighted equally by two sources placed at different distances and emitting their rays through the same range.

The conditions for accurate results consist in having the photometer and the eye removed from all other lights except that which is to be compared.

The photometer, such as I have been using in my tests for the government of the District of Columbia, was made by the American Meter Company, of New York, and designed especially for the particular work in view. It consists (see Fig. 1) of a standard lamp (either oil or incandescent), A placed upon a tripod, C , with leveling screws and graduated bar, D , which carries the box E . Placed at the end of this bar is a mirror, F , so that the

rays of the lamp to be tested may be reflected upon the screen in box, *E*. The box *E* (Fig. 2), is made of sheet metal rectangular in form, partly open at both ends. The front side has a transverse partition, *B*, dividing it into two equal parts, which partition has a large central opening closed by a semi-transparent disc, in the usual manner, the light striking upon the screen from the standard and the electric lamp being reflected to the eyes of the observer by the mirrors *A A*. The frame carrying the screen is shifted on the bar *D* (Fig. 1), until the shadows reflected on the semi-transparent disc become equal and the divisions

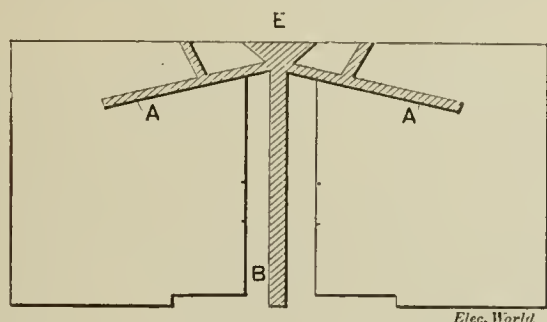


FIG. 2.

on the bar, as marked by the index on the box, is then noted. The distance of the screen from the lights is then recorded, and the ratio at the squares of the distances will give that of the intensities.

Let a lamp, *B* (Fig. 3), be hung 15 feet above the horizontal plane (photometer bar), or 20 feet above the floor; from a point directly under the lamp measure 11 feet and place the standard lamp directly over this point, thus making the mirror 15 feet from the point directly under the lamp being tested.

In observing the projection of the arc upon the screen it

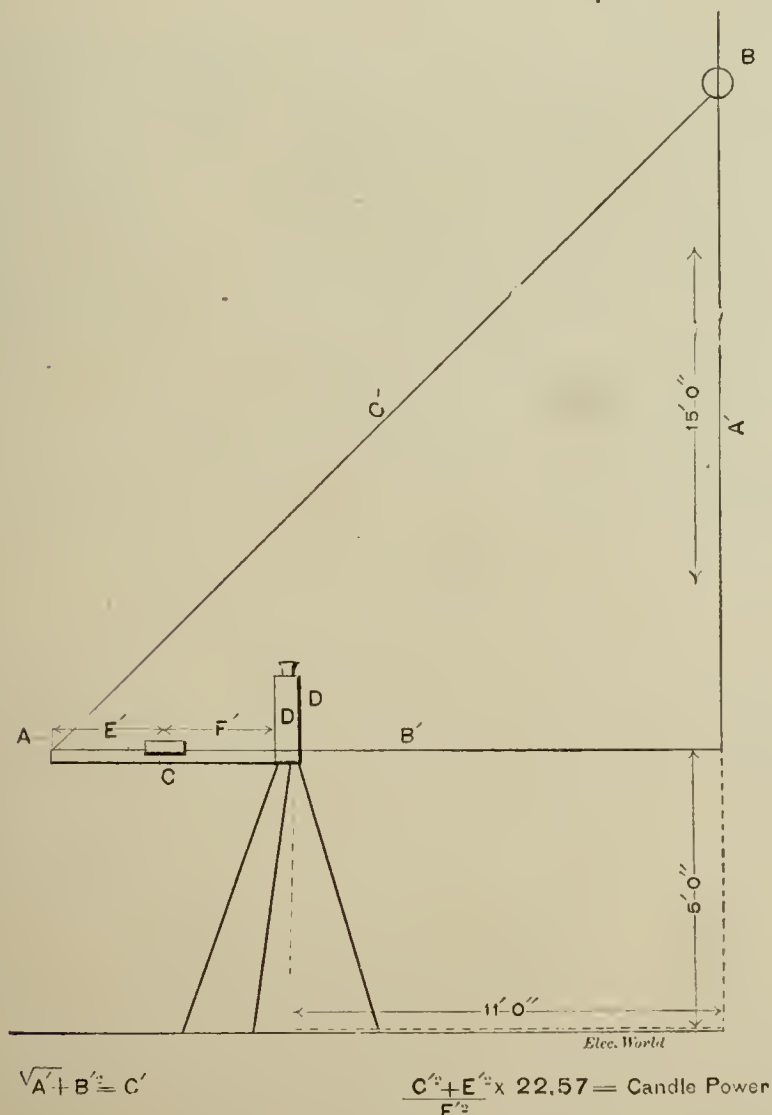


FIG. 3.

will be seen, that the two carbons are not equally efficient in illuminating power. The negative carbon becomes pointed; the positive, on the contrary, is hollowed out in a crater, and of the total quantity of the light emitted about 5 per cent.

only is attributable to the arc itself, 10 per cent. to the negative, and 85 per cent. to the positive.

The following rule I have used in all of my tests and experiments: The candle power of the standard lamp should be determined by direct comparison with standard candles; the electric lamps should be measured at different heights above the horizontal plane, the axis of the carbons being vertical with the positive. After each observation the lamp should be revolved 90° about its vertical axis, in one direction only, and at each reading of the photometer the E. M. F. should be taken, and the mean of ten such observations be taken in determining the candle power. Tests may be made with or without globes, as desired. The following were made with the globe in place. These tests were made at the station of the United States Electric Lighting Company, of Washington, D. C., with the assistance of Mr. Edward McCarthy, in charge of the arc lamp department. The lamps tested were of the Thomson-Houston manufacture, with clear glass globes, and known as the 2,000 nominal candle power lamps, such as are used in lighting the streets of Washington.

First test: Taken at a height of 15 feet above a horizontal plane and at an angle of 45°. The mean E. M. F. readings were 48.8 volts and a current of 10 amperes, equal to 1225.55 standard candles.

Second test: Taken as above, with an E. M. F. of 51.5 volts and a current of 10 amperes, equals 1365.22 standard candles.

Third test: Taken at an angle of 41° 38" and 10 feet from a horizontal plane, with the following results: 47.9 volts, 10 amperes; 1090.13 standard candles.

Fourth test: This test was taken on the horizontal plane, with the following results: 49 volts, 10 amperes; 905.02 standard candles.

A Home-Made Telephone.

BY R. RADDATZ.

As the telephone question is now prominently before the public, a description of how this simple instrument may easily be made at home, with such tools as are everywhere to be found, may prove of interest to the readers of The Electrical World.

The instrument described, although simple and easily constructed, is nevertheless practical and efficient, and will transmit speech to a distance of several miles. For this purpose two instruments exactly alike are needed, one at each end of the line, but no battery or separate source of electricity is required.

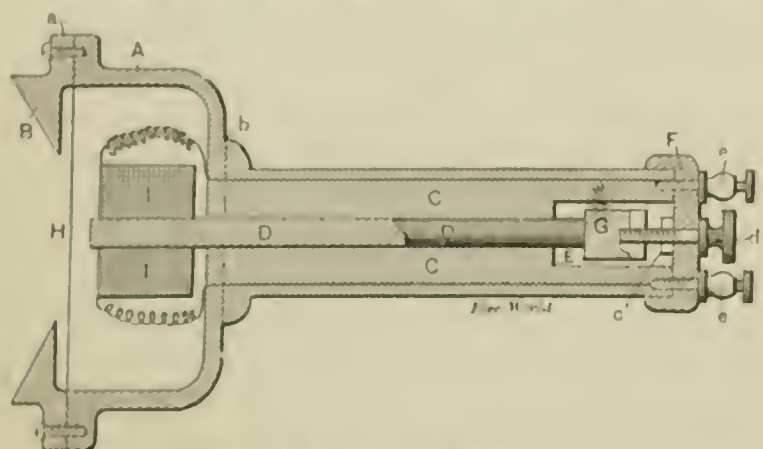
The working drawing herewith is one-half size, linear measurement, and the dimensions of any part of the instrument not mentioned in the text may be obtained therefrom by measurement. The shell of the telephone may be made of hard wood, and in case a lathe of any description whatever is at hand will offer no difficulty. In the absence of a lathe an expansive bit or a chisel and penknife will do the same work, but not so rapidly.

The resounding box, *A* in the drawing, may be made first, having a cavity 2 1-2 inches in diameter and about 1 1-8 inches deep. In making it care should be taken to have straight surfaces at *a* and *b*, so as to form square and tight joints with the parts *B* and *C*, respectively. In case this box is made with chisel or knife and turns out somewhat rough and uneven, it may be easily smoothed with a piece of sandpaper. Then the mouthpiece *B* may receive attention, the funnel, or outward part of which, is 2 5-8 inches in diameter at the widest part, and has an opening 1 1-4 inches in diameter at the bottom.

The handle *C* of the instrument may be of pine wood about 1 inch in diameter and 3 1-2 inches long, but be-

fore working upon it the permanent bar magnet *D, D*, must be obtained. This may to advantage be home made (or it may be bought), being a piece of magnetized steel 4 inches long and 1-4 inch square, or, if round, of that diameter. As the round magnet is probably most easily procurable, it was the one used in the instrument here shown. Whichever magnet is used, a corresponding tunnel must be cut or bored through the pine handle *C*. For the round form of magnet this hole is easily made with a 1-4-inch bit, while for the square form, it would be easiest to split the handle and cut a groove with a 1-4-inch chisel the full length of each half cylinder, just wide enough to allow the magnet to slide rather tightly in it. A square channel, *E*, is now cut with a 1-2-inch chisel for a distance of one inch from one end of the handle, and the two parts are glued together to form a cylinder with the tunnel, large enough to hold the magnet through it. In case of the round magnet being used and the round hole through the cylinder, it may also be found easiest to split the same and form the square channel *E*, with a 1-2-inch chisel, as in the other case, and then gluing the two halves together. The purpose of this 1-2-inch square channel *E* will be shown further on.

Next the magnet *D, D*, may receive upon one end its bobbin *I, I*, of No. 36 silk covered copper magnet wire, of which rather less than 1-2 ounce will be required for each instrument, about 6 inches of wire being left free at each end of the coil for purposes of connection. The coil should be a tight fit on the magnet, or the wire may be wound on the end of the same, putting a layer of silk over the metal



HOME-MADE TELEPHONE.

before winding with wire and when wound immersing the coil for a few moments in hot paraffine, to insure better insulation as well as to prevent the wire from absorbing moisture.

The handle *C* should now be joined to the box *A* by means of glue, and when thoroughly dry the magnet *D, D*, with its bobbin *I, I*, is pushed into the channel prepared for it in the handle, and the free ends of wire from the coil are run through 1-8-inch channels (made with a red hot wire) through the handle, as shown in drawing, to be afterward passed through the wooden cap *F* and placed under the small binding screws *e, e*.

But before the cap *F* is prepared a 1-2-inch square piece of hard wood, *G*, and 1-2 inch long, is to be obtained which will just fit the channel *E*, already cut for it in the handle *e, e*. Then the small thumb-screw *d* is obtained and screwed into the block *G*, so as to form a threaded channel in the block *G*, which is then fastened to the end of the magnet *D, D* by means of a drop of glue and set away to dry. The cap *F* can now be made and a small hole drilled through it to receive the thumb-screw *d*, which is passed through the hole, and a wooden washer or collar, *c*, is fastened upon the screw by means of glue, care being taken that the glue does not prevent the screw from turning freely in the cap *F*, the object of the collar, *c*, being

merely to prevent the screw *d* from drawing out of the cap *F* when turned.

The cap *F* can now be fastened upon the end of the handle *C, C* by means of the binding post screws *e, e*, under which the ends of the wires from the coil *I, I* are passed, as before noted.

The screw *d* should be screwed into the block *G* as the cap *F* is drawn down by the binding post screws *e, e*.

The purpose of the square recess *E* in the handle and of the block *G* glued to the magnet is now evident, as when the magnet *D, D* is drawn out and in by turning the thumb-screw *d* these prevent it from turning.

In the case of the square magnet being used, this square recess is not absolutely necessary, but it is advisable to put it there for the block *G* to slide in, as this block, were it to be made of a 1-4-inch square piece of wood, would probably split apart when forcing the thumb-screw *d* into it.

The instrument being thus far completed, it only remains for us to obtain the diaphragm, shown at *H*, which is of very thin sheet iron. The "tintype" of the photographer will be found to be just what is wanted, and should be what is known to the trade as a "quarter plate," which is the smallest regular size, being 3 1-4 inches by 4 1-4 inches. This should be perfectly smooth and free from wrinkles and indentations.

When such a one is obtained the mouthpiece *B* of the telephone is laid upon it, and with a needle its exact size outside is marked upon the plate, which is then cut out with an ordinary pair of shears. The circle thus obtained is then placed between the parts *A* and *B*, and these latter fastened together with small screws, as shown. This will complete the instrument, which may then be varnished with two coats of shellac varnish (shellac dissolved in alcohol) and lamp black.

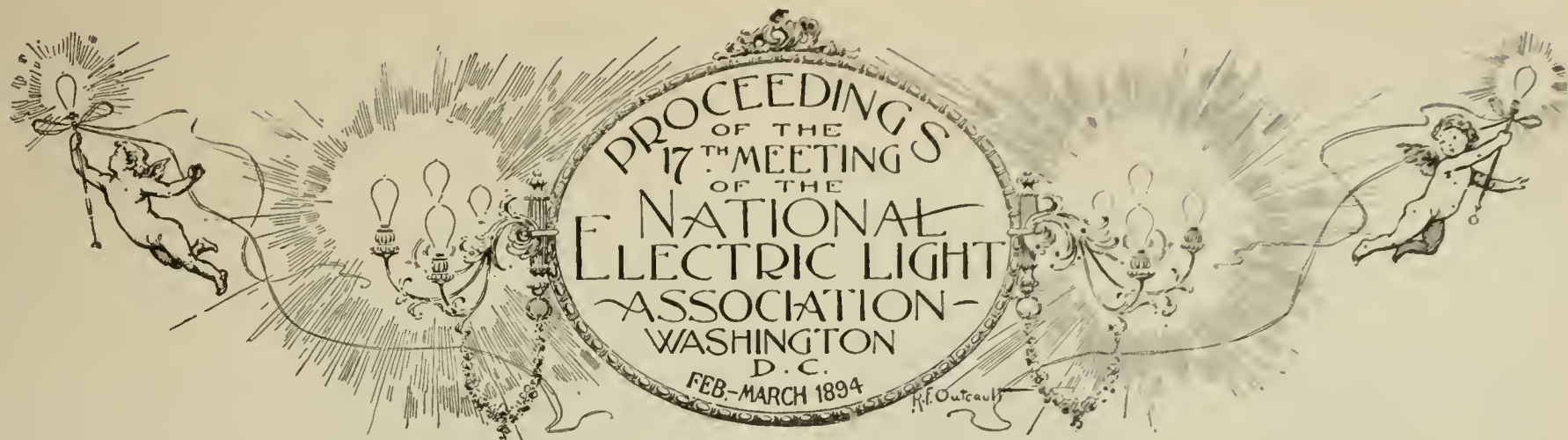
When the instrument is to be used the magnet *D, D* is to be just clear of the thin iron plate *H*, which is easily effected by means of the thumb-screw *d*.

As before stated, two instruments exactly alike are necessary to carry on speech. These may be connected with two wires leading from the binding screws *e, e*, or one wire being used between the telephones, with a "ground" return. If the line passes in proximity to wires carrying alternating currents it will be necessary, in order to avoid inductive effects, to use a metallic circuit—that is, two live wires instead of using the ground for the return circuit.

A "ground" may be obtained in moist earth by driving an iron rod into the latter and connecting same by wire with the telephone.

Steam Boilers for Central Stations.

In an article with the above caption in our last issue is a statement which, owing to a delay in the mails, we were unable to qualify by a note in accordance with the author's request. After stating that 5 h. p. remained in a boiler of the ordinary type for each horse power of rated capacity, the further observation is made "if a 100-h. p. boiler is run from 6 to 9 P. M., 500 h. p. will be left in it, or nearly twice as much as it has furnished." This method of comparison, is, however, not correct, as the rating is made on a basis of available horse power, while the 500 h. p. left in the boiler is the total horse power. Making this correction, the true results would be, that the amount of energy left in a boiler is about equal to the energy given out during two hours run under ordinary conditions. It would not, of course, take that amount of time to raise the pressure on a 100-h. p. boiler, as a boiler has an efficiency of almost 100 per cent. when started up cold, and it is not until the pressure has risen that the efficiency falls to its working amount.



The seventeenth Convention of the National Electric Light Association, held in G. A. R. Hall, Washington, on February 27 and 28 and March 1 and 2, 1894, was one of the most successful in the history of the Association. The attendance was large, about four hundred in number, and the general spirit of hopefulness as to an early revival of business was most noticeable and encouraging. The admirable manner in which Judge Armstrong discharged the duties of presiding officer was commented on and had much to do with the successful results achieved at the meeting, and the election of Mr. Francisco gives assurance of the continuance of the reputation enjoyed by this body for the dignified and successful manner in which its proceedings are conducted.

Owing to the attractions of the Capital City and the short journey from the homes of most of the eastern members, the Convention was brightened by the presence of an unusual number of ladies, whose attendance added a social feature most agreeable and the manifest appreciation of which again demonstrated the genial and gallant character of the electrical fraternity.



THE convention was called to order on Thursday morning at 11:07 by the president, Judge E. A. Armstrong, of Camden, N. J., who then delivered his presidential address, after which the convention was declared opened. The address of Judge Armstrong was in his usual felicitous style, and opened with a humorous allusion to all the advantages missed through the con-

vention not being held in Philadelphia, in accordance with his personal desire, but full justice in a more serious vein was done to the attraction and merits of the Capital City. After referring to the recent business depression, the wonderful extent of the electrical industry, the great capital invested, and of its benefits to man, the feature of the address was introduced—the rapidly growing tendency toward municipal ownership of electric lighting plants.

The revival of the sentiment in favor of municipal ownership is attributed largely to electrical manufacturing companies in their efforts to extend sales, a policy pronounced bad both for cities and the manufacturing concerns advocating it. An editorial from the Philadelphia "Public Ledger" was quoted, which, while pronouncing the general principle of municipal ownership to be sound, argues strongly in favor of just compensation to the electric lighting interests affected by the adoption of that policy. "I have read this editorial," continued Judge Armstrong, "because it sounds the proper sentiment; and every municipality that is honest, every government that is honest, every man that is in authority who is honest, must have due regard for every dollar that is invested in a business, whether of a corporate or private nature: and this unholy, this infamous, communistic warfare on these enterprises, not alone upon us, but upon kindred enterprises,

is something that is distinctively antagonistic to the principles of our government, to the principles of our institutions and to the principles of fair minded business equity; and I tell you, whenever such principles are suffered to gain a foothold in any part of this continent, whether it affects my company or your company, whether it affects a small plant in some village or town or a big company in a large city, it strikes at the interests of all alike. If the spirit that is shown in this editorial pervaded all those who are opposing us, we would have no trouble, but we do not find this to be the case. Let us join hands in this one thing. If you have a ten



M. J. FRANCISCO. GEO. F. PORTER. C. H. WILMERDING.
HON. E. A. ARMSTRONG.

thousand dollar plant in some small village, and some one opposes you unjustly there, let us feel that it strikes the two hundred millions of dollars invested in this business in this country, and that we are behind you. As electric light men and those who have invested our money in these enterprises, if met by that spirit and with that determination, there is nothing that we can say, and if that spirit and determination is exercised, and the majority believe contrary to what we do as citizens, we must acquiesce in that decision, but we have a right to expect and to demand from our city and from our government absolutely fair treatment. As I have taken occasion before to say in our counsel, a governmental department, whether municipal, state or national, cannot afford to have anything less than a fair return; it can-

not afford to deal otherwise than strictly in accordance with that beneficent rule of conduct which mankind has named the golden rule. As soon as you lower the governmental standard, you of necessity deeper sink the individual standard of morality." (Applause.)

After referring to the prosperous condition of the association, the high character of the programme and the large attendance, attention was called to a new feature, consisting of queries from members on every subject within the province



J. FRANK MORRISON.



E. R. WEEKS.

of the association, of which he hoped full advantage would be taken, feeling sure that the answers would bring forth much information of value. After paying a graceful tribute to the ladies present, the convention was then declared opened.

A letter of regret was read from Colonel Thurber, secretary to President Cleveland, stating that owing to the absence of the President from the city, it would not be possible for him to meet the delegates. Mrs. Cleveland also regretted her inability to meet the ladies accompanying the gentlemen in attendance upon the convention.

The thanks of the association were tendered to the Metropolitan Street Railway Company for passes over its line tendered the members, and to Messrs. Bryan and Hall and the Long Distance Telephone Company for their courtesy in placing at the disposition of members the use of their system, free of charge, between the hours of 8 and 9 A. M. and 4 and 7 P. M., and to the Cosmos Club for extending the courtesies of the club house to the delegates. After reading a number of letters of regret from eminent gentlemen invited to attend the meeting of the Association, the reports of committees were called for.

Mr. C. H. Wilmerding informed the meeting that there was no report from the committee on legislation, of which he is chairman, which gave rise to a lively discussion. Mr. Huntley asked that as the committee had never done any-



C. R. HUNTLEY



JAS. L. AYER

thing, it be discharged, and another means devised to accomplish the desired end. Mr. Clay offered a resolution that an attorney be employed to continuously compile a record of legislation, passed and proposed, affecting the electric lighting interests, the information to be supplied to the

various members of the association in time to be of value. Mr. Insull spoke in favor of preventive action rather than retrospective discussion, and asked that the executive itself take timely action in matters affecting the association. Mr. Morrison submitted a late bill introduced before the New York Legislature, which was read, and denounced by the president as an unjustifiable attack on the rights of property. Mr. Stetson spoke of the combined action of the electric lighting interests of Massachusetts in opposing before the Legislature adverse legislation. Mr. De Camp spoke in favor of Mr. Clay's resolution, but Mr. Seeley expressed an opinion that it was the duty of the secretary to perform the functions proposed, and thus save the expense of an attorney's fee. The resolution was referred to the executive session for action.

Mr. Seeley presented the report of the Finance Committee, which showed the association to be in a flourishing financial condition.

Mr. Frederic Nicholls, chairman of the committee on relations between manufacturing and central station companies, reported the situation unchanged, and referred to the practice of electrical manufacturers in urging the establishment of municipal plants by specious arguments. The subject was referred for further discussion to the executive session.

President Armstrong introduced Dr. Gatling, the celebrated inventor and president of the American Inventors' Association, who made some interesting remarks on the industrial growth he had witnessed during his long life. He called attention to the part played by our patent system, and



A. J. DE CAMP.



T. CARPENTER SMITH.

impressed upon the meeting the necessity of guarding it, and protecting the rights of inventors. Judge Armstrong assured the speaker that the association sympathized with his ideas, and that its efforts would be always enlisted on the side of right and justice.

Mr. Hammer called the attention of the association to a recent ruling of the Postmaster General discriminating against the periodical publications of professional, scientific and other similar associations and societies, and asked that a committee of three be appointed by the president to co-operate with a similar committee of the American Institute of Electrical Engineers in laying before the Post Office Department a protest against said action and urge a request that such periodicals be again classed as second-class matter. By a unanimous vote the president was authorized to take the necessary action, and Messrs. Adams, Young and Gwinn were appointed as members of the committee.

AFTERNOON SESSION

The report of the Committee on Data was read by Mr. H. M. Swetland, chairman, an abstract of which is given elsewhere.

In the discussion which followed Mr. Swetland stated that the average might have been lowered materially if they could have secured reports from the best stations, which

they did not. Out of the 800 answers received to inquiries sent out less than 100 were suitable for use, and the table, even as compiled, contains manifest inaccuracies. Exception was taken by some of the members to the average of seven pounds of coal per horse power, but several others stated that from their experience, particularly with the older stations, this was not excessive, and that in some cases within their knowledge it was even exceeded. The quality of coal as an important factor was referred to, and there was a consensus of opinion that in the newer stations the consumption of fuel was gotten down to four pounds per horse power, and in some instances much lower. Those joining in the discussion were Messrs. Burleigh, Nichols, Vail, De Camp, T. C. Smith, Stetson, Gwinn and Orford.

The report of the Committee on Underground Conduits and Conductors was called for, but Mr. Francisco, the chairman, explained that he thought the committee had been discharged at the Buffalo convention and therefore no report had been prepared. On motion the committee was discharged.

Copies of the report of the Committee on Rules for Safe Wiring were distributed, but the discussion was postponed until Thursday morning.

Mr. W. E. Harrington then read a paper on "Faults Incident to the Protection of Lighting and Power Circuits," an abstract of which is given elsewhere.

In the discussion Mr. White, of Evansville, Ind., said that he had used magnetic cut-outs in his station for three years with excellent results, and Mr. Robertson, of Minneapolis, stated that his experience with magnetic cut-outs was also favorable. Mr. T. C. Smith, of Philadelphia, cited in-

units adopted at Chicago. Upon the motion of a member, a resolution was adopted favoring the passage of the act referred to, and the Committee on Legislation was instructed to use its best efforts to further the measure.

The president recommended that a competent engineer be employed to prepare an address to the Association on "How Electricity and Electric Power are Generated and Used," in simple, untechnical language, the object being to furnish members with matter they may reprint and distribute for the information of their customers.

An invitation was read from the Rock Creek Railway Company offering free passage to members over its line, after which the meeting went into executive session.



MR. J. H. Vail read a paper on "The Importance of a Complete Metallic Circuit for Electric Railways," an abstract of which is given elsewhere. Messrs. Burleigh, T. C. Smith, Mason, Brophy, Law, Wright, Harrington and Cuttriss took part in the discussion on the paper, and on the topic next on the programme—"Electrolytic Effects of Return Currents." Before opening the discussion the president accepted on behalf of the Association, in an appreciative and gallant speech, a floral offering from "The Wives, Sisters and Sweethearts of the N. E. L. A.," which was accompanied by the following graceful address:

"To the Gentlemen Composing the National Electric



DELEGATES TO THE WASHINGTON CONVENTION.

stances of fuses becoming oxidized on the exterior and the interior rendered molten by the passage of an excessive current without blowing the fuse. Remarks were made by Messrs. Burleigh, Hammer, Brophy, Vail, Orford, Insull and Carnes. The general expression of opinion was that fuse wires are unreliable, and magnetic cut-outs suited only for station work.

The president introduced Prof. T. C. Mendenhall, superintendent of the Coast and Geodetic Survey, who addressed the meeting on the subject of electrical units and requested the aid of the Association, and of its members individually, in securing the passage of an act legalizing the electrical

Light Association: The ladies accompanying the N. E. L. A. as guests of the seventeenth convention of this body—with the same 'great diffidence' expressed by President Armstrong in his opening address—ask your acceptance of this expression of their appreciation of your courtesy extended to them in a never-to-be-forgotten national drive through the city of Washington. Kingsley has told us that 'Men must work, and women must weep.' We would modestly suggest that Kingsley had the misfortune not to be acquainted with the ladies of this Association, who could have assured him that 'Men will work, but never let women weep,' at least while guests of the N. E. L. A."

Mr. Bracken opened the discussion on "Storage Batteries," and was followed by Messrs. Salom and Appleton. An abstract of the discussion is given elsewhere.

Mr. Huntley gave an account of a favorable experiment with the Howard incandescent arc lamp, and at his request Professor Marks explained the technical details of the lamp. The experiment extended from Feb. 4 to Feb. 23, and was on 50 lights in one circuit 11 miles long. The streets were better lighted than with the ordinary arc, and the lamps only



PROF. GEO. FORBES



PROF. H. A. ROWLAND

required to be trimmed once in four days. In reply to an inquiry Mr. Huntley stated that he did not go into the question of cost, but that the illumination was very satisfactory. Prof. Marks spoke of the causes of former failures to produce a lamp of the Howard type, and ascribed them to insufficient knowledge as to the carbons and glass required. He stated that by a recent improvement the negative carbon would last indefinitely, and referred to the superior distribution of light from the lamp in question, and how the problem in regard to the inclosing jacket had been solved. Messrs. Seely, De Camp, Nicholls and Burleigh also took part in the discussion.

AFTERNOON SESSION.

The discussion on the Howard lamp was continued. Mr. Howard, the inventor, stated that the rod did not require cleaning during the life of the carbon, and that a saving in carbons and trimming of 20 per cent. was guaranteed. The breakage was covered by this, and the carbons cost less than those now in use. The lamp required 61 volts and less than 500 watts. A general discussion in regard to the commercial features of the question followed, in which Messrs. Howard, De Camp, Van Trump, T. C. Smith, Stetson and others took part, the opinion being that if this part proved satisfactory the lamp had a bright future.

A PAPER by Mr. A. B. Herrick on "The Development of Switchboards for Modern Central Stations," printed elsewhere in abstract, was read and discussed by Mr. Edward Weston.

Mr. Charles F. Scott then read the paper of the convention, which, with the discussion, we will print in full in our columns. After explaining in simple terms the various phenomena connected with alternating

transformed to two-phased currents; by this means a three-phased system could also supply two-phased apparatus. The convention showed a lively interest in Mr. Scott's new system, and manifested its appreciation by frequent applause.

AFTERNOON SESSION.

Prof. George Forbes opened the afternoon session with a discussion of Mr. Scott's paper. He referred to the beauty and ingenuity of the method devised by Mr. Scott, which seemed to look feasible and practical. In the course of his remarks he paid a very high compliment to Mr. A. E. Kennelly, whose recent work he regarded as the most beautiful treatment of a mathematical subject yet produced. Prof. Forbes also briefly explained why the Cataract Construction Company had made no reply to the criticisms passed upon it, stating that what was wanted was work properly done, and that it is of no moment to them what opinions others may hold.

Prof. H. A. Rowland was the next speaker, and stated that he considered that this work of Mr. Scott marked a new era in polyphase transmission; he was working along a similar line himself, and while he had succeeded in finding a way to transform the frequency, as well as the phase, his method lacked the practical merits of the one under discussion.

Mr. Scott, in reply to a question of Mr. Spenser in regard to the calculation of distributed self-induction, said that the calculation would be made in parts, and after referring to several points in Prof. Forbes' address, and paying a tribute to the work of Mr. Kennelly, spoke of the great lighting plant at the World's Fair, the vast experience gained through it, and the complete success met in solving the various problems involved.

Mr. Stillwell took issue in regard to a remark of Prof. Forbes' contradicting the statement of the Westinghouse company that the system adopted at Niagara was the Tesla polyphased system, as developed by the Westinghouse technical staff, in which position he was sustained by Prof. Rowland, when the president declared the discussion closed.

Prof. Anthony presented the report of the committee on the rating of arc lamps, which was adopted. The report, after referring to the difficulty, if not impossibility, of measuring with any degree of accuracy the illuminating power of arc lamps and the great necessity of a precise definition and statement of the obligation of the producer of electricity to the consumer thereof, defines an ordinary 2,000-candle power arc lamp as one requiring on the average 450 watts for its maintenance. The measurements should be made at the lamp terminals with no sensible resistance included in series with the arc; in case there is such resistance, it must



EDWARD WESTON



PROF. W. A. ANTHONY

be excluded in the measurement of the voltage.

The report of the committee on the National Electric Light Association's standard rules for electrical construction and operation was then read, and after a number of changes adopted. When printed we will give a comparison of these rules with those recently adopted throughout the



currents, Mr. Scott introduced for the first time to the electrical public a system combining the advantages of both the two and the three phased systems. By means of specially designed converters it was shown that the currents generated by a two-phased generator could be distributed as three-phased currents and then applied directly to three-phased apparatus or again

country by the various underwriters' associations, which were based on the rules for safe wiring formulated by the Association at a previous meeting.

The meeting then went into executive session and the following officers were elected for the ensuing year:

President, M. J. Francisco, Rutland, Vt.

First vice president, C. H. Wilmerding, Chicago, Ill.

Second vice president, Frederic Nicholls, Toronto, Can.

NEW MEMBERS OF THE EXECUTIVE COMMITTEE.

Chas. R. Huntley, Buffalo, N. Y.

A. J. Markle, Hazleton, Pa.

W. W. Carnes, Memphis, Tenn.

Upon motion of Mr. J. I. Ayer the thanks of the Association were tendered to Mr. C. O. Baker, Jr., for the admirable manner in which he had discharged his duties as master of transportation. Thanks were also voted to Judge Armstrong, president of the Association, and to the several street railway and telephone companies which had extended courtesies to the delegates during the convention.

An invitation was read from the Georgia Electric Light Company, of Atlanta; the Mutual Light and Power Company, of Montgomery, Ala., and the Anniston (Ala.) Gas and Light Company, asking that the next meeting of the Association be held in Atlanta.



PROF. L. B. MARKS, after explaining that the Howard incandescent arc lamp, while requiring a somewhat higher voltage than the usual form, took less current and could be run at a greater efficiency than the open arc, opened the discussion on the topic "Arc Lights on Incandescent Circuits," which is given in abstract elsewhere. Those participating were Messrs. Marks,

Barstow, Spencer, Andrews, Ayer, Burleigh, Nichols, Van Trump and Stetson.

The next topic, "Meters vs. Flat Rates," was opened by Mr. Frederic Nichols, who stated that most central stations using flat rates were doing so by compulsion, not being able to change without loss of customers. He spoke of the loss through the use of low efficiency lamps with flat rates, and referred to a bill recently introduced in the Canadian Parliament relegating meter disputes to government inspectors of meters. Mr. Burleigh stated that in changing from flat to meter rates one of his stations cut down the output almost one-half without materially decreasing the revenue. Mr. Carnes was in favor of meters, but Mr. Scott found that his 365 contract lights netted more than his 1,817 meter lights. Mr. Johns and Mr. Weeks both spoke in favor of meter rates. The meeting then went into executive session, at the end of which the convention was adjourned sine die.

The New Officers.

PRESIDENT M. J. FRANCISCO.

M. J. Francisco, the newly elected president of the National Electric Light Association, is a Vermonter by birth and lineally descended from the men who made the Vermont shore of Lake Champlain famous during the days of the Revolution. He entered Oberlin College at an early age, and after completing his studies travelled extensively in the South and West, locating in Harrisburg, Pa., in 1867, where he established the Pennsylvania College of Trade and Finance. Over this he presided until failing health compelled him to return to Vermont, since which time he has been identified with the best interests of his native State. As manager of many of the largest English insurance companies, he has made a record second to none in New England. He entered the electric light field in 1887 as the president of the Rutland Electric Light Company, becoming a

member of the National Electric Light Association in its early struggles, was made a member of the executive committee at the Kansas City convention and second vice president at Providence, being advanced to the position of first vice president at the St. Louis convention, and at the Washington convention was elected president. At the Cape May convention he read his first paper on "Municipal Ownership," which attracted widespread attention. He has contributed to many journals on this and kindred subjects.

In 1893 he published a book entitled "Municipal Ownership—Its Fallacy," which secured favorable editorial notice from the press of this country and Europe. So great was the demand that the first edition was soon exhausted, and the third edition is now in press.

Mr. Francisco's reputation, both upon electric light and insurance matters, has been such that he has been called to Washington, and before the State Legislatures of Massa-



PRESIDENT M. J. FRANCISCO.

chusetts and Vermont, to discuss matters pertaining to these subjects. He is a member of the American Institute of Electrical Engineers.

FIRST VICE PRESIDENT C. H. WILMERDING.

The popular first vice president, Mr. C. H. Wilmerding, served last year as the second vice president. Mr. Wilmerding was born in New York City in 1858, and was educated as a boy largely abroad, in Germany and France, and afterward at the Sheffield Scientific School at Yale, where he graduated in the class of 1879 as a civil engineer. In this profession he was employed in the construction of waterworks at Troy, N. Y., and afterward went to Colorado for about two years, where he was interested in mining work in Leadville. He then entered the employ of the Rio Grande and Western Railroad, and located and constructed a considerable portion of the road between the Colorado and Utah lines and Salt Lake City. In 1884-1885 he was employed as an assistant engineer on the new Croton Aqueduct in New York City, and continued in the practice of

civil engineering until the beginning of 1888, when he turned his attention to electricity and located in Chicago.



FIRST VICE PRESIDENT
C. H. WILMERDING.

In the fall of that year he was made superintendent of the Chicago Arc Light and Power Company, and subsequently its general manager, and served in that capacity until about a year ago, when that company consolidated with the Chicago Edison company, since which time he has been in charge of the operating of the combined companies' properties. Mr. Wilmerding has always taken great interest in the National Electric Light Association, and well deserves the

the honor which has been conferred upon him.

SECOND VICE PRESIDENT FRED. NICHOLLS.

The second vice president, Mr. Frederic Nicholls, is one of the best known and most popular members of the Association, and his connection with the press and various commercial enterprises has brought him prominently before the public. Mr. Nicholls enjoys the distinction of being the only "foreign" officer of the Association, his home being across the border in Canada. For many years he has taken an active part in the meetings of the Association,



SECOND VICE PRESIDENT
FREDERIC NICHOLLS.

and has been at its various meetings. He has also manifested great interest in the Canadian Electrical Association and in the Association of Edison Illuminating Companies. That he has occupied a prominent position in the business world is evidenced by the following positions which he has occupied: Second vice president and general manager of the Toronto Construction and Supply Company; director of the Incandescent Light Company of Toronto; president of the Brantford Electric Street Railway Company; general manager of the London (Ontario) lighting systems; and vice president and general manager of the Canadian General Electric Company.

Convention Notes.

HERE AND THERE

The youngest attendant at the convention was Miss Mac Everett Mason, the ten-year-old daughter of General Manager Mason, of the Simplex Electrical Company, of Boston.

Brides of the convention were numerous and handsome, including Mrs. Hammer, Mrs. Sullivan, Mrs. Foster and Mrs. Issertel.

The convention brought genuine happiness to at least two

of its attendants. Early in the session a pretty romance was quite completed by the betrothal of a well-known electrical man to one of the prettiest of the girls at the Ebbitt.

The convention was notable for its thoroughly business-like aspect. People attended strictly to business, and the result was that every one was satisfied.

PERSONAL.

J. H. MASON was the only representative of "Simplex" wire, but that was sufficient.

CHARLIE HUNTLEY arrived Tuesday morning and was kept busy renewing old acquaintances.

FREDERICK A. DUGGAN did much to advance the fame of the Imperial Porcelain Works, of Trenton, N. J.

ISAAC H. DAVIS carried the banner for Westinghouse, Church, Kerr & Co., and did it exceedingly well.

GEORGE G. CARTER, whose name has recently come into prominence in Chicago, made a host of new friends.

J. JONES & SON, 39 Vesey St., New York City, had their interests well cared for in the hands of James Jones, Jr.

A. H. PATTERSON, of 42 Murray street, New York, had much to say on behalf of the Phoenix Glass Company.

GEORGE A. MCKINLOCK was one of the notable Western men. He is East on a short trip, accompanied by his family.

C. B. PRICE did the honors for the Pettingell-Andrews Company, of Boston. Mr. Price knows how to do the right thing.

FRANK R. FORD, for many years with the Brush-Short interests, represented the La Roche Electric Works at this convention.

F. H. LEONARD, of the Dahl Electric Company, was among the early arrivals. He was likewise one of the most popular fellows present.

HENRY G. ISSERTEL, of 39-41 Cortlandt street, New York, was one of the busiest men present. He had a very neat display in the red parlor.

EX-PRESIDENT AYER came up from St. Louis somewhat behind time. As every one knows, Mr. Ayer is now in business for himself in that city.

L. K. COMSTOCK, the well-known electrical engineer of the Monadnock Block, Chicago, was one of the youngest yet best known of the visitors from the West.

E. A. RECORD, special manager of the electrical department of the Vacuum Oil Company, of Boston, hustled as hard, if not a little harder, than usual.

E. WARD WILKINS was another of the solitary representatives of a great house. Every one knows that he speaks only for Partrick & Carter, of Philadelphia.

HENRY C. KELLOGG, JR., kept the name of Alfred F. Moore, manufacturer of insulated wire, with headquarters at 200 North Third street, Philadelphia, among the leaders.

FRANK W. BRIGHAM, one of the busiest men at the hotel, hustled hard and did much good on behalf of the Indiana Rubber and Insulated Wire Company, of Marion, Ind.

P. H. ALEXANDER came up from the Monumental City to renew old acquaintances. He is now an electrical engineer, with an office in the Equitable Building, Baltimore.

DR. CHARLES H. BOWEN, of Washington, had something of great interest in the line of insulation.

J. HOLT GATES was the only representative of the Waddell-Entz Company. The opinions expressed at the convention were that this company would soon be all right.

FRANK W. HARRINGTON easily kept the name of the New York Insulated Wire Company prominent. "Jim" Godfrey was detained at Chicago on important business.

J. H. VAIL distributed a folder entitled "Facts of Interest to Electric Lighting and Railway Companies." If you failed to get a copy, address Mr. Vail at 44 Broad street, this city.

JOHN MCGHIE, the popular representative of the General Electric Company, was one of the busiest men in sight, and he was always in sight. It is doubtful if any one missed securing the neat pamphlets which he distributed.

E. H. HEINRICH, the genial advertising agent of the Westinghouse Electric and Manufacturing Company, did his usual amount of careful, effective work for his company. Every one familiar with conventions knows the value and importance of such efforts.

FIELD DAY at the convention was the day the following gentlemen by the name of Field, who happened to meet in Washington, celebrated the occasion by a social dinner to become better acquainted: Burr K. and John M., of the Berlin Iron Bridge Company; C. J., of the Field Engineering Company, and W. A., of the local electric lighting company, of Columbus, Ohio. The Messrs. Field are not related, except by ties of friendship and of business.

"CHARLIE PRICE!" rang out in the rotunda of the Ebbitt House, in Washington, during the convention, and four men promptly answered: "Hello!" "That reminds me," remarked Mr. C. B. Price, of the Pettingell-Andrews company, blushing furiously, "of several awkward dilemmas in which I found myself at the Montreal convention, when delegate after delegate assured me that he had had the pleasure of meeting my wife; but," he added, "this convention surpasses the one at Montreal in the number of Prices." "You haven't seen Cut Price at the convention?" asked one of his auditors. "No," was the rejoinder, "but I have seen Low Price everywhere."

AMONG THE EXHIBITORS.

"AJAX" SWITCHES were kept in line by their maker, C. S. Van Nuis. Van was, as usual, very popular.

THE ABENDROTH AND ROOT water tube boilers had out a very complete line of pamphlets and literature.

THE NATIONAL WATER TUBE BOILER was represented by some neat printed matter that was well distributed.

THE BACKUS ELECTRIC CEILING AND COLUMN FANS were well represented by neat flyers, and further by R. B. Cissel.

WASHINGTON CARBONS, by a happy coincidence of names, were very prominent. J. S. Crider was their chief hustler, and he did hustle.

"CHICAGO WIRE," in white letters on a black ground, arrested the eye of all those who were looking for standard literature on insulated wires.

MUNSON BELTING had a brilliant corps of men in the persons of President A. Groetzinger, of the home office, and Colonel Shay, of Chicago.

THE SHAWHAN-THRESHER APPARATUS had an unusually enterprising corps of drummers in F. G. Bolles & Co. They distributed some very neat cards.

THE UNITED STATES MINERAL WOOL COMPANY, of 2 Cortlandt street, New York, had out an effective little card, with sample of its corrugated copper gasket.

"O. K." WIRES AND CABLES, manufactured by the Phillip Insulated Wire Company, of Pawtucket, R. I., were two letters that no one failed to observe.

SCHIEREN BELTING, whose interests were well taken care of by Charles A. Schieren, Jr., gave away scores of their "Points on Perforated Electric Belting."

THE IONA MANUFACTURING COMPANY, of Boston, by some clever movement secured the mirror space in the red parlor, where it displayed a full line of its famous specialties.

BELKNAP MOTORS were very much in evidence. Manager Brown was on hand early with a new woven wire dynamo brush that he took pride in showing to the delegates.

"THINGS ARE NOT ALWAYS WHAT THEY SEEM" is an axiom on the cover of a neat little booklet issued by the Goodrich Hard Rubber Company. This is worth writing for.

THE HOLTZER-CABOT ELECTRIC COMPANY, of Boston, was well represented by the firm of Royce & Marean, of Washington, who distributed some neat cards and dodgers.

W. R. BRIXEY must have been side-tracked somewhere, for he did not show up. "Kerite," however, was in no sense lost sight of, as it was particularly well advertised.

BONNELL'S NUBIAN SYSTEM OF SCALE PREVENTION was described in a neat booklet issued by the manufacturers of the same, the National Chemical Works, of Craigin, Ill.

A NEW MAST ARM was shown by its inventor, Thomas F. Brady, of New Britain, Conn. This, by the way, is a very clever device, and is certain to meet with popular favor.

FRANK A. THAYER, representing the Goubert Manufacturing Company, of New York, was one of the busiest men at the convention. He kept the name of his house well to the front.

MR. W. J. NEWTON, head of the firm of the Newton Electric Company, of 41 Cortlandt street, New York, was one of the youngest of the hustlers. He made many new acquaintances.

McEWEN ENGINES had an excellent representative in the firm of F. G. Bolles & Co., general agents. They distributed some splendid literature descriptive of this well known engine.

DAVID E. EVANS & Co., of Baltimore, Md., doing a large business in construction of street railways and isolated plants, was represented by Mr. David E. Evans and Mr. G. R. Holmes.

PASS & SEYMOUR, of Syracuse, N. Y., as usual, displayed an interesting line of porcelain specialties. They were nicely located in the parlor, and were well represented by Partner Seymour.

AGENT JOHN R. COFFMAN, of the Eureka Tempered Copper Company, had some trouble getting his exhibit to Washington and in place; but he "got there," as all agreed who visited the red parlor.

THE ELECTRICAL ENGINEERING AND SUPPLY COMPANY, of Syracuse, N. Y., received many congratulation on its handsome switchboard display in the red parlor. Manager H. J. Gorke was in charge.

THE PAGE BELTING COMPANY, whose headquarters seemed to be everywhere, had an excellent representative in Geo. T. Moore. He handed out some pamphlets that every central station man present secured.

ABENDROTH & ROOT was one of the most conspicuous names in the exhibit parlor, for under this title was displayed a remarkable amount of literature on that well known water tube boiler.

THE ROYAL ARC ELECTRIC COMPANY made a fine impression. Two of its very best lamps were burning in the rotunda of the Ebbitt House, and Louis B. Marks and J. J. Gates were hustling hard to promote its interests.

"SUNBEAM" LAMPS had an excellent representative in the person of Mr. F. S. Terry, who may justly claim to be one of the pioneers of the Association. He reports the condition of the lamp market in the West as all right.

THE FALLS RIVET AND MACHINE COMPANY sent Mr. E. L. Babcock, who has been a familiar figure at events of this kind. He reported business on the mend. Mr. C. A. Babcock was also in attendance and made many friends.

AUTOMATIC MOTOR STARTERS and rheostats, as well as a line of electric heaters, were exhibited under the auspices

of the Automatic Switch Company, of Baltimore, Md. This was one of the few operative exhibits shown.

"PARASITE" stared at every one from the attractive pamphlets distributed by Manager Brigham, of the Insulated Wire Company. Whoever missed securing one of these should write the company; they are worth preserving.

THE BRYANT ELECTRIC COMPANY, of Hartford, had an artistic display of their specialties. The new things shown were their arc light cut out and 500-volt porcelain switch for railroad work, and "Bryant Switches" loomed up in good shape in the handsome red covered pamphlet distributed. Mr. Bryant was himself in attendance, and his neat exhibit won for him many compliments.

"THESE ARE OUR JEWELS" is something of a novelty in way of expressions. The Electric Appliance Company, of Chicago, used it to good effect in describing its specialties. Its interests were looked after by Mr. Frank W. Brigham.

"HAVE YOU EVER HEARD OF PARAGON PITCH?" is the query with which the Meriam & Morgan Paraffine Company addressed the reader in a neat little book on its new insulating compound. This bit of literature was much in demand.

THE "WARD" ARC LAMP, that has been prominent at all the conventions of recent years, had no need of an exhibit. Hundreds of them were in active service in the city of Washington, and Manager Corey was himself everywhere.

GEN. E. S. GREELEY, head of the oldest electrical supply house in America, was in attendance. This firm has been located in Dey street, New York, for twenty-nine years consecutively. General Greeley was ably assisted by Mr. F. A. Magee.

THE PATRIARCH OF THE CONVENTION WAS Mr. Joel Sharp, president of the Buckeye Engine Company, of Salem, Ohio. Mr. Sharp, though seventy years old, is bright and active. His company was one of the first to manufacture an engine for driving dynamos. Supt. G. A. Barnard was also on hand.

AGENT JOHN R. COFFMAN, representing the Eureka Tempered Copper Company, had a hard struggle against the carelessness of express officials and others to get his exhibit in place, but he finally got there and made a very creditable display.

THE LOVE ELECTRIC CONDUIT SYSTEM had most genial advocates in Manager A. G. Wheeler and Mr. M. D. Law. They called attention to the success of the system on the Rock Creek Railway, and many of the delegates took occasion to inspect the same before leaving Washington.

A single "S" was conspicuous about the hotel. Every one knew that this stands for Safety insulated wire and cables. The absence of General Manager Requa was certainly to be regretted, but important business engagements prevented his coming.

"PARTICULARLY ATTRACTIVE" is a term that describes the ceiling fan exhibit of Diehl & Co. They showed a combination ceiling fan and electrolier, in which a group of five incandescent lamps was placed below the fan motor. It was much admired.

THE STERN UNIVERSAL ELECTRIC COMPANY had a unique operative exhibit of their "Universal pull socket" at the head of the stairs, in charge of Mr. Stern. He lost no opportunity, and they were numerous, of telling the good points in favor of this clever device.

THE JEWELL BELTING COMPANY, of Hartford, a name that is familiar to every electrical and street railway man, was represented by Secretary Charles E. Newton and Charles L. Tolles. They gave away some of their souvenir bill cases that were highly appreciated.

THOUGH NOT IN THE EXHIBIT HALL, many of the delegates had an opportunity of seeing one of the new Crocker-Wheeler motors in operation in the window of Royce &

Marean, 1,408 Pennsylvania avenue. Dr. S. S. Wheeler was in attendance at the convention.

THE STANDARD UNDERGROUND CABLE COMPANY, of Pittsburg, Pa., was fortunate to be so well located. It was next door to headquarters. In addition to the hustling of Messrs. Marsh and Wiley, it had a neat exhibit in the red parlor, and also distributed its price list, No. XII.

QUEEN & Co.'s exhibit of measuring instruments was much admired, including, as it did, samples of their finest instruments. James G. Biddle and E. G. Willyoung proved themselves worthy representatives.

C-S SPECIALTIES, manufactured by the Cutter Electrical and Manufacturing Company, of Philadelphia, were neatly displayed on a sample board in the exhibit hall and clearly described in its circular price list C. Every one who missed this pamphlet should write for a copy.

THE FAMOUS HART SWITCHES were represented in an attractive pamphlet issued over the name of Hart and Hegeman Manufacturing Company, of Hartford, Conn. These were widely distributed and received many compliments. Manager A. H. Pease was on hand and kept busy.

THE MOSHER ARC LAMP COMPANY, of Chicago, expected up to the last moment to send one of its new and remarkable alternating lamps, but Secretary Sheriffs wired that he was detained to close a big contract for arc lamps at Sandwich, Ill. This lamp is meeting with a royal reception.

SOCKETS AND INSULATORS of an improved type were shown in the red parlor by the Hammond Cleat and Insulator Company, of 220 Devonshire street, Boston, Mass. Frank W. Brigham was in charge and Inventor D. J. Cartwright was with him. This line received many compliments.

THE BROWN TELEPHONE, well known in Washington, where many years ago it had an operating central station, advertised to the members of the convention in a new and much improved type. Major Groesbeck, of the Chicago office, was expected, but he did not arrive.

THE W. S. HILL ELECTRIC COMPANY, of Boston, displayed a complete line of its specialties in Parlor 40. President Hill was in attendance, assisted by Mr. George H. Poor. Its switches were particularly admired, while particular interest was shown in the Doane lightning arrester.

THE PACKARD LAMP COMPANY, of Warren, O., had, by all means, the most complete and interesting incandescent lamp display. It showed a neat string of lamps in candle powers from 5 to 500, the latter being worthy of special attention. W. D. Packard was himself in attendance.

F. P. LITTLE ELECTRICAL CONSTRUCTION AND SUPPLY COMPANY, of Buffalo, N. Y., manufacturers of the popular Kester arc lamp, made a splendid showing. Several of their handsomest lamps were on exhibition, and they gave away the most complete catalogue distributed at the convention. They were represented by Messrs. Little, Kester and Williams.

THE MATHER ELECTRIC COMPANY, of Manchester, which claims to have more isolated plants in the city of Washington than any other company, was contented with the exhibit of its apparatus afforded by the lighting plant of the hotel. Vice President Thomas C. Perkins felt very proud of his display.

"OKONITE" was as well as ever to the front. Its corps of representatives included Captain Candee, George T. Manson and George A. McKinlock, the latter from Chicago. These busy men found time to distribute a very handsome paper weight, representative of a section of "Okonite" cable.

THE NEW HAVEN INSULATED WIRE COMPANY exhibited a fan motor running 720 revolutions per minute on 110 volts, and using but 1 1-2 amperes. With this power it was capable of exhausting 7,500 cubic feet of air per minute. The motor can be wound for arc, 220 or 500 volt circuits.

MCMANARA BROTHERS, of Fairhaven, Vt., miners of slate

and marble for electrical purposes, circulated cards and literature of a character that made their name prominent. This firm has recently opened an office at 156 Liberty street, New York, and placed it in charge of George W. Zelig.

THE HENRY R. WORTHINGTON PUMPS had many an effective word spoken for them by Mr. Louis R. Alberger, of the city office. The company have perfected a system by which electrical plants do not of necessity have to be located near a river or water supply in order to obtain the benefits of condensation.

DOUBLEDAY, MITCHELL & Co. showed quick-break knife switches, which they control as manufacturers and sales agents, and also the flexible canvas jacket conduit, manufactured by the American Circular Loom Company, of which they are agents. Both excited much attention.

P. H. HOOVER, of Chicago, so long representing the P. & B. interests in that city, was present, his new card showing that he is now with the Mica Roofing Company, of 73 Maiden Lane, New York, with an office in the Boyce Building, Chicago. Hoover found a host of friends at the convention.

THE H. W. JOHNS MANUFACTURING COMPANY, whose interests were well looked after by W. F. D. Crane, gave out a handsome set of chips made from their well known insulating material. "No limit" was the assurance written on the box. They also made a very neat display of their specialties.

NOT LARGE, BUT ELOQUENT about describes the exhibit of the Interior Conduit and Insulation Company, of New York. Representative Mace was kept busy "hustling" among old customers and making new ones. He distributed to good effect an excellent number of their "Architects' Bulletin."

CHARLES E. GREGORY, from Chicago, of course, had a good deal to say for the "Climax rheostat and starting box," manufactured by McDougall, Lucas & Co. He had no other exhibit than his vocabulary and unique personality, but those seemed very effective. He also said a thing or two for the Chas. E. Gregory Company.

"P. & B.," by which letters every one knows the most famous insulating compounds, had their hard-working manager, Frank De Ronde, on the scene early. Later he was joined by President Shainwald, and together they kept the two letters of their house in the most conspicuous altitude.

THE WESTON STANDARD INSTRUMENT was particularly well exhibited. A full line was shown in the red parlor, while a particularly attractive set of pamphlets and descriptive matter was distributed. Mr. Edward Weston and Mr. Richard O. Heinrich were kept busy, and their efforts were made doubly effective by the presence of Agent Charles D. Shain.

"BRUSH APPARATUS FOR ELECTRIC LIGHTING" is a sentence that has been perhaps the foremost for the longest period since the starting of arc lighting, yet they advertised and hustled as hard as ever for business at this meeting. Manager Hamill, assisted by Brother Prentice, could be found almost anywhere.

BUCKEYE LAMPS were in charge of Representative Lean. Neat signs about the hotel announced that these lamps were burning on the hotel circuits. In addition to this, he had one of his well-known coiled filament lamps burning at the head of the stairs, and another in the red parlor. Also a fine case of samples, including a 50-volt filament and small house lamps.

THE METROPOLITAN ELECTRIC COMPANY, though not represented in person by any of its well known men, distributed some effective literature, speaking with special emphasis of P. & B., of which the company is general Western agent. The Messrs. McKinlock found it impossible at the last mo-

ment to get away on account of numerous important engagements in the West.

NEW TELEPHONES figured more than ever before in this electric light convention, on account of the expiration of the patents. The instrument of the Western Telephone Construction Company, of Chicago, had already been installed by many of those in attendance, and was most favorably mentioned. President Keelyn was expected, but was unable to be present.

THE "IDEAL" INSULATED WIRE loomed up in an ideal fashion. A coil of this wire that had been "two months in soak," was displayed in a pan of water. Current for the operation of several incandescent lamps was flowing through this immersed coil, and there was no diminution of the light. Henry C. Adams had charge of the display, and distributed some neat literature.

THE BERLIN IRON BRIDGE COMPANY had a neat exhibit of its "patent corrugated iron roofing." The interests of the company were looked after by Burr K. and John M. Field. They called attention to the fact that their new roofing had been used in the Washington station of the United States Electric Light and Power Company. Many of the delegates journeyed there to inspect it.

THE AMERICAN ELECTRIC MANUFACTURING COMPANY, of St. Louis, was one of the most noticeable of the incandescent lamp companies. Mr. Louis Nahm had with him samples of his "American" and "Republic" lamps, and in addition gave away the neatest souvenir of the convention, in the shape of an incandescent lamp arranged as a balloon. He also distributed some neat pamphlets.

THE STIRLING COMPANY, of Chicago, makers of the celebrated Stirling water tube boiler, had out some effective literature, the title of which commences curiously with the query, "Has a Competitor Ever Advertised You?" Agent Scheffler also distributed some neat memoranda books that were greatly sought after. Secretary Stettinius was at the last moment detained at Chicago, but his interests were well taken care of.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY, of New York, was one of the most prominent exhibitors. Its most interesting display was on the second floor of the Ebbitt House, where it had installed one of its handsome two-light chandeliers. This was greatly admired. The exhibit of switches in the red parlor was equally noticeable. Mr. S. A. Douglas, its representative, was particularly active at all times in saying a good word for his house.

MR. ELIAS E. RIES, president of the Ries Electric Specialty Company, of Baltimore, and representing the above company at the convention, extended a cordial invitation to all the delegates and all interested to visit the company's factory at South Gay street, Baltimore, where a line of the well known Ries sockets and switches, and also a full line of the "Ries & Scott" single phase and alternating current motors were on exhibition. He also had a neat exhibit in the red parlor.

WESTINGHOUSE INTERESTS were, as usual, well taken care of. C. Townley and Oscar H. Baldwin, of the lighting department; C. F. Scott and A. J. Wurts, of the technical corps; Messrs. C. A. Bragg, E. F. Seymour and C. B. Humphrey, of the selling department, and L. B. Stillwell, representing the company in general, were all active in their efforts to make the name of Westinghouse prominent. The company's headquarters in parlor 47 of the Ebbitt House were quite popular, and there was a big demand for its new pamphlet describing the series arc lighting system of the company.

THE CARPENTER ENAMEL RHEOSTAT COMPANY, exhibited for the first time an invention of H. Ward Leonard, which has great promise. It is an improvement in rheostats, but on

account of patents still pending, Mr. Leonard would not make public any of the important details, but stated that any device for the conversion of electricity into heat, such as soldering irons, flatirons and rheostats, can be so constructed as to be operated at a red heat or less temperature without any destructive effect. Under this principle a No. 18 B. & S. German silver wire has been made to carry a current of 80 amperes instead of 4 amperes, which would be its full current capacity if exposed to the air as usual. Both Mr. Leonard and Mr. Carpenter were present.

GENERAL ELECTRIC COMPANY, while making no special display of the improved apparatus it has recently perfected and brought out, brought down the first few of the new Thomson '93 arc lamps for incandescent and railway circuits. These were suspended in front of its Washington agency, opposite headquarters. Examination of the lamp mechanism showed its marked superiority from the point of view of simplicity. These lamps formed the centre of an admiring crowd of arc light station men. In addition, the new arc and railway watt meters were shown. These have only very recently been perfected, to meet what had become a crying necessity. Their practical operation showed a precision and perfection equal to that of their well-known recording watt meters for incandescent circuits. The General Electric Company was well represented by the following gentlemen: S. Dana Greene, A. D. Page, C. B. Davis, F. C. Todd, W. S. Howell, T. Beran, John McGhie, A. B. Herrick, and one or two others. They were all warmly welcomed by their old friends, the central station men, and from their busy appearance, seemed to be laying the foundation for much future business. Mr. Herrick's paper on switchboards and switchboard work was one of the attractions of the convention, and illustrated with numerous views projected on a screen.

Faults Incident to the Protection of Lighting and Power Circuits.

Mr. W. E. Harrington read a paper with the above caption, of which he and Mr. L. S. Stanley were joint authors, calling attention to the various causes affecting the reliability of fuses and magnetic cut-outs. The defects in fuses are enumerated as follows:

1. Lack of uniformity in proportioning and mixing the constituent alloys of the fuse; also in the methods of drawing the wire to a uniform geometric cross section, and in preparing the fuse for the market.
2. Lack of uniformity, in practice, in the actual placing of the fuse in the following particulars:
 - a. Length of fuse for a given service.
 - b. Mass of the terminals used.
 - c. Position of fuse as to whether it be vertical or horizontal.
 - d. Environment, whether it be held in suspension, between terminals, or is allowed to lie along its entire length upon a mass of heat radiating material, and whether it be open to the air or enclosed in a chamber.
3. Deterioration caused by—
 - a. Recurring abnormal currents.
 - b. Oxidation from various causes.
 - c. Disintegration from local voltaic action.
4. Impairment of contact at terminals due to loosening of the clamps from temperature expansions and contractions, or to mechanical or electrical causes.
5. The "Peltier" effect.
6. The abuse of acceptable fusing devices, by substituting for the metals designed to be used in them others that are unsuitable.
7. Time element. Practice has demonstrated that fuses rarely, if ever, "blow" in time to accomplish the object for which they are placed in circuit. There is also a wide range of uncertainty as to the constancy of this period of time for any given fuse.
8. Capacity of the ordinary fuse wire to pass current far in excess of its rated blowing capacity for a period of time sufficient, in a majority of cases, to cause damage to some portion of the circuit. The conclusion of

the authors is that the fuse wire cut-out is not only an absolute failure, but actually dangerous.

Magnetic cut-outs are divided into two classes: first, a long throw knife-blade switch operated to open by a trip actuated by the armature of an electromagnet, and, second, a device for preventing or for blowing out the arc formed at the switch jaws by the breaking of the circuit. The principal point of difference in any two magnetic cut-outs of the present day is the methods adopted to overcome the destructive effect of the arc, which are the auxiliary break method and the electromagnetic blow-out method. Of these the first is criticised on account of the carbon plates or pencils employed, which are not only fragile and quickly destroyed by an abnormal current, but generate a highly conductive gas, which may not only cause damage in the circuit in which it is evolved, but also to neighboring circuits on the switchboard. Besides, the auxiliary circuit is not competent to carry its proportion of an abnormal current, with the consequence that both the bridge and switch plates may be fused before the circuit is opened. Other defects are pointed out, but the conclusion is reached that, with all of their faults, magnetic cut-outs are superior to fuses.

A magnetic cut-out which would exhibit a long stride toward ultimate perfection would be a switch operated to open by the direct action of a magnet upon the switch bar in such a manner as to cause the current itself to drive the bridge away from the switch plates, thus insuring the quickest possible response to an abnormal current. The break at the switch terminals should be protected by a by-path or shunt across the switch terminals, composed of a fuse wire of a carrying capacity sufficient to carry the current for a period of time ample to allow the switch bridge to reach a point of safety, and of a fusing capacity that will cause it to "blow" instantly when the switch bridge has thus reached a point of safety. The magnetic circuit should be so arranged that the point of saturation would be beyond the capabilities of the flux incident to the opening of the switch upon the passage of a current at which it might be set and expected to open. Consequently, when abnormal currents, in excess of that at which the switch was set to open, occurred, the result would be an acceleration of movement of the plunger up to the point of saturation, and the time element would thus be reduced to a minimum.

Coal Consumption in Generating Electricity.

The committee on data of the National Electric Light Association, consisting of H. M. Swetland, T. Carpenter Smith, E. F. Peck, G. G. H. Blaxter and C. E. Scott, presented the following table as the result of their efforts to procure data on the consumption of coal in generating electricity. The report calls attention to the fact that the results do not compare favorably with those secured in generating power for manufacturing purposes, and point out the superior economy obtained with large units running continuously. In order to facilitate comparisons, a table has been prepared on the basis of 90 per cent. mechanical engine efficiency and with the same efficiency for the dynamo, as follows:

Coal per hour per 1 H. P.	Watt hours per lb. of coal
1.00	600.00
1.05	571.43
1.10	545.45
1.15	521.74
1.20	500.00
1.25	480.00
1.30	461.54
1.35	444.44
1.40	428.57
1.45	413.79
1.50	400.00
1.55	387.10
1.60	375.00
1.65	363.64
1.70	352.94
1.75	343.28
1.80	333.33
1.85	324.07
1.90	315.79
1.95	307.69
2.00	300.00

Central Station Storage Batteries.

TABULATED STATEMENT OF DATA.
(Where there are blanks in the table, details were not given.)

Hours.	Amperes.	Volts.	Watt-hours.	Pounds Coal.	Kind.	Watt hours per lb. coal.
24	58½	115	1,609,070	10,800	slack	150
15½	101	120	187,860	2,940	.....	64
14	.....	.....	386,385	3,755	slack	103
.....	.....	.....	10,989,870	64,155	slack	171
6	25 inc.	1,000	312,000	4,200	.....	72
6	18 arc.	1,500	.....	.....	.....	.....
6	800 inc.	52	361,800	8,000	slack	45
9½	6.8	2,750	.....	.....	.....	.....
24	200	1,100	2,090,000	39,750	Ind. block	53
22	10	117	250,600	16,420	Ind. block	166
7	879½	1,180	59,500	2,000	soft	30
10	4½	2,000	247,500	4,400	slack	56
14½	225	110	381,023	7,300	soft	52
7	20	1,046	110,880	1,000	pea	110
6	6.8	1,632	315,360	6,930	slack	46
14.6	7	2,640	401,249	5,469	slack	73
6.5	.....	.....	982,800	.....	.....	.....
24	39	1,050	172,058	30,852	slack	42
8½	9.6	2,068	355,200	5,925	slack	46
24	296	500	270,000	7,000	Pekay	95
15	150	120	81,000	.....	.....	.....
13	400	113	279,000	4,000	.....	70
10	10	810	152,000	1,404	slack	108
6	300	120	99,550	1,584	.....	79
8	10	1,050	26,460	.....	.....	.....
8	19	1,000	12,920,136	70,352	screenings	183
7	113½	110	2,217,600	38,220	hard sc'gs	208
24	6¾	560	375,000	7,942	Cumberland and sc'gs	106
inc. 24	4,409	122.1	421,600	46,000	.....	.....
arc. 24	84	1,100	189,100	6,000	.....	31½
pwr. 24	80	2,000	283,820	5,450	Ptbg. nut and slack	52
.....	145	550	974,160	12,267	soft	186
15	234	50	720,000	.....	.....	.....
4	6.8	500	132,000	2,000	bit. slack	67
7	285	54¼	3,000	1,400	Lehigh pea	65
12½	268	52	91,368	4,200	buckwheat	90
inc. 24	369	110	1,838,700	18,600	.....	132
pwr. 18	80	500	614,250	8,960	ant. bkwt.	110
arc. ..	.....	.....	990,000	3,257	Vgy. lump	83
6	200 inc.	110 inc.	132,000	3,500	Pardee soft	96
16	10 arc.	50 arc.	3,000	6,000	ant. bkwt.	92
14½	141	108	787,520	6,500	bituminous	121
15½	26	1,000	389,760	27,366	Y'ghiogheny	104
15 inc.	108	1,135	2,455,200	3,000	bituminous	98
18 pwr.	65	525	81,812	3,360	slack and nut	111
15	60	1,100	370,760	6,100	bituminous	88
inc. 11	20	1,000	2,160	6,048	buckwheat	126
arc. 5½	9½	1,000	12,090	6,500	buckwheat	192
12	28	1,000	52,500	8,190	Pittsburg	122
inc. 13	400	52	312,666	2,880	Leh. V. pea	109
arc. 11	9½	2,700	267,375	3,500	bituminous	76
16	46	1,070	121,680	1,681	Cumberland	85
pwr. 12	160	203	21,600	16,000	hard rice	152
inc. 24	775	132	1,344,000	4,805	buckwheat	114
inc. 8	240	110	1,080,000	4,800	bituminous	71
arc. 7	8½	1,375	547,028	7,380	slack	68
inc. 15½	230	104	110,250	1,800	.....	112
arc. 6	8	45	138,600	1,800	slack	40
inc. 15½	15	52	307,800	6,760	Sidney	46
arc. 13	10	4,050	594,000	4,300	buckwheat	170
inc. 14½	20	1,000	140,400	1,400	bit. slack	62
arc. 14	10	3,400	87,230	2,000	pea	143
15	1,600	52	284,600	55,420	soft coal	68
24	373	112	3,750,000	2,100	coal	117
14	22½	1,000	246,400	5,320	lump	46
7½	310	115	246,001	1,800	.....	112
inc. 6½	156	120	72,800	1,800	slack	40
arc. 6	30	120	135,000	2,400	bituminous	56
inc. 24	500	112	1,180,306	16,053	good lignite	73
arc. 8	100	9.6	308,000	12,000	slack	40
pwr. 24	200	225	165,000	3,200	McAl. lump	76
16.3	33.56	1,000	171,197	3,640	Iowa slack	47
inc. 12	25	1,000	501,256	7,500	buckwheat	67
arc. 5	8½	1,000	.....	.....	.....	.....
inc. 15	26	1,000	.....	.....	.....	.....
arc. 7	350	45	.....	.....	.....	.....
inc. 7	180	110	.....	.....	.....	.....
arc. 12	9.5	2,700	.....	.....	.....	.....
inc. 18	30	1,100	.....	.....	.....	.....
arc. 12	6½	1,800	.....	.....	.....	.....
6½	122	110	.....	.....	.....	.....
8	inc. 19.25	1,100	.....	.....	.....	.....
25	arc. 9.6	1,500	.....	.....	.....	.....
10	1,200	125	.....	.....	.....	.....
10	220	112	.....	.....	.....	.....
6	217.7	113	.....	.....	.....	.....
5	inc. 22	1,060	.....	.....	.....	.....
9	arc. 6.8	1,500	.....	.....	.....	.....
10.46	120	112	.....	.....	.....	.....
14	120	125	.....	.....	.....	.....
11	200	110	.....	.....	.....	.....
11	10	1,500	.....	.....	.....	.....
7½	20	1,100	.....	.....	.....	.....
14	203	115	.....	.....	.....	.....
inc. 17½	inc. 30½	1,000	.....	.....	.....	.....
arc. 7½	arc. 52	102	.....	.....	.....	.....
	14	54	.....	.....	.....	.....
	10	1,000	.....	.....	.....	.....

Average watt-hours per pound coal, 91.7

The discussion on central station storage batteries at the National Electric Light Convention was opened by Mr. Wm. Bracken, who claimed that now all of the storage battery interests in this country had come under one flag, and that besides the advantage of peace there was the additional one resulting from a combination of experience. As to guarantees, he stated that he knew of no company asking a larger percentage for maintaining a battery than 10 per cent.

Mr. Salom said that the question of the use of storage batteries at the present time in central stations was a purely commercial one. He advised each station manager to settle this for his own case, first ascertaining the cost of generating his power, and the various factors involved in that cost and then determining whether, with an additional investment for a battery with a given output and efficiency and at a given cost for maintenance, he can advantageously add to his plant a storage battery. Mr. Salom stated that the life of a battery under reasonable working conditions is directly proportional to the amount of lead used, and that his company would undertake to build a battery that will last one hundred years, if any one were willing to pay for it.

Mr. J. Appleton described the storage battery plant of the Germantown, Pa., Electric Light Company, which, he stated, was the first installed in this country of American design and manufacture.

The Germantown company had a day load of incandescent lamps and motors on the three-wire system, which was very unprofitable, and about 15 months ago they decided to try the use of a storage battery, to see if the day load could not be made profitable instead of a dead loss.

A small battery was put in, sufficient to carry the day load. Its capacity was 800 ampere hours, with a normal rate of discharge of 80 amperes.

The machinery was then shut down from daylight till dusk, the battery taking care of the day load.

This being an experiment to ascertain the true facts about the working and value of a storage battery for central station purposes, very careful figures were kept, and the result of the first year's working was eminently satisfactory, and showed a saving in labor, coal, water, oil, waste, etc., not counting the decreased depreciation of machinery due to shutting down from daylight to dusk, \$2,500. Besides this there was a great advantage in being able to overhaul and examine all machinery in the day time while everything was shut down.

This being so satisfactory, and the behavior of the battery being equally good, the Germantown company decided to put in a battery of two and a half times this capacity, which would enable it to increase its day load, and consequently increase the savings, as the cost of charging a large battery is only the extra fuel required. This larger battery was installed at the beginning of this year, and is the one illustrated herewith.

The battery consists of 120 cells of the chloride type, G, eleven plates in each, arranged 60 on each side of the three-wire system. The capacity of each cell is 1,000 ampere hours, or 2,000 hours with both sides; the normal rate of discharge is 200 amperes, with a maximum of 400 amperes, and this can safely be increased in case of sudden demand or emergency.

The plates are protected by asbestos insulation, and are contained in lead-lined wood tanks. An asphalt floor, well drained, is provided, so that there is no trouble in handling the acid.

One special feature of these cells is the size of the plates of 15 inches by 15 inches, which involves much less trouble and expense in the maintenance, there being only 11 plates to give 1,000 ampere hours' capacity, instead of about 80

plates, as in most other types of batteries. Plates of the chloride type can be constructed larger than this without any difficulty, and give equally good results.

This battery plant has been designed to meet all the requirements of the three-wire system, and to give the greatest possible flexibility. The ordinary course of working in the Germantown station is as follows:

The machinery is shut down at daylight, and the battery carries the whole of the day load till dusk, when the dynamos are started again. The battery is then started out during the hours of heavy load and started in again for charging when the load decreases. By this means the general plant is working at an efficient load during all the hours it is running, and the extra fuel for charging the battery is hardly noticeable.

The daily routine is very simple; the discharge of the battery is noted by hourly readings, and at the end of the day the total discharge is ascertained. A charge of about 10 per cent. in excess of the discharge is put on, and this is found to be sufficient; in some cases even less charge than this will bring the cells up to the proper E. M. F. Just before the end of the charge readings are taken in some of the cells with the hydrometer and voltmeter, and the condition of a cell can be accurately obtained by this means.

Until recently sufficient attention was not paid to designing the cells for the work they had to do. Engines and dynamos are designed and installed according to the nature

be used for a very short time during the 24 hours, standing idle and unprofitable the remainder.

There is another question, too, which electric light men have to face: How can we profitably reach the outlying districts with our direct current mains? Here again the battery plant proves valuable. Small sub-stations in the outlying districts can be built for the batteries, and those can be charged in sense from, say, 400 to 500 volts and the current distributed at the required pressure.

Things have now changed; figures, facts and guarantees are obtainable, which will enable electric men to feel that storage batteries, as a whole, are not what they were, but when properly designed, manufactured and installed are to be welcomed instead of shunned.

In the general discussion which followed, Messrs. De Camp, Nichols, Wright, Van Trump, Barstow and Williams took part. Mr. Wright stated that he was connected in an unofficial capacity with the Germantown Electric Company, and that he had found that its loss by the entire incandescent business was exactly the loss on the day circuit, while with the battery there was a saving of \$2,500 and a net profit on this business of \$700. The battery earned about 35 per cent. of the investment the first year.

Mr. Barstow related his experience on a tour of inspection of storage battery stations in Europe, and said that although he left the United States prejudiced against their use, he returned converted in their favor and installed a plant in the Brooklyn Edison station.

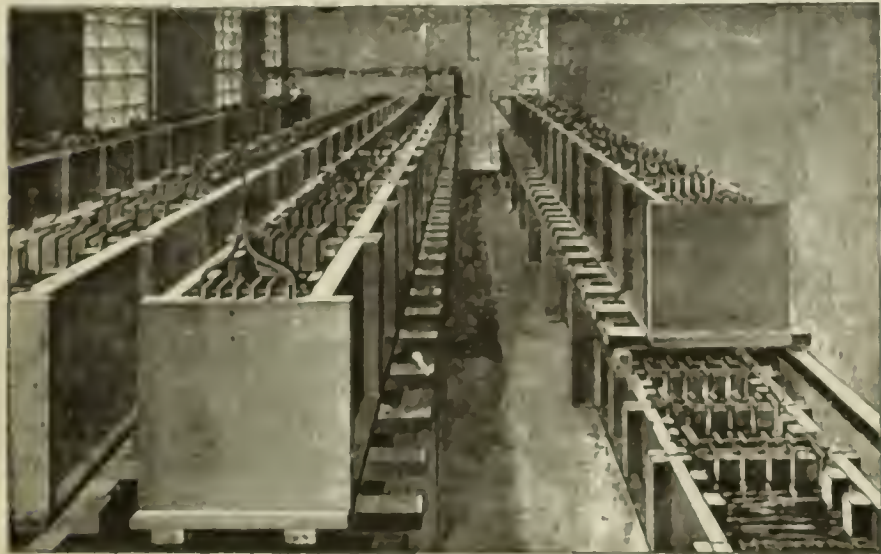
The Importance of Complete Metallic Circuits for Electric Railways.

Mr. J. H. Vail, in his paper with the above caption, read before the Washington Electric Light Convention, after briefly reviewing the practice of the last few years in street railway circuits, gives several instances of damaging electrolytic action from ground returns. In one case an electric arc formed across the ends of a pipe being separated for repair by a plumber, and in another a fireman received a shock when opening a furnace door, while a case is known of a house being set on fire through an arc forming between a water and gas pipe, eventually burning a hole in the latter. The effects of electrolysis are referred to, and illustrated by a section of 6-inch water main shown by Mr. Vail, which had been corroded through two and one-half years after laying. After citing other evils of the earth return, including the frequent waste of energy through high resistance, the present system of banding of rail joints is criticised, as well as the usual method of employing supplementary wires, the statement being made that 99 per cent. of the money spent for supplementary wires is thrown away.

After analyzing the entire matter, the writer recommends the use of the complete metallic circuit, to be obtained by so bonding the track as to render the rail joints of equal conductivity with the rails, and leading insulated feeders direct from the bus bar in the power station to predetermined points of the track system, the feeders being either overhead or underground, preferably the latter.

The author had observed on some roads that large quantities of copper for return circuits have been placed at great expense, apparently without a proper conception of how to obtain the best results. Frequently a far less amount of copper, judiciously applied for improved distribution by the feeder system, would give superior equalization of pressure at reduced cost.

If for the movement of cars singly or in quantities at a high rate of speed the electric current is to be distributed uniformly over an electric railway system, the subject must be handled with as much scientific accuracy as is always used for a perfect system of incandescent lighting, in order



GERMANTOWN STORAGE BATTERY PLANT.

of the work they have to perform, and this must be done with batteries.

Given a properly designed and installed battery, such as the one described, the maintenance and depreciation will not exceed that of the other portion of a central station plant. A storage battery does require attention, but not skilled attention; the most important thing is to give it regular attention, and to not leave it for weeks and months till some fault develops, but treat it like other machinery, overhaul it regularly and prevent the occurrence of any fault.

There are many stations in this country which are running the day load at a loss, or are losing business by not supplying current at all in the day. To these stations a battery plant would be invaluable and would give a very different result when the balance sheet is taken out.

In many cases it would, of course, be best to leave the battery on the line always, and then when the general plant is running the battery acts as a regulator, taking up any fluctuation in the load, relieving the generating plant and keeping the potential constant.

Again, in some stations the load carried takes the form of a sharp peak for a short time during the evening, when most of the lights are in use. A battery will assist the dynamos during the period of maximum load, and saves the necessity of providing a generating plant, which will only

to obtain equal distribution and free flow of current in both sides of the system.

The author states that he has fully and completely provided for all contingencies in the following manner:

First. By a careful study of the conditions under which a system will be operated; these important points being ascertained with reasonable accuracy, the requisite supply and distribution of current for the service is determined, and the system of conductors arranged to meet the requirements.

Second. The conductivity and current carrying capacity of the track system is calculated, and a system of insulated track feeders is provided, leading from the switchboard in the station and connecting at predetermined points, and with a calculated fall of potential.

Each feeder must be determined for its maximum current requirements at a stated drop in potential. The actual work required of the feeder and number of track feeders necessary is determined upon such factors as:

The cars in service—their weight, speed and headway; the position of power station and the geographical lay of the railway system; the weight of rails, and whether double or single track, and the amount of load concentrated on sections of track between feeder junctions.

The carrying capacity or conductivity of the sum total of all the feeders of the system will be found to give complete and ample circuit for the free flow of the entire current required, and to take care of extra heavy traffic and blockades at any point.

The parallel track main is only applied in sections of systems extending over very large territories and long distances.

The conductivity of the rails is calculated with as much care as the overhead system, and when the track needs reinforcing the purpose is accomplished by laying a thoroughly insulated main line (not a bare line) and making frequent sub-feeder connections bonded to the track. If used at all this main will be of large size.

Such a system, accurately worked out, will show by actual test with instruments on the cars a surprising equality of electromotive force throughout a large territory.

A very careful test has been made with instruments on moving cars, throughout a system covering forty miles of streets, with double tracks, equal to eighty miles single track. The readings showed: Maximum volts, 512; minimum volts, 420; average of electromotive force over entire system, 460 volts, the electromotive force in station, at bus bars, being 520 volts. The feeders were calculated for 10 per cent. drop. The actual average drop from dynamo to motor does not exceed 12 per cent.

This will be found to result in reduced fuel consumption, better working of the motors, a most satisfactory reduction in repair accounts, and an improved general economy of the entire system.

In the system of distribution secured by the above method the use of ground plates, rods or other insufficient methods is needless; the current travels only over the paths provided for it, and electrolysis of gas and water mains is entirely obviated.

Part was taken in the discussion that followed by Messrs. Burleigh, T. C. Smith, Mason, Law, Cuttress, Brophy, Young, Harrington, Seeley and Wright. The fishplate was pronounced useless for bonding. Mr. Wason expressed the opinion that rail bonds would not do away with electrolysis and favored electric butt-welding the joints, but neither Mr. Vail nor Captain Brophy believed electric welding practicable. Mr. Law spoke of the success of the Love underground system, which did not require rail bonding, and Mr. Cuttriss spoke of the evil effects of the return circuit on the working of cable and telegraph instruments. Mr. T. C. Smith referred to the effects of contraction and

expansion, and quoted a case where a mile-length of rail had been joined by extra long fishplates with six rivets on a side, and yet no increase or decrease of length had been noted.

Arc Lamps on Incandescent Circuits.

Prof. L. B. Marks opened the discussion of the above topic at the Washington convention by describing a new high potential incandescent arc, the invention of himself and Mr. C. Ransom. By confining the arc in a very small bulb filled with carbon gas the current can be reduced and the potential increased with excellent results. No difficulty had been met in running 100 to 120-volt arcs in this way. The bulb used for the purpose is a modified Howard cylinder, containing a special device for controlling the inclosed gas.

When operated under these conditions the arc is about half an inch long and very steady. The violet hue, so common to open air long arcs, is not marked, the quality of the light being especially valuable for in-door illumination. The life of a pair of 7-16-inch carbons in a 500-watt lamp is about 100 hours, and the necessity of running two lamps in series is dispensed with, a single arc without appreciable dead resistance being sufficient to bridge the mains. The consumption of carbon is so slow that even if the points are fixed the P. D. between the electrodes will not increase more than a few volts per hour.

With a P. D. of 115 volts between the carbon points and a current of 4 amperes, a single lamp consumes 480 watts on a 120-volt incandescent circuit, the amount of energy expended in the arc itself being 460 watts. The loss equals 20 watts per lamp, or 40 watts for two arcs, each directly across the mains. Comparing these figures with the data obtained from existing conditions under the most favorable circumstances, the loss of energy for two open air arcs, each 460 watts, across a 120-volt circuit, is 280 watts, as against 40 watts in the first case. Thus, there is a clear saving of about 20 per cent. in energy accruing from the use of the high potential lamp.

In the lamp there are two regulating coils differentially wound on the same core, and in series relation to each other, one coil being in series with the other in shunt around the arc. By properly proportioning the coils we have obtained a very sensitive feed. The claims made for the lamp arc: (a) Saving in energy; (b) saving in cost of trimming; (c) saving in carbons; (d) improvement in the quality of the light; (e) subdivision of the light; (f) cleanliness, no carbon dust or soot; (g) perfect spark arrester.

Mr. Barstow, of Brooklyn, stated that the disadvantages of low tension arc lighting are of immediate concern, first, the requiring of a dead resistance in the circuit of the lamps, which means lost energy; second, the installation, for commercial reasons, of lamps in pairs. He said that the low tension direct current system could easily manufacture current cheaper by using large units operating multiple than a high tension system with its larger number of small machines. He had been assured by a large company operating circuits on both high and low tension systems that it cost it 25 per cent. less to generate current for low tension than for high tension arcs. The question of the desirability of installing lamps in pairs must be answered by the consumer, and in Brooklyn the results will warrant a strong affirmative.

In regard to a price for current for low tension arc lamps, renewals must be taken into account, and the renewal of the lamp resistance as well.

In order to get the same price for an arc current as for an incandescent current, which, of course, comes from the same generator, the price of current per 16-candle power lamp hour was taken as a basis. It was then found that 9 cents per

hour for a 1,200-candle power arc lamp current corresponded with 8 cents per hour for equivalent incandescent current, as the proportion of arc lamp renewals exceeded the incandescent. As the cost of labor in trimming an arc lamp is the same whether the lamp is burnt for one, two or six hours, it was found that in order to be fair in a meter rate a sliding scale should be used. Therefore, a scale commencing at 9 cents per lamp for the first hour and decreasing in proportion to the length of burning was adopted. It was further thought that if customers paid for current actually used without reference to the number of lamps installed, and the company was to loan the lamps, there would be no limit to the number of lamps asked for, while the customer would not bind himself to use all of them. This difficulty was easily settled by grading the discount price of current according to the lamp average hours per day, which was obtained by comparing the total current with the number of lamps installed.

The first pair of arc lamps were installed in Brooklyn, where, indeed, the history of low tension arc lighting began in the spring of 1890, and since then the progress has been very rapid, as the Brooklyn Edison station is now operating 2,700 lamps, with orders for 400 more.

It has been shown that low tension arc lamps can be furnished as cheap as their high tension competitors, and still yield as much profit as an incandescent installation. The growth of the business can only be ascribed to the fact that the light is good, the control of pairs by individual switchboards a great advantage to the customer, as is also a meter basis for bills, and the further fact that very ornamental fittings can be used.

The following table is a complete report on arc lamps for the year 1893, which will show clearly the defects which are now being corrected:

DATA.

Number of Ward lamps in use.....	2,246
Number of Edison lamps in use.....	400
Total number of complaints.....	3,911
Defective carbons.....	2 per cent.
Retrimms.....	7 per cent.
Defective adjustment.....	12 per cent.
Fuses and plugs blown—unknown cause.....	10 per cent.
Loose connections caused by storms.....	6 per cent.
Trouble with mechanism of lamp.....	12 per cent.
Carbon holders broken and burnt out.....	1 per cent.
Lamps grounded external.....	8 per cent.
Defective cleaning.....	16 per cent.
Defective house wiring.....	2 per cent.
Resistances burnt out and grounded.....	5 per cent.
Defective installation.....	1 per cent.
No trouble when men arrived.....	10 per cent.
Special complaints.....	8 per cent.
Total number of trimmers.....	17
Average number of lamps per trimmer.....	144
Maximum number of lamps per trimmer.....	170
Maximum trims per trimmer.....	182

Labor and material for repairing, repainting, rewinding resistances and changing lamps, including testing of all new lamps, 75 cents per lamp per year.

Globe renewals, exclusive of those paid for by customers, 7 cents per lamp per year.

The Brooklyn company is now working on a system of carbon renewals, which plan, although not a novel one, will, if finally successful, effect a considerable saving.

Mr. Andrews, of Philadelphia, said he had introduced a considerable number of arc lamps on incandescent circuits and had increased the income of the station. In many stations where customers had complained about the quality of incandescent lights they had been replaced by arc lamps at double the expense, but with four to ten times as much light, and the customers had been perfectly satisfied. He thought that in general arc lamps on incandescent circuits would eventually supercede the high tension arc lamp, one of the reasons being that they could be turned on and off at pleasure. He used both direct and alternating current lamps, and he regarded the alternating arc lamp as a great

addition to the central station income, as well as possessing the advantages of great flexibility. Charges were made by meter exclusively, the rate being 15 cents per kw. hour, with a varying discount according to the size of the bill. The company supplies the carbons and trims the lamps. He said that they had tried nearly every carbon manufactured in this country, and had come to the conclusion that it was impossible to produce a perfectly satisfactory light. Mr. Andrews, therefore, regarded an improvement in the manufacture of carbons as very essential, and was supported in this by Mr. Ayer and others.

Mr. Van Trump stated that they had installed some arc lamps on incandescent circuits at Wilmington, and were running series arcs as well. They were charging a rate of 10 cents per watt hour, or about 21 cents per kw. hour, with a minimum charge of \$12.50.

Mr. Stetson stated that he had had trouble about bills, which had proved too high for customers.

Development of Switchboards for Modern Central Stations.

Mr. A. B. Herrick, in a paper read at the National Electric Light Convention, held at Washington, stated that the universal modern practice in regard to the location of switchboard, both abroad and at home, is to place it in a gallery, or in some elevated position, where the attendant has full observation of the operation of the different units under his charge, and can judge, in the case of any peculiar behavior of the generators, the proper remedy to be applied, and be prepared to take the unit off the circuit if necessary. There is another marked general tendency in switchboard construction; that is, to make the whole structure absolutely fireproof. This is, of course, an economical investment, for lower insurance rates are easily obtained on central stations properly safeguarded.

In the case of low equal potential distributing systems, especially in the three-wire feeder and main system, the switchboard arrangements bear a very important relation to the satisfactory operation of the system.

In order to distribute the current at a high economy by means of the feeder and main system, it is necessary to place the station at the average centre of distribution. This simple proposition is complicated by the fact that a city is divided into business and residential portions, each having different periods of maximum demands on the station, and as these districts are not generally symmetrically located, as regards the station, the centre of maximum efficiency of distribution travels over considerable distances during the day.

Different methods have been adopted in the past in order that the station may deliver its current to the mains at an equal potential; in other words, artificial means have to be used to bring the varying centre of distribution to the station.

As the low potential systems have been expanding over larger areas to include a greater number of customers, it has become necessary to deliver current at the station ends of feeders at different potentials to compensate for the unequal loading of the system. This was originally effected by running the dynamos at different potentials, feeding into independent busses, the feeders being so arranged that they could be thrown on any of these busses and supplied with current at the proper potential to deliver their current to the mains at a uniform potential. When the units in the station were small they could be divided up on the different busses with comparatively high economy, but, as central station business has expanded, units had to be adopted, both for economy and first cost per kilowatt, higher economy in current production, and to obtain a larger kilowatt output per square foot floor space. With the introduction of these large units two conditions confront the engineer—one: it

was necessary to run the unit at nearly the maximum output in order to get the maximum efficiency of the generators and engines combined; and the other, to deliver this current at two or more potentials to different groups of feeders.

To follow the ordinary load diagram of a station, beginning at the lowest point, it is very rarely required to produce the current at more than one potential. Here all the feeders may be thrown on one bus bar, or the bus bars may be tied together. As the load rises certain feeders will become more heavily loaded, and they will have to be supplied with a current of high potential, but to run a large unit on this high potential bus, where the load it has to carry is a small part of its total capacity, it would be an uneconomical method of producing this current, as the unit under these conditions is working disadvantageously both as regards expansion of steam in the engine, the friction, field and armature losses. Several different methods are now used to effect a higher economy in the delivery of the current to the busses. Mr. Barstow, general manager of the Brooklyn Illuminating Company, has devised the well-known "booster" system. This method works out very well where three potentials are required. The medium potential bus in this case is fed by the units operating the station; the current is delivered from the medium bus to the high potential bus through the armature of a dynamo whose field is separately excited. The current in passing through this armature has its initial potential exalted, and the amount of this increased potential is controlled by a field regulator. The currents supplying the bus of lower potential than the medium bus also flows through an armature, but in this case the armature is rotated as a motor and has its initial potential reduced. In the three-wire system two "boosters" are required for each potential, and it is the usual practice to couple these boosters together, making one continuous line of shafting, to which is also coupled a motor for the purpose of keeping the boosters up to full speed and making good the losses due to transformation and unequal loading of the high and low busses. The losses inherent in the booster system are those occurring from friction, armature losses and field excitation.

A method has been devised by which to obviate these losses, a dynamo being used to produce on a single armature two or more potentials. Where the difference of potential is small, and where the load on the high and low busses does not fluctuate very rapidly, a smooth body, multipolar, direct driven dynamo can be used; but where the differences of potential and load are extreme a special dynamo is applied, and different parts of the armature run at different potentials and on two or more separate busses. Its action will be similar in every respect to that of two or more independent dynamos. The different parts of the armature giving different potentials are controlled by separate regulators, and the load on these separate busses carried to a point at which it will be economical to operate a separate unit. Then this special dynamo can be connected to any one of the busses in the same manner as any other unit in the station. The different parts of the armature are brought to one potential and thrown in on any required bus in the same manner as in the operation of three separate dynamos. In this way some of the losses inherent in the booster method are obviated, and full economy of the supplementary bus output is always obtained; and the full load of these auxiliary busses being carried by the one dynamo, brings the output of this dynamo up to an efficient point, both as regards the operation of the engine and dynamo.

After having thus reviewed the methods of producing different potentials in the station, we come to the modern switchboard, which has required very careful thought on the part of the engineer to make both simple and easy. Fol-

lowing the natural operation of the switchboard, provisions made to take care of the field circuits are the first requiring our attention.

In the introduction of the modern multipolar machine great attention was necessary in the field circuit arrangement, and the proper method of exciting dynamos is still an open topic. Two methods are commonly used, each having its own peculiar advantages and specially applicable to different systems—the self-exciting, bus-exciting. The advantages and disadvantages of these methods are as follows:

In the self-exciting method the field terminals are connected to the brushes. The advantage of this is that the field gradually dies away as the dynamo slows down, and when the dynamo has stopped the field has entirely disappeared. The danger of a sudden discharge of the field, which would submit the field winding to a strain, on account of the high potential induced, or breaking down the armature is thus avoided. The disadvantages of this method are: First, the slowness with which the dynamo builds up its own field, as the dynamo frequently runs at full speed for some time before it develops sufficient electromotive force to be connected to the system; second, the possibility that the field may build up reversed. This may be caused by the sudden discharge of the field by a short circuit, or even by proximity to another dynamo.

In the bus-exciting method the fields are connected to the station mains or busses. The advantage of this method is that the field is instantly made and the dynamo can be connected into the system as soon as it is up to speed. The polarity of the field is always the same and cannot be reversed. In bus-exciting of large multipolar dynamos the taking of the field off the bus introduces into a system of low potential a high potential discharge, which submits the field insulation to a strain, which can be avoided in several ways. One method is by taking a special switch, which, before severing the fields from the bus, connects the fields in such a way that it is divided into halves; the electromotive forces of discharge are opposed against each other and consequently die away without having any effect.

The disadvantages of the bus-exciting method are: First, that in case the system is short circuited, sufficient potential cannot be generated to burn out the short circuit; second, if the dynamo is operated on a different bus from which it is excited, full output of the machine cannot be obtained in case the exciting potential is lower than its working potential.

The electrical data which is used in connection with switchboard designing is as follows:

Regarding bus bars, the most economical point to carry the current density in copper bus bars is 1,500 amperes for naked copper bar 2 1-2 inches by 1-2 inch.

The most economical size of bus bar, radiating and cross-section considered, which has also sufficient mechanical strength, is a bus bar 4 inches wide by 1-2-inch thick. This is called the standard central station bus bar. They are placed in multiple to make up the required carrying capacity with 1-4 inch between the 4-inch sides, and the long sides are placed vertically. This gives ample space for dissipating the heat by radiation and convection. This space between the bars makes a convenient place for inserting lugs, and can be secured by means of bolts passing through the bus bar. Brass will carry from 400 to 500 amperes per square inch, depending upon its conductivity. In regard to the current carrying capacity of contacts, this depends both upon the area and pressure, the pressure playing the most important part. In ordinary switch blades, where they are carefully assembled, 60 to 80 amperes per square inch should give a contact which should heat not over 20 degrees Fahrenheit above the surrounding air, carrying full load con-

tinuously. In the matter of switches, the perfect adjustment of the contact surfaces, the wearing surface of the contacts and the conductivity of their terminals should be all taken into consideration in the design of these appliances. In the matter of contact surfaces for connections of the different appliances, a taper plug, when ground to its seat, will carry 180 amperes per square inch, and laminated blades, bolted together, will carry 120 amperes to the square inch. A well faced lug screw down to a true surface, by means of bolts, will carry 190 amperes per square inch of surface. It is necessary in designing contacts to keep the temperature within 20 degrees rise above the temperature of the air, to have the conductors leading to and from the contacts of ample capacity to carry the current, and also to assist in radiating the heat that may be generated in these contacts; and the above current densities for contacts are given when the matter of ample adjacent conductors has been embodied in the design.

A word in regard to temporary work in stations would not be out of place here. A great deal of temporary work done, especially in switchboards, is a reflection on good engineering. There is no reason, with foresight on the part of the designer, why a great deal of this work could not be obviated, thereby saving labor and capital being expended which has only a short period of dividend earning capacity and on which expenditure a dividend has always to be earned as long as the plant is in existence.

The iron framework is the best for switchboard construction, and is constructed with standard steel channels and T's. The framework is made in sections and can be readily taken down, and where it is secured to any metallic portions of the station building it should be carefully insulated from it. The frame is usually set on top of the slate floor, which makes a very serviceable flooring for a gallery, and all bolts going through the iron framework of the switchboard should be insulated where they are in contact with the beams under the floor. With a grounded neutral the insulated iron framework has great advantages, both in regard to leakage and in working behind the board. A four-foot space should be allowed between the walls and switchboard for convenience in working and erecting.

In the case of the switchboard carrying different potentials, such as are light, railway and incandescent circuit, the different parts of the iron framework are also insulated from each other. The materials best adapted for the switchboard slabs can be of carefully tested slate, a chocolate colored fine grain Tennessee marble, or light gray marble, used largely in the West. Italian marble is very good, and makes the most effective switchboard, and if care is exercised in keeping it clean, it is very durable. Tennessee marble of the proper quality should drill nearly as readily as slate, and is the most durable of all the marbles.

A line of porcelain insulators is very convenient for station wiring for bare cable and copper rod, which can be built up in any form to lead the conductors through the station, either on iron framework or recessed in the wall. The cost of station conductors can be cut about 20 per cent. by the use of bare conductors. Solid copper wire on porcelain insulators give very high insulation, and in exposed places can be served with asbestos twine, which affords the conductors protection from mechanical injury, and fire cannot be transferred along the conductors to other parts of the building. A welding machine is very useful in connecting the adjacent lengths of copper rod, and provision for expansion is made at elbows by a flexible laminated L. Bus bar supports are also made of porcelain, doing away with all inflammable material in the switchboard and for the wiring of the station, and reducing the insurance risk on this class of property.

It will also be noticed that all conducting parts and switch

contacts are made more massive than in the old type appliances. The economy of this is very apparent; for instance, if a thousand ampere switch were used which had an average elevation of temperature of 20 degrees Fahrenheit above the average air temperature of the station, this would mean an average loss of 72.2 watts, and with electrical horse power delivered at \$60 per year, the energy expended in heating this switch would cost nearly \$6 per year. From this it is evident that a switch possessing more material and contact surface would be a very economical investment. These points of sufficient carrying capacity unfortunately do not become evident until the station becomes fully loaded.

If any part of the switchboard passes an average of 20 degrees Fahrenheit above the surrounding air, the high water mark for economy has been passed in the design of this board, and it is unprofitable to pass the current through devices whose temperature averages more than 20 degrees Fahrenheit. In this case the manufactured product of the station is uselessly wasted in its transmission. It should be utilized for earning dividends by passing it through the meter of the consumer instead of wasting it in the station.

In the discussion, Mr. Weston criticised the adoption of 20° as a standard of temperature. All resistances should be made as low as possible and great attention given to joints and the material used in a shape giving the largest cooling surface. The losses in various cases investigated through defective joints and conductors and switchboard instruments with higher resistance than necessary were expressed in dollars and cents per annum. In one case a single switch and instrument involved an annual loss of \$5,000. In conclusion, Mr. Weston recommended that the switchboard be brought as near to the dynamo as possible, and every inch of unnecessary conductor should be left out. Every joint should be left out that possibly can be, and when joints are made they should have large surface contacts. Conductors should not be circular, but flat, and have plenty of air, so that there can be an abundance of the cooling action of the atmosphere.

It is clear that the stations should be so arranged that the feeder circuits are as short as they possibly can be. The switches must be made very differently from what they are now: polished brass looks pretty, but it is not what you want: do not sacrifice good qualities for appearance. The conductor should be given plenty of space: they should not be laid flat on one side of the switchboard, placed upon a slab, and closed at the bottom. Keep the temperature of the conductors down as low as you can; it may even pay to put an oil bath around conductors and cool the oil by water.

Practical Properties of Polyphase Apparatus.*

BY LOUIS BELL

The author states that while most of his personal experience has been with triphase currents, much of what he has to say is quite applicable to systems having more or less phases, provided, of course, that such systems are symmetrical. Of those wherein this condition is not filled he will refer to in discussing polyphase motors. It is also pre-supposed that currents giving tolerable approximation of sine waves are dealt with. While any departure from this theoretically causes loss of energy due to the presence of higher harmonics, electrical power transmission must be developed in conditions beyond those that now seem extreme before the current curves now readily obtainable will need revision.

*Abstract of a paper read at the eighty-third meeting of the American Institute of Electrical Engineers, Jan. 17, 1894.

Cases are referred to later in which the form of the curve is really a matter of decided importance.

While the general character of polyphase dynamos must closely resemble that of the ordinary alternator, the necessity of applying to the same armature two or more phase windings leads to modification of the design so far as the winding is concerned, and quite generally in the direction of the direct current type. It may sometimes be useful, too, to derive polyphase currents from two or more ordinary alternators with their shafts coupled together, or from composite machines having phases on separate armature cores, but these devices are rather to be regarded as expedients convenient for divers reasons than as final types. This is on the broad general principle that one large machine is more economical than two or more small ones aggregating the same output, and that the more completely the armature core can be utilized the better output can be obtained from the same structure. Therefore, with similar machines of equal size and equal magnetic and electrical constants, a polyphase armature winding does give a better output than a single phase winding. Of course it is possible to construct a single phase machine that shall give a better output per pound of weight than a certain concrete polyphase machine, just as one might manage to double the voltage obtained from a given armature while retaining the same output, but other things being equal, the more phases the better output in a given structure. All this has been made so clear of late that it is only necessary to emphasize the fact, that while the difference in output between a single phase and a two phase armature is quite considerable, the step from two to three phases is somewhat less marked, and that from three to more of relatively little importance.

The tendency in building polyphase generators is certainly toward the development of a rather better machine than we have become familiar with in the ordinary alternators, due mostly to the impetus given alternating current machinery in general by recent demands. This has led, first, to the adoption of a lower frequency than formerly, both to facilitate the use of motors and to avoid the serious difficulties due to inductance on the long lines that are now becoming more common. Second, it has caused more attention to be given to the production of generators able to take care of fluctuating and inductive loads, such as are produced by motors, without excessive over compounding. With a properly designed machine the popular idea of the difficulty of regulation under an inductive load is grossly exaggerated. A generator built, as alternating generators should have been built long before now, with proper attention to the production of a good machine for all around practical work, will take care of an inductive load of the severest kind more easily than the average alternator found to-day in central stations will handle a load of incandescent lights.

The practical ease of regulating a polyphase generator under an inductive load is shown by the results of some experiments recently tried with a triphase generator of 260 kw. normal output, run at 600 revolutions per minute and a uniform voltage of 2,500 volts between lines. Accurate readings were taken of the currents necessary to excite the generator, with the following results, the voltage being preserved uniform at 2,500:

Exciting current output about 30 kw. No lag.....	19.05 amp.
Exciting current output about 30 kw. Power factor .2....	21.50 amp.
Exciting current output 260 kw. No lag.....	2.80 amp.
Exciting current output 260 kw. Power factor .84.....	24.80 amp.

No better test than this could be wished for showing the excitation required under a lagging load. It should be noted that the power factor in the last case was similar to what would be found under ordinary circumstances in running a load of inductive motors, and yet the increase in exciting

current from a very light load with no lag to a full load with very decided lag was only 25 per cent. Experiments with other machines under an inductive load show results similar to this, so that I think we can safely say that a well designed polyphase generator will take care of an inductive load easily and without excessive variation of the field strength. More than this, the regulation required can easily be made automatic in cases where this method is preferred to hand regulation, which, however, answers most purposes very well.

Of course the polyphase generator can be made self-compounding in a manner closely analogous to that followed with an ordinary alternating generator. The rectification of the necessary amount of current makes this method somewhat inconvenient in large machines. In such cases, we may effect a very complete automatic regulation by the following means:

The generator is excited from a rotary converter taking its polyphase current from the main machine of which it feeds the field magnets through its direct current side. In the lines between the rotary converter and the generator are inserted inductive resistances which serve to cut down the voltage applied to the polyphase end of the rotary converter. On these choking coils are, however, reversely wound turns from the main circuit of the machine. The result of this arrangement is, that as the current in the main line fed by the generator rises, the inductance in the line which feeds the rotary converter is gradually removed, allowing the voltage to rise higher and higher, in proportion to the current in the main line.

Fig. 1 gives a clear idea of the arrangement. In this figure A' is the field magnet of the main machine, of which B is the armature, a the three collector rings, the machine being of triphase type; $F F$ are the field magnets of the rotary converter, of which D is the armature, b the collector rings and E a commutator delivering direct current to the fields of the rotary converter $F F$ and to the field magnets $A' A'$ of the generator. The rotary converter may conveniently be brought up to speed by its pulley P unless another triphase machine be at hand by which to start it; $M M' M''$ are the three inductive resistances, e the windings connected with the rings b , d the reversely wound turns connected to the main line. Of course, transformers may be inserted in the line between the inductances

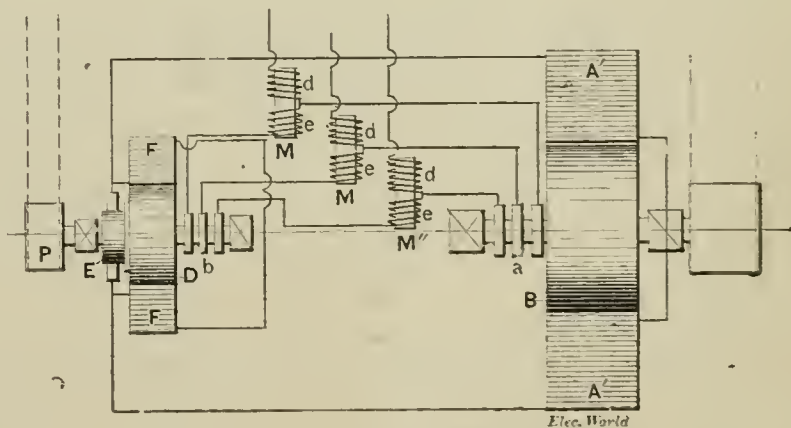


FIG. 1.—DIAGRAM OF APPARATUS.

and the rotary converter if the voltage of the main generator renders it desirable. In fact, such converters wound with cumulative turns from the main circuit may replace inductive resistances. I have experimented rather more, however, with the form shown in Fig. 1. It may sometimes be convenient to employ the rotary converter merely to excite an auxiliary compound winding, in which case it can be started up from the generator already worked up nearly to normal voltage of its own exciter.

(To be continued.)

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE
PRINCIPAL FOREIGN
ELECTRO-PHYSICS.

ELECTRICAL JOURNALS.
BY CARL HERING.

Properties of the Alternating Current Arc.—An Academy paper of Mr. Claude, reprinted in abstract in "L'Ind. Elec.," Feb. 10, describes the following phenomena: A condenser of 1 microfarad, a key for closing the circuit and 12 lamps of 100 volts were connected in series to an alternating current circuit of 2,400 volts and 80 periods; on closing the key the lamps reddened, due to the charging and discharging current of about 0.1 ampere; on opening the key, so as to leave a break of short length, an arc was formed at these points and the lamps increased greatly in brilliancy; they increased until the distance was about 1 millimetre, the increase being from 30 to 90 volts at each lamp; the difference of potential of the arc was 1,200 volts and the intensity was 0.4 ampere, but it did not consume 480 watts, as the contacts heated only slightly, and it seemed as if the arc was a nearly perfect self-induction; in reality, the explanation is as follows: The arc passes only when the difference of potential is sufficient to discharge through the air, and the condenser is therefore charged suddenly by a high electromotive force, instead of being charged gradually, as it is when the circuit is closed; the charging current is therefore of very small duration and of much greater intensity, and the mean of the squares of the intensity is therefore greatly increased; this explains why the power absorbed in the arc is so small; with carbon points only 500 to 600 volts could be obtained at the arc, with a length of 3 to 4 millimetres; an arc alone in series with the lamps diminishes their intensity; the experiment can be shown best with a current of a frequency of four, as generated by a modified Gramme machine.

Abnormal Resistance of Liquids for Alternating Currents.—An article by Mr. Lohnstein, abstracted in the "Elek. Zeit.," Feb. 8, states that when certain electrolytic cells are connected with a galvanometer in the secondary circuit of an induction coil, a relatively great and continuous deflection will be obtained, which, with an increased frequency, changes to the opposite direction; the effect is greatest when zinc plates are used in zinc sulphate solution; he does not offer any explanation.

What Is Electromotive Force?—An article under this heading by Mr. Schwartze is published in the "Elek. Anz.," Feb. 4; it is one of a series in which he endeavors to show that there are great errors in the conception of electric units as usually published in text books.

Ohmic Resistance.—The "Elek. Anz.," Feb. 10, contains another article by Mr. Schwartze, in which he discusses the real nature of electric resistance and magnetic reluctance, claiming that it is a misleading error to assume that a resistance is a velocity; he claims that many statements in text books are very misleading and incorrect, and that the congresses would have done better if they had occupied themselves with the development of a sound physical foundation of electrical quantities.

Dielectrics.—The "Elek. Zeit.," Feb. 8, abstracts from a Vienna journal a paper by Dr. Benischke, in which he describes the measurement of the dielectric constants of a

number of different substances with alternating currents having a frequency of 80; they are almost all smaller than those usually used; neither high voltages up to 1,100, nor increased time had any effect on these constants; a slight variation was observed for paraffine for that high voltage; he does not believe that a permanent change is caused by alternating currents.

Dielectric.—In addition to the information given last week, "L'Ind. Elec.," Feb. 10, states that this substance resists strongly changes due to the atmosphere, samples of it having been tested for two years; it is specially applicable to moist atmospheres.

Electric Waves.—Mr. Deeley, in a correspondence to the Lond. "Elec.," Feb. 16, discusses the subject of electric and magnetic waves in connection with the English translation of Prof. Hertz's book.

MAGNETISM.

Electromagnetic Synchronizing.—The paper mentioned in the Digest last week is abstracted in "L'Ind. Elec.," Feb. 10; the author describes a method for studying the problem.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Electro-Dynamometers Used as Wattmeters.—"L'Elec.," Feb. 3, contains the first part of an article by Mr. Meylan, in which he discusses very clearly the best conditions when they are used for alternating currents. Regarding such wattmeters, he says that if there is a difference in phase between the series and the shunt current (apart from that due to the shunt coil), the power factor, as the cosine of the angle of lag in the case of sine currents, affects to an equal degree the value of the mechanical couple which remains proportional to the watts, while the product of the volts and amperes is then no longer a measure of the power; another advantage is that they can be used for both kinds of currents and can be calibrated with continuous currents, which is a much more exact method. There are two causes of error which limit the application of electro-dynamometers as wattmeters; the first, which is the same for continuous as for alternating currents, is the loss in the apparatus itself, which is easily determined and corrected; the second is that due to the self-induction of the shunt circuit, which, he believes, has not yet been studied practically; a third error is caused by exterior fields, to eliminate which it is only necessary to make two measurements by reversing all the connections and taking the mean of the two readings. In taking up the question of the loss in the instrument, he discusses first the measurement of the energy of a receiving apparatus as distinguished from a generator; there are two ways of connecting a wattmeter; in the first one the shunt coil is connected to the beginning of the series coil; that is, it measures the voltage of the receiving apparatus and the series coil together; in the second case, the shunt coil is connected to the end of the series coil as distinguished from its beginning; the shunt current in that case passes also through the series coil; in each case there will be an error. In the first case this error is equal to the ratio of the power lost in the series coil to the total power which is measured; it becomes greater, however small the resistance of the series coil is, if the voltage is very small; in the second case the

error is equal to the ratio of the energy lost in the shunt circuit to the total energy measured; the error is greater the smaller the series current. In discussing which is the best combination to use, he states that in practice it is generally necessary to measure a variable current at certain definite potentials, in which case the first combination is much the better, which he shows by an example, in which the error in the second case was 20 times as great as that in the first. Considering next the application to the measurement of sources or generators of energy, the same reasoning applies to the first combination, if the same binding posts be connected to the source that were connected to the receiving apparatus, in which case the shunt circuit will be connected at the farther end of the series coil, so that the shunt coil passes through the series coil. If the current is the principal variable, the error will therefore be reduced to a negligibly small quantity in all practical cases, if the connections are made so that the series coil forms, so to speak, a portion of the apparatus of which or for which the energy is to be measured; the shunt circuit is therefore connected at the beginning or at the end of the series coil, according as the apparatus is the receiver of current or the generator. He believes the ingenious compensating device of Mr. Swinburne (see Digest Oct. 28) is too complicated and increases the heat in the apparatus, which disadvantages more than counterbalances the advantages. In the next section he will discuss the influence of self-induction.

Potentiometer for Alternating Currents.—The Lond. "Elec. Rev.," Feb. 16, in an editorial calls attention to the advantage of using the potentiometer for alternating currents, and refers to a Physical Society paper of Mr. Swinburne describing a method in which a direct pressure is balanced against an alternating one by means of a differential electrometer with single fibre suspension, a zero method being used; an alternating and a direct current are similarly compared by means of a differential dynamometer with the controlling spring removed.

Error in Measuring Coefficients of Induction.—In a Physical Society paper abstracted in "L'Ind. Elec.," Feb. 10, Mr. Abraham calls attention to a cause of errors in these measurements when a turning commutator is used; if the real induction, L , is rather large, its time constant, $L \div R$, is comparable with the period of the commutator, and the total induced current is then no longer obtained, as its duration would be greater than that of the closing of the contacts, and the coefficient of induction would then be too low; this error may be avoided by a sufficient increase in the resistance; this explains why two solenoids on the same iron core seem to have two different coefficients of mutual induction.

Thermometer.—"L'Ind. Elec.," Feb. 10, abstracts a description from an Academy paper of Mr. Barille of a thermometer which indicates by an alarm bell any desired maximum temperature; a good illustration accompanies the description; it consists of an ordinary mercury thermometer, the mercury of which is connected to one end of the circuit; in the space above, which forms the larger part of the thermometer, another wire passing out through the glass is connected to the other pole, but the end in the tube does not reach the mercury; a third wire is loose in the interior and makes a sliding contact with the upper wire; the upper end is fastened to a short iron rod and the lower end makes contact with the mercury; by means of a horseshoe magnet this iron rod, to which the movable wire is attached, can be moved up or down, so that the lower end can be set to any desired mark on the temperature scale; the upper part of the thermometer is filled with a liquid (ortholuidine or ethylorthotoluidine is preferred); the total length is about 17 inches.

Electrical Units.—In an article by Mr. Campbell in the London "Elec.," Feb. 16, he gives a brief description of the practical and the two systems of absolute units, including a table, in which they are represented in terms of each other and distinguished from the usual tables in which their dimensions are given; he shows how those of one system can be converted into those of another, and concludes with a calculation of a magnetomotive force in the two different systems.

Bolometer.—The "Elek. Zeit.," Feb. 8, gives an illustrated description of the iron wire bolometer of Dr. Edelmann for examining heat spectra, based on an instrument devised 20 years ago, which is made more accurate now by the use of the Rosenthal micro-galvanometer.

DYNAMOS AND MOTORS.

A Difference Between Dynamos and Motors.—In an article in the "Elek. Zeit.," Feb. 8, Mr. Baumgardt calls attention to the well-known fact that for the same excitation, armature current and speed the counter E. M. F. of a motor is greater than the E. M. F. when used as a generator; if the Foucault currents and self-induction are great, the loaded motor can even generate a higher counter E. M. F. than when running unloaded. He quotes from a number of well-known authors, some of whom offer explanations; Froelich states that the Foucault currents in the generator weaken the field, while in the motor they strengthen it; Kapp states that the losses due to Foucault currents and hysteresis must be compensated in the motor by an increased voltage, but Baumgardt states that these losses diminish only the torque, and therefore require an increase of the current but not of the voltage. He discusses the various factors systematically, summing them up to obtain the total effect; in the generator the proper position of the brushes is determined by the sum of the influence of the magnetic armature reaction and the influence of self-induction, while in a motor it depends on their difference; in a motor, therefore, the shifting of the brushes is less than that in a generator by double the effect of the self-induction; as the weakening of the magnetic field by the armature increases with the shifting of the brushes nearly proportional to the angle, it follows that in the generator the armature current weakens the field more than in the motor. The magnetic field due to the Foucault currents is less in the generator than in the motor on account of the diminished field, and has the opposite effect on the useful field; in the generator the self-induction diminishes the E. M. F., while in the motor it strengthens the counter E. M. F. The torque on the armature wires in the motor is larger than under the same circumstances in generators, but he states that the torque at the pulley need not therefore be greater. In conclusion, he describes a simple test by means of which the values of these factors can be determined experimentally.

Hollow Magnets for Dynamos.—The "Elek. Zeit.," Feb. 8, contains another article of the interesting series by Mr. Schultz. Referring to the statement made by Prof. Grottrian (see Digest Feb. 17, under "Magnetization of Solid and Hollow Iron Cylinders"; in that abstract the word "higher" near the end should read "lighter") that for weak magnetization only the outer layers of the iron are magnetized, Mr. Schultz describes a series of experiments made with a dynamo of a commercial type, in which the magnetization curves were constructed from actual measurements while running, and in which the fields were afterward bored out with a relatively small hole and then with a large one; in each case he found that the curves differ by precisely the amount that calculation would give in connecting for the diminished cross-section of the iron, even for very low magnetization and remanent magnetism; the cross-section was diminished from 50 square centimetres to 28; the results of

the tests are given. These do not agree with the statement of Prof. Grotrian, which he explains by the fact that the length of the magnets as compared with the diameter was very great in these experiments, while with his dynamo the magnets were, as usual, very short; it follows from this that Prof. Grotrian's results do not apply to dynamos as usually constructed.

Output as a Function of Size.—The "Elek. Zeit.," Feb. 1, contains an article by Mr. Wiener on this subject, in which more data and less formula are given than in his article in The Electrical World, Nov. 18.

Irregularities in the Action of Dynamos.—The translation of the French serial, mentioned before in these columns, is continued in the Lond. "Elec. Rev.," Feb. 16.

Construction and Working of Electromotors.—An elementary paper by Mr. Dykes is reprinted in the Lond. "Elec. Eng.," Feb. 16.

ARC AND INCANDESCENT LIGHTS.

Efficiency of Different Lights.—In an article by Mr. Henry in "La Nature," Feb. 10, chiefly on phosphorescent lights, he gives the following efficiencies, which represent the amounts of the energy which are converted into light as distinguished from heat: Oil lamp, 3 per cent.; ordinary gas burner, 4 per cent.; incandescent electric lights, about 6 per cent.; arc lamps, 12 per cent.; magnesium light, 15 per cent.; Geissler tube, about 32 per cent.

Automatic Mercury Pump.—The "Elek. Anz.," Feb. 1, gives an illustrated description of an improvement of Prof. Neesen's vacuum pump, mentioned in the Digest Nov. 18; the improvement consists in an important simplification which obviates the necessity of any connections.

ELECTRIC RAILWAYS.

Heilmann Locomotive.—In "L'Ind. Elec.," Feb. 10, Mr. Hospitalier gives a full and detailed description of this locomotive, together with a table of data and dimensions, and a number of good illustrations, including two full-page views of the finished locomotive. It will be remembered that this locomotive contains a steam boiler, a steam engine, a dynamo and a number of motors; references and results of tests have been given in the Digest May 6, July 22, Oct. 7, Feb. 17; the main object is to obtain softly running movements and an entire absence of alternating motion, to obtain great speeds and great adherence; it has passed through various stages during the past four years, the present arrangement being the one finally adopted. A description by Mr. Heilmann of the principles is quoted at some length: the electric transmission takes the part not only of a true transmission by pulleys, but also of one in which it is possible to obtain any ratio between the diameters of successive pulleys; as the steam engine operates under better conditions than those of ordinary locomotives, the loss due to the double transformation is said to be more than compensated, the efficiency of the whole combination representing a greater economy of coal for the same work done; the adherence is said to be increased very greatly. A detailed description of the different parts is given: the effective horse power at the axles is given as 500; the whole rests on two bogie trucks, each having four axles; the steam engine is specially constructed and is of the compound tandem type; the dynamo generates 1,000 amperes at 400 volts, which is separately excited by a small 20-h. p. dynamo and engine, which, at the same time, lights the train; the gearless motors are of the two-coil, two-pole type, one motor being mounted on each of the eight axles; each motor takes 125 amperes at 400 volts; they are connected directly to the dynamo, without any resistances in circuit, in two groups of four motors, each in parallel; each two groups can be coupled in series or in parallel, and their excitation can be varied; any of the motors can be cut out of circuit separately. Besides the results of

the tests already published in these columns, it is stated that at a velocity of 33 miles per hour and on an up grade of 3 feet in 1,000 it drew 90 tons, consuming 1,000 amperes at 300 to 350 volts; although very complete measurements were taken during the recent trials, they have not yet been prepared for publication. "La Nature," Feb. 17, contains a briefer description, including almost all of the illustrations. According to "La Nature," Feb. 10, in a recent trial of this locomotive, a train of 90 tons was drawn at a rate of 33 miles an hour up a grade of 8 feet to the thousand and at a velocity of 48 miles an hour up a grade of 3 feet to the thousand; it considers these results quite favorable; a complete description of this locomotive is promised in the next issue of that journal. In a short article by Mr. Lea, in the Lond. "Elec. Eng.," Feb. 16, some illustrations are given, as also a profile of the road over which the trial was made, the length of which is about 16 miles. He states that Mr. Heilmann claims, and quite rightly, that his method enables high speed electric traction to be adopted at once on any line without interfering with the present conditions or necessitating changes in the permanent way, or requiring the erection of generating stations.

Liverpool Overhead Railway.—According to the Lond. "Elec.," Feb. 16, during the past six months passengers were carried at the rate of five million per year; the gross earnings for six months were about \$92,000 and the working expenses about \$69,000. A report of a recent meeting of the stockholders is given in abstract in the Lond. "Elec. Rev."

Underground Electric Railway in Budapest.—According to the "Elek. Zeit.," Feb. 8, a definite proposition has been made to construct an underground railway about two miles in length; it is not to be tunnelled like the City and South London line, but is to be run directly below the pavement; it is to be ventilated throughout with electric ventilators; it is to be completed before the year 1896.

Steam Tramway.—"La Nature," Feb. 10, gives a well-illustrated description of the steam tramway, in which the Serpollet boiler is used. (The principle of this unique boiler is that the water is heated between two flat surfaces of iron very close together and heated over a fire; it is inexplosive and instantaneous in action, water being pumped into it only at the moment when steam is required.)

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

The Question of the Best Frequency.—In a well-written article by Mr. Kolben in the "Elek. Zeit.," Feb. 8, he discusses in a systematic manner the various different influences of different frequencies, giving in each case simple practical formulas for determining the influences of different frequencies; he divides the subject into three parts: (1) the dependence of hysteresis and Foucault current on the frequency and the resulting effect on the efficiency, heating and cost of construction; (2) the increase of the resistance, the self-induction and capacity of the line with increasing frequency; (3) the influence of the frequency on the parallel coupling of generators and on the running of motors. The results can be indicated only briefly here; the hysteresis loss increases proportionately with the frequency and with the 1.6 power of the maximum induction; the Foucault losses increase with the square of the frequency and with the square of the induction; a series of curves are given, one for each of the frequencies used in practice from 40 to 140, a set of curves being given for the hysteresis losses, for the Foucault losses and for the sum of the two, the ordinates being induction and the abscissas the losses; the results were verified experimentally by the writer by a large number of tests; a similar set is given for the low frequencies occurring in continuous current armatures. From one of these he deduces the induction for various frequencies for a constant

loss of 15 watts per cubic decimetre; from the formula for calculating the cross-section of the iron he shows that it diminishes with the product of the frequency and the induction density; but as the induction need not diminish in the same degree as the frequency increases, an increased frequency results either in a reduction of weight for the same watt losses—that is, the machines are cheaper—or the efficiency is increased with the frequency; aside from this the weight of copper is less, owing to the smaller length of wire; for small machines and transformers whose surface is proportionately great a high frequency is allowable, but for large units, as used in Europe, an increase above 60 is too great and is not rational, as nothing is gained in efficiency and little in weight and cost. Regarding the second division, he states that these considerations are the most important factors, and he divides them into an increase of resistance in large secondary circuits, the self-induction and the capacity of the high tension lines; regarding the first of these he gives the formula showing that the resistance increases with the square of the frequency, a set of curves being given for different values, showing that for 50 periods and for diameters of less than about 3-8 inch this factor can be neglected; but with the frequency used in this country extensive secondary networks are for this reason out of the question, as the increase is quite great; stranded cables do not overcome this; either flat cables or stranded ones, in which the strands are alternately in the middle and on the outside, could be used; he discusses the effect of impedance, giving a set of curves taken from those of Kennelly, and concludes that for large transmissions to long distances frequencies of over 60 are not to be used, but in underground cables self-induction and capacity effects may neutralize each other under certain conditions, for which he gives the relation, showing that in installation there would be only one value for the frequency; regarding the capacity of overhead lines, he states that the effect, even for great distances, is by no means as great as is often stated; the higher the frequency the greater this effect; he gives a formula for calculating the capacity of air lines and the resulting charging current, which he finds increases proportionately with the frequency; for underground rubber cables he also gives a formula, showing that this current is relatively great; he refers to some tests made over a long distance overhead line with 25,000 volts and a frequency of 42, showing a close agreement between calculation and observation of the charging current, the watt loss being less than 1 per cent.; the increase in the transformation ratio of transformers caused by the capacity of the line (Ferranti effect) is due, he claims, to improper construction of the transformers and can be made inappreciable by a proper design. Regarding the parallel coupling of alternators, he says that it cannot be discussed with simple theories, as it depends on a great many factors, but experience has shown that the frequency affects this but little; for instance, in some installations with a low frequency an artificial load is absolutely necessary, while in others with a high frequency it is not required; regarding motors, however, a high frequency increases the difficulty in design, as it increases the number of poles for given speeds, a table of which he gives; for lower speeds the design can be made much better; for a frequency of 50, for instance, the number of poles can be reduced to from 4 to 8 for motors of 1 to 50 h. p., whereas with a frequency of 130 the number of poles would have to be from 10 to 20; as the current for no load increases directly with the number of poles and becomes very great with small motors, this factor becomes the most important one in the designing of motors for high frequency. In conclusion, he states that with the exception of the transmissions of very great powers to unusually great distances, a frequency between 50 and 60 is about the best.

Long and Short Feeders from the Same Dynamo.—In a

description of the central station in Suhl in the "Elek. Anz.," Feb. 8, a system is described in which a series machine for 12 volts is coupled in series with one of the pair of feeders leading to a distant centre, the machine being coupled to the main dynamo; it is said to keep the voltage at the distant end quite constant.

Regulations for Steamship Lighting.—Mr. Kennedy begins a series of articles in the Lond. "Elec. Rev.," Feb. 16, in which he suggests rules and regulations for installations on board ship; the first portion is only introductory. In the same issue Mr. Cline suggests a few rules.

Fatal Accident.—The report of Major Cardew to the Board of Trade regarding the death of a horse from connection with a faulty underground main is given in the London journals of Feb. 16.

Steam Turbine Generator.—"Ind. and Iron," Feb. 16, gives a brief description, with good illustrations, of a plant in London in which storage batteries are used in connection with several steam turbine dynamos; the illustrations include a complete diagram of the switchboard, showing the connections for charging and discharging the batteries.

Double Acting Gas Engines.—The Lond. "Elec.," Feb. 16 publishes some correspondence of Mr. Dowson and Mr. McMullen, the latter being in favor of double acting engines.

Double Acting vs. Single Acting Engines.—The Lond. "Elec. Rev.," Feb. 16, contains a long communication from the Willans & Robinson Company in favor of single acting engines.

Direct vs. Rope Driving.—A correspondent to the Lond. "Elec. Rev.," Feb. 16, writes in favor of rope driving.

Motive Power and Gearing.—In Mr. Carter's serial in the London "Elec.," Feb. 16, he discusses thermo-dynamic principles.

Berlin.—The Lond. "Elec.," Feb. 16, gives briefly an abstract of a report of the Berlin stations up to June, 1893. The number of 30-watt lamps rose from 272,000 to 328,000 and the output from 45.9 to 53 million ampere hours; besides what was consumed at the stations the total receipts were nearly \$900,000, representing an increase of 8 1-2 per cent. in spite of the reduction in the price; the number of motors increased from 121, representing 500 h. p., to 232, representing 785 h. p., or nearly 60 per cent.; the coal has been reduced 23 per cent., the total decrease being 15.6 per cent. per indicated h. p. hour; the system of regulating clocks from the central station, described some time ago in these columns, is now working satisfactorily; the net earnings were about \$272,000.

London.—The first part of Major General Webster's paper is reprinted in the Lond. "Elec.," Feb. 16, in which it is also discussed editorially at some length; it is chiefly of local interest. The paper is continued in the Lond. "Elec. Eng.," and begun in the Lond. "Elec. Rev.," Feb. 16.

The Lond. "Elec. Eng.," Feb. 16, reprints the reports of several London stations, giving tabulated data of the accounts. Several similar reports are given more briefly in the Lond. "Elec. Rev."

Blackpool.—The Lond. "Elec. Eng.," Feb. 16, reprints a paper describing this installation, in which 2,000-volt alternating currents and transformers to feed separate installations or groups are used, together with high tension continuous currents for public arc lighting.

St. Pancras.—The paper describing this station, which was the first that was owned and operated by municipality, is given in full in the Lond. "Elec. Eng." and in abstract in the Lond. "Elec.," Feb. 16.

Huddersfield.—A description of this station, with some good illustrations, is given in London "Lightning," Feb. 1,

Burnley.—An illustrated description of this station is given in London "Lightning," Feb. 8.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Mileage of Submarine Cables of the World.—A correspondent to the Lond. "Elec." calls attention to a discrepancy of nearly 10,000 miles in the figure given by Mr. Preece, 139,574, and that given in the British Electrical Directory, which is 148,882 for the end of 1892.

Norway Telephones.—The Lond. "Elec.," Feb. 16, publishes a note from the report regarding the taking over of the telephone lines by the state.

ELECTRO-CHEMISTRY.

Plating Aluminium.—In a paper by Dr. Neesen, reprinted in the "Elek. Zeit.," Feb. 8, he describes a simple, cheap and very satisfactory method discovered by himself for successfully plating aluminium with any other metal; it is based on the so-called nascent state of the metal. The object, after being cleaned in hot nitric acid, is dipped into a not too concentrated solution of potassium hydrate, at about the temperature of a warm room, until the evolution of gas begins; it is then removed and rinsed in water but not dried, and while there is still a thin layer of the potash adhering to it, it is placed in the silver or other bath; this process cannot be used for acid baths, and is therefore not applicable to copper sulphate baths, which should be replaced by one that is not acid; aluminium of different makers behaves quite differently in regard to the adhesion of the metal, but in any case it may be plated by first amalgamating it, which is done as follows: After cleaning it, as before, dip it into potassium hydrate until gas evolution begins, and after rinsing, but not drying, it is dipped into a dilute solution of some mercury salt, as 5 grams of chloride of mercury to 1,000 grams of water; the black deposit formed is brushed off and the process may then be repeated and the article plated as described above; the adherence is said to be perfect. This also solves the question of soldering aluminium, which, after plating, can be soldered with soft solder very readily. Aluminium may also be plated without a current if treated as described; it may be silver plated by simply dipping into a cyanide bath after treating as described; it may be readily amalgamated as described above; this also is an exceedingly delicate test for the presence of mercury; the process is patented in Germany. In the discussion which followed Dr. Coehn stated that he had obtained good results in plating aluminium in a solution of copper chloride in alcohol. Mr. Huhnholz mentioned, but did not describe, a newly discovered process of tinning or galvanizing aluminium very successfully; the tinning admits of its being burnished and the parts can be soldered or plated like other metals.

Silver Plating Industry.—The serial in "Ind. and Iron" is continued in the issue of Feb. 16.

Electrolysis of Alkaline Salts.—Mr. Nourison, in an Academy paper abstracted in "L. Ind. Elec.," Feb. 10, calculates the minimum E. M. F. necessary for the electrolysis of soluble alkaline salts and gives an experimental verification; for chloride of sodium it is 2.02 volts, assuming that no work other than that of electrolysis is performed; for sulphate of sodium he obtains 2.15 volts and for nitrate and chlorate of sodium 2.7 volts; for potassium compounds the figures are the same; he concludes that the minimum E. M. F. of an alkaline soluble salt is constant for all the oxy-salts, as also for the haloid salts derived from the same acid.

Caustic Soda and Chlorine.—According to the Lond. "Elec.," Feb. 16, the company at Snodland has concluded that the best material for anodes is gas retort carbon, the terminals for which are made of lead, which, however, does not dip into the solution.

Electrolysis of Fused Salts.—In Mr. Andreoli's article in

"Ind. and Iron," Feb. 16, he continues the summary of the work which has been done in this field.

Phases and Conditions of Chemical Change.—The "Phil. Mag.," for February contains a long article by Mr. Veley, a brief abstract of which is given in the Lond. "Elec.," Feb. 16; he discusses what the chemical change is and what the cause of its commencement is; he does not favor the theory that chemical changes are due to electrolysis.

Chemistry and Electricity.—An editorial on this subject in the Lond. "Elec. Rev.," Feb. 16, calls attention to the importance of chemistry and recommends its study to the electrical student, stating that a thorough knowledge of chemistry will be of the utmost value to the electrician.

Effect of Polarization Upon Thin Partitions.—The Lond. "Elec. Rev.," Feb. 16, contains an editorial on this subject.

Striated Deposits.—An abstract of an article by Mr. Behn in the "Elek. Zeit.," Feb. 8, discusses the vertical striations noticed when silver and other metals are deposited from a bath; he believes that the explanation lies in the different current densities due to changes in the concentration; the striations are shown best in concentrated nitrate of silver with weak currents and increased temperature; an increased E. M. F. has no effect.

MISCELLANEOUS.

Ozone.—In "Ind. and Iron," Feb. 16, Mr. Andreoli criticises very unfavorably the statement of Mr. Christmas (see Digest Feb. 10). He claims that the statements are inaccurate and that the experiments are misleading and not conclusive; he quotes from a report by Dr. Ohlmüller on "Influence of Ozone on Bacteria," published in the proceedings of the Imperial German Sanitary Board, in which it is stated that anthrax, typhus, cholera bacilli, as well as anthrax spores are destroyed in a few minutes by ozone (but with what degree of dilution is not stated); he also refers to a successful treatment of tuberculosis by ozone.

English Patent Office.—The Lond. "Elec. Rev.," Feb. 16, contains a humorous article by "Moonshine," intended to ridicule the English Patent Office system.

A Storage Battery Competition.

The Electric Storage Battery Company, of Philadelphia, offers to place in the hands of Houston & Kennelly, electrical experts, a chloride accumulator for competitive test against any others that may be offered. The conditions are that each competitor is to deposit \$500, and in every case in which the chloride accumulator does not prove at least 50 per cent. better in efficiency, capacity and durability the entire deposit of \$1,000 is to go to the other competitor, the Electric Storage Battery Company to be awarded that amount if its battery shows an excess of 50 per cent. of superiority in these three respects. In order that the tests may be of the greatest practical value, it is suggested that a small cell suitable for traction or other purposes, weighing about 50 pounds, and a larger cell, suitable for central station work and weighing from 500 to 1,000 pounds, be entered, although the challenger offers to meet the weight of any element entered.

Messrs. Houston & Kennelly have agreed to make the above tests on the following conditions:

1. All results to be published.
2. Each contestant to be permitted to have one representative present at the firm's laboratory during the tests.
3. Each contestant to be permitted, through his representative, to withdraw his battery at any time, but in all such cases the tests will be published up to the point of withdrawal, and the deposit will be forfeited to the opponent.
4. No tests will be commenced until after the battery has been discharged 100 times at a rate of $\frac{3}{4}$ of an ampere per pound of electrode as shipped.
5. The tests to be of three kinds, namely, efficiency tests, capacity tests and durability tests.
6. The efficiency to be the ratio of output to intake, and to be measured in watt hours for energy capacity, and in ampere hours for current

storage capacity. The battery to be considered as discharged when the E. M. F. per cell, on opening the circuit, falls below 1.75 volts. The criterion of full charge to be agreed upon in writing before the tests commence in each case. 7. The current capacity to be determined in ampere hours' output from the point of full charge to E. M. F. of 1.75 volts, as above, and to be rated in capacity per pound weight of charged cell and per pound weight of dry electrodes as shipped. 8. The above tests to be made at varying rates of discharge per pound weight of dry electrodes as shipped, in order to determine the range of efficiency and capacity at varying outputs. In deciding the relative merits of two competing cells whose efficiency or capacity may be equal at different rates of discharge, the award will be given to the cell possessing the greater efficiency at the higher rate of discharge per pound of plate weight as above. 9. The durability tests to be made on the completion of the preceding tests and to be under conditions no more severe than those required for traction work. The durability will be measured by determining the number of working hours of charging and discharging at the rate of $2\frac{1}{2}$ amperes per pound of dry electrodes as shipped, which will reduce the storage capacity of the battery in ampere hours to one-half of its first valuation at that output. 10. The award will be made on the basis of the sum of the percentages of the chloride accumulator over contesting batteries on the three claims of efficiency, capacity and durability. The mean efficiency of energy and current and the capacity in ampere hours of battery and electrodes being selected as the relative competitive efficiency and capacity in each case. The efficiency, capacity and durability of the contesting cells will then be divided into the corresponding efficiency, capacity and durability of chloride cell, and if the sum of the three quotients exceeds three and one-half, i. e., 350 per cent. minus 300 per cent., the decision will be given in favor of the chloride cell, but not otherwise.

Electric Heat from Isolated Plants.

The use of electricity, generated by isolated plants for electric lighting, may be extended to a number of commercial processes, which are employed in nearly every form of industrial work in connection with high temperatures, and we are indebted to the Central Electric Heating Company, 26 Cortlandt street, New York, for the following useful information on the subject:

The well equipped manufactory of to-day has its own electric lighting plant; the investment in lighting apparatus is productive capital for a very small part of the time—entirely idle for several months in the summer and productive during the winter for only about three hours per day, on an average. In such cases the current can be used for industrial purposes and the cost of producing the energy can be set down as not materially greater than the number of pounds of coal burned to secure the H. P. H. For instance, if three pounds of coal are burned per H. P. H., at a cost of \$5 per ton, the rate would be three-quarters of a cent per H. P. H. All coal is burned under the boiler in the boiler room, and the dirt and the discomfort are confined there.

In all fabric, as well as in other textile industries, the use of electricity for heating sad irons and similar devices offers a means for securing constant working apparatus, together with uniform temperature; and the temperature to which the heated surface is raised may be predetermined, so that little or no loss may occur from the carelessness of the employee in scorching goods.

A 7-pound electric laundry iron requires about 330 watts, so that, including a 10 per cent. loss in transmission, two irons may be run per horse power, or one iron may be run at a cost of only about three-eighths of a cent per hour. Not only can the iron be successfully operated at this low cost, but the employees' time be made more productive. From continuous working and constant temperature of working surface the work is uniform in quality and the loss and damage from overheated irons entirely eliminated.

The mean temperature of the workroom is reduced, there are no injurious products of combustion, the shop can be kept cleaner, the surface of the iron clean and brightly polished. For factory work, no more desirable distribution of fuel can be conceived than electricity for fuel purposes, especially in those operations where the heat is localized, and

in nearly every process where high temperatures are required localized heat is wanted.

In the equipment of rubber goods factories or brush factories, or any factories where with present methods flame is used, electric heaters can be used for heating the pitch kettles, glue pots, irons, etc., so that no flame is required in any part of the factory. In a brush factory equipment recently installed, the pitch kettles are heated by heaters immersed in the pitch. Every unit of heat is utilized, and the hottest surface brought 1-2 inch from working surface of pitch. The heating mechanism is arranged for three working heats; a large amount of heat for heating the pitch from the cold; a moderate amount of heat for use when the surface of the pitch is being constantly agitated; a small amount of heat for maintaining temperature when the pitch is not being used. In this equipment the cost of the horse power hour has been determined as c.9 cent; each kettle uses 275 watts on working heat, so that the cost per hour per kettle is about one-third of a cent. There is absolute safety from fire, and from the underwriters' standpoint the electrical distribution of energy for fuel purposes is as great a boon as the use of electricity for lighting has proved to be.

In the manufacture of varnishes, electricity can be used diffused over a constant temperature working surface to melt the gums; and here, as in a number of chemical processes where hydro-carbons are used, the melting point is so near that of heat of decomposition of some of the constituents that a uniformly diffused heat has to be employed, and by using electricity at constant potential absolutely constant working temperatures are secured. By this means cheaper grade materials produce as good results as more expensive gums heated in the ordinary way.

In hospitals electrically heated apparatus can be successfully applied to many processes: for heating food, etc., in the various wards, warming of bandages, beds, etc., and in the laundries, kitchens, etc.

On steamships the dynamos are generally run during the whole day to light the hold, engine and fire room and other dark places, and the various applications for heating purposes are made at the cost per horse power hour of the coal consumption.

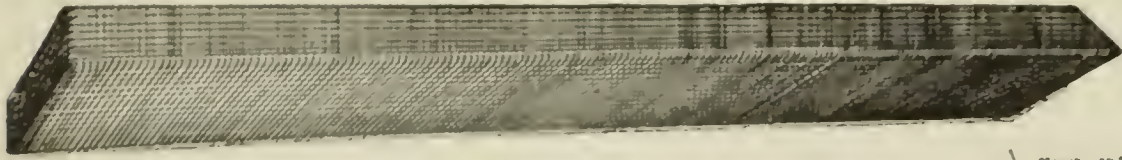
In hotels there is probably the widest field for the development of the isolated plants in electric heat engineering. The kitchen of the average hotel contains long, red-hot ranges, charcoal broilers and great unwieldy ovens. The fuel is used inefficiently and accompanied by dirt, unequal fires, stifling, radiant heat, etc. By burning all the fuel under the boiler, using localized electric heat in ovens of small heat capacity, in broilers of high constant working temperatures, in griddles, grease kettles, etc.; in short, for all purposes requiring temperatures over that of live steam. The objectionable elements in present methods are eliminated, labor saved and apparatus introduced that renders the employment of expensive chefs unnecessary.

The efficiency of fuel in hotel work will be greatly increased when the concentrated heats from electricity are used for the high temperatures, live steam for all water boiling processes and exhaust steam for warming purposes, such as steam tables, coffee urns, plate warmers, etc.

In isolated plant work it may be stated generally that the cost of the electrical power can be figured at the cost of coal burned to secure this power; that for concentrated heat the energy can be used successfully and economically; that for fire risk, it is as important a change as that wrought by electric lighting as compared with other methods of illumination. Electric lighting is highly localized electric heating, and the two are directly comparable. Properly introduced and used, the working range of money invested for lighting will serve a number of useful mechanical processes at high temperatures and small heat capacity.

Composite Graphite and Copper Woven Wire Brushes.

We illustrate a new woven wire and graphite commutator brush, made by the Belknap Motor Company, Portland,



COMPOSITE WOVEN WIRE BRUSH.

Me. These brushes contain all the essential qualities of both copper and carbon, and avoid sparking at the commutator; the graphite acts as a lubricant, and the copper as a conductor. It is a well known fact that carbon offers a very high resistance, or 1,500 times as great as that of copper, but notwithstanding this it is used very extensively. By continual experimenting in the use of all kinds of brushes in connection with its machines, the manufacturers found nothing equal to the brush they are now making, which is being adopted by street railway, electric light and power stations in all parts of the country, and the same favorable report is received from them all. While the first cost is some higher than plain copper, the length of life of

creased resistance in receiver, with the result that it affords an intense magnetic field, and a wide diaphragm. The mass of metal employed is very large, giving increased magnetic saturation and great lasting powers.

The generator which rings the signal bell generates a current that strengthens the magnets of the instruments so that with every call the telephone is brought up to the point of highest magnetic action.

A recent test was made of two Western telephone instruments between Chicago and New York, and proved a thorough success, the voice being perfectly clear and distinct. Clearness of vocal sound, simplicity of adjustment and economy of maintenance are the points of merit which are claimed for the instrument.

A New Multipolar Generator.

The latest type of multipolar, direct current generator which the Standard Electric Company has placed on the market is shown in the accompanying illustration, and is certain to achieve the popularity which the other types of machines manufactured by this company have attained.



IMPROVED MAGNETO TELEPHONE.

both brush and commutator more than makes up the difference, so they are much more economical than any others. The brush, being flexible, gives a good contact.

Improved Magneto Telephone.

We give an illustration herewith of a new and improved magneto telephone now being manufactured by the Western Telephone Construction Company, of Chicago. The transmitters are wound in series, and the receivers in multiple arc. This gives an increased potential in the transmitter and de-



NEW MULTIPOLAR GENERATOR.

The machine is of a solid and substantial design, with large base, insuring rigidity and freedom from vibration. The field has four consequent poles, the wrought iron cores being bolted between soft cast iron pole pieces. The two horizontal pole pieces have two lugs each, and by them the field magnet frame is bolted to the base, a zinc distance piece being interposed at each side to prevent magnetic leakage to the bed plate.

The journal seats are bored in line with the armature bore, and the journal supports being turned in a lathe to a corresponding arc, absolute alignment of the shaft with centre

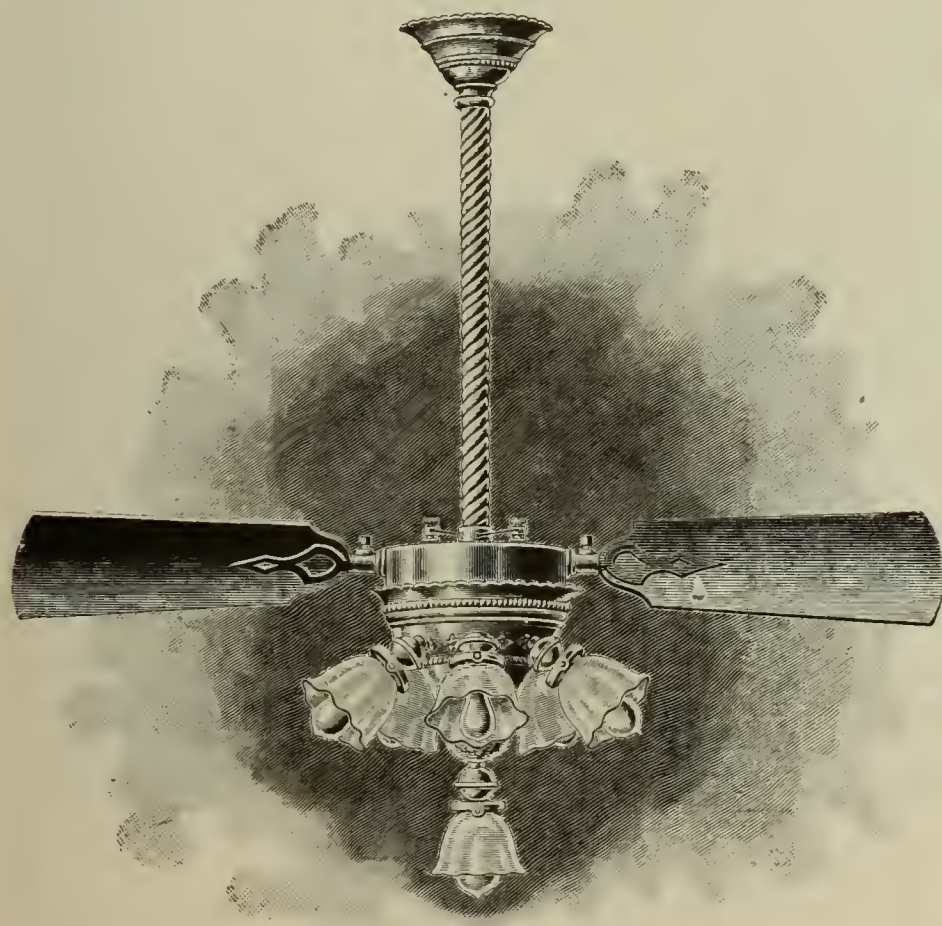
of field bore is assured. The journals are self-oiling, two loose rings being provided for carrying the oil from a reservoir to the shaft. The journals are self-adjusting, being of the universal ball bearing type, allowing the armature shaft to have all necessary adjustment at all times. By removing a pedestal at either side of the machine the armature can be easily and quickly taken out for inspection or cleaning.

The armature is of the conventional Gramme ring type, but has several important modifications in its details, securing better insulation and absolute stability of the armature conductors. The soft iron armature rings are supported by a split gun metal spider.

The mechanical construction of the commutator is such as to enable any intelligent mechanic to renew any defective segments, or even replace the entire commutator in a comparatively short time.

A neat and substantial switchboard of slate or marble is supported over the two upper fields, and incidentally quite an ingenious use is made of the well-known property of a magnet to repel an arc. The two main line fuses are located almost directly over the ends of the upper fields, and the result is that in case a fuse is blown from any cause, all dangerous arcing is prevented, owing to the repelling action of the pole piece underneath the switchboard.

The brush holders are of a novel and neat design, short blocks of carbon being clamped firmly between two metal jaws, thereby giving a minimum resistance to the brush proper and securing perfect contact with the commutator. In the 125-h. p. machine five brushes, each 1 3/4 inches wide, are used on each brush holder stud, the current allowed in the commutator being as low as 200 amperes per square inch. The two sets of brushes of the same polarity are con-



COMBINED ELECTROLIER AND FAN.

nected together by two double connecting bars, no cross connections in the armature itself being used.

The base is arranged so that a pawl and ratchet may be applied to either end, and in case it is desired to reverse the direction of rotation of the armature, no change in the connections is required, the simple reversing of the brushes and bringing them into the opposite neutral plane, respectively, being all that is necessary.

The Standard Electric Company will soon have a complete line of these machines on the market of 110, 220 or 500 volts.

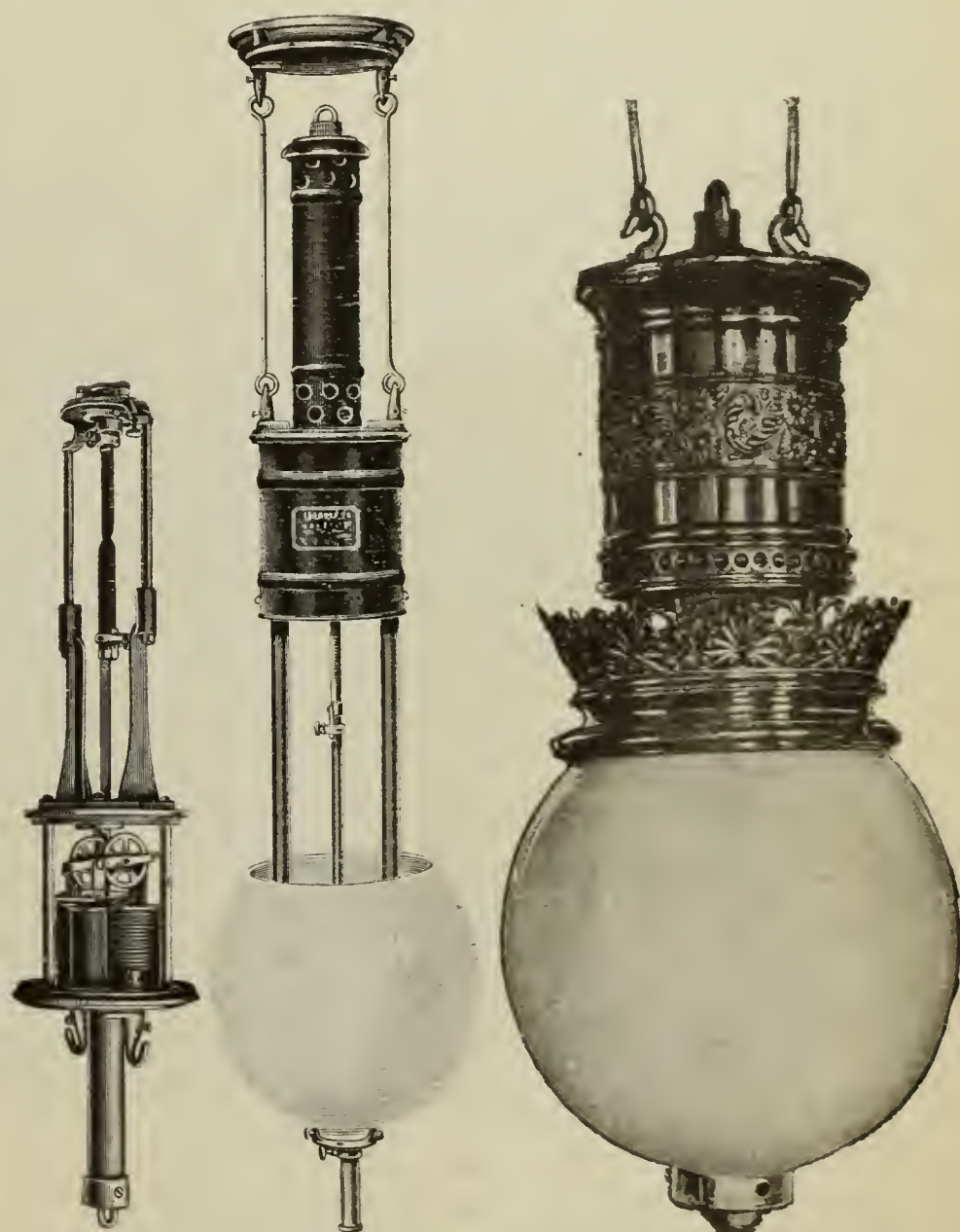
A Combined Electrolier and Fan.

The accompanying illustration shows the "Diehl" electrolier fan, combining with the popular "Diehl" electric ceiling fan a lighting fixture as well. It is of handsome design and finish, and both the fan and lights can be operated separately or together at will. Diehl & Co., 385 Broadway, are entering the coming season with full lines of other fan devices, and with increased factory facilities.

A New Arc Lamp for Incandescent and Railway Circuits.

That arc lamps capable of being satisfactorily operated on the ordinary incandescent or railway circuits are a necessity is evidenced by the extraordinary demand for them, which seems to have arisen in a surprisingly short space of time. They have been especially advantageous for use in the lighting of interiors of large halls, stores, etc., already wired for the incandescent light.

The General Electric Company announces a new arc lamp for incandescent and railway constant potential circuits. This lamp is known as the Thomson '93 arc lamp, and is the adaptation of a principle and construction patented some years ago by Prof. Elihu Thomson. It possesses charac-



CONSTANT POTENTIAL ARC LAMPS.

teristics of excellence not found in any other lamp hitherto brought out for constant potential circuits, the most striking of which are the following:

The lamp is constructed of but very few parts; it has no delicate mechanism with its attendant constant liability to get out of order, and the parts are practically interchangeable in all the lamps. The motion of the carbon rod either up or down is entirely free; this allows of a rapid and accurate change of carbons, and the usual rough handling incident to this process cannot injure the mechanism. In the ordinary type of lamps the motion of the rod, in one direction at least,

is restricted to slow speed, even with the application of force. As force must be employed in order that the trimmer do his work rapidly, the life of the mechanism in the ordinary lamp is necessarily shortened.

The Thomson '93 arc lamp is a geared lamp, but has none of the disadvantages of either the clutch or clockwork feed mechanism, while possessing all the advantages of a clutch lamp. The feeding of the lamp is entirely independent of the weight of the carbon, it being equally regular whether with a whole carbon or one partly consumed. The lamp burns a very steady arc, noticeably free from noise, and instantly adjusts itself to any variation of potential. The principle of the feed mechanism is that of the rack rod, which carries the upper carbon holder. This rod is of rectangular section; the rack meshes into the teeth of a pinion on an arbor in the case. This arbor also carries a gear which engages with the second pinion on the controlling arbor. Any downward movement of the rack rod and carbon is regulated by a pawl and ratchet wheel on the second arbor. The pawl is controlled by the shunt magnet of the lamp, and the design is such as to permit a single tooth only to pass at one movement. The movements can, however, follow each other so rapidly as to allow a practically continuous feed until the proper length of arc is obtained. The series magnet in the lamp acts to draw and maintain the arc.

The lamps are adjusted for nine amperes of current with a 45-volt arc, but can be furnished for any current from 4 amperes upward on special order. As with any arc lamp,

also of plain design, is intended for indoor use. A separate rheostat is here necessary.

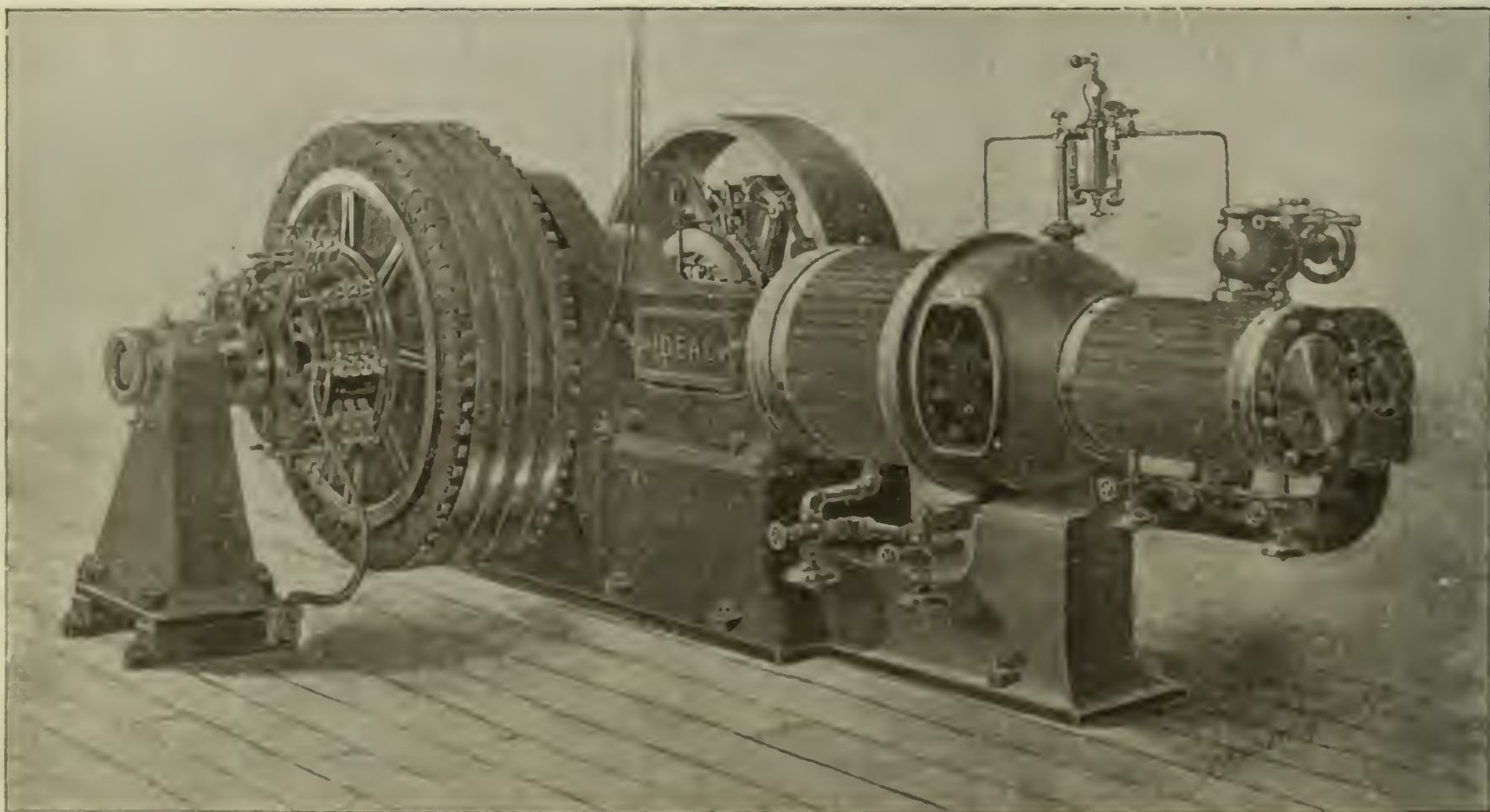
The long lamp, for use on 500-volt railway circuits, designed to be run ten in series, with a rheostat furnished free of charge with each set of ten lamps ordered. In external appearance this lamp is like the long lamp for incandescent circuits, but the resistance in the chimney is replaced by a cut-out thrown into circuit when the carbons burn out or the arc is accidentally extinguished.

The ornamental lamp has a still shorter frame than the short, plain lamps, and the globe is supported from the top on the side of the rods.

The focusing lamp, the smallest practical arc lamp on the market, being but 23 inches long, is designed for indoor use only. The globe is held from the top, as in the short ornamental lamps, and as the carbons are consumed the arc maintains the same position in the globe, owing to the movement of the carbon rods.

Direct-Connected "Ideal" Engines.

The direct connected combination of engine and dynamo of to-day is demonstrating, by an increasing number of plants, its practicability, efficiency and sound principles. We illustrate herewith one of the most modern of these dynamo engine combinations yet produced. This comprises a multipolar dynamo of the Waddell-Entz type, driven by a Harrisburg tandem compound Ideal self-oiling engine. The



DIRECT-CONNECTED ENGINE AND DYNAMO.

the best results can be obtained by the use of first quality cored carbons, but the Thomson '93 lamp will give better results with ordinary commercial carbon than any other arc lamp at present before the public.

At present four varieties of this lamp have been designed by the General Electric Company, and are now ready for delivery; that for the alternating current is nearly completed. The varieties alluded to are as follows:

The long lamp for incandescent circuits is of plain design and intended for out-of-door circuits, to be used two in series on 110-volt lines. The necessary resistance is placed in the chimney and external rheostat is unnecessary. The total length of this lamp is but 40 inches.

The short lamp, for incandescent circuits, 32 inches long,

dynamo is 80 kw. capacity, and the engine cylinders 10 inches and 17 inches by 12 inches, built for running, in this instance, non-condensing. The speed of the combination is 260 revolutions per minute, and it operates under a pressure of 115 to 125 pounds.

The Ideal engine has several strong points of improvement, as compared with what has heretofore been considered "good enough" practice. The self-oiling feature is shown to be a highly efficient device, all the bearing surfaces being, by its use, supplied with continuous streams of oil, by which the following very apparent advantages are obtained: First, perfect circulation of oil without the care and attention dependent on drop feed and other devices for oiling; second, important bearing surfaces are dust proof; third,

there is freedom from all splashing and unsightly dripping of oil on the floor and dynamos.

In direct connected work it is extremely important that the dynamo should be kept as free from oil as possible, for the short circuits of dynamos are most frequently traced to the throwing or conveying of oil from the engine to the dynamo. The simplicity and heaviness of the machine is noticed, and the method of support under the cylinders is well designed.

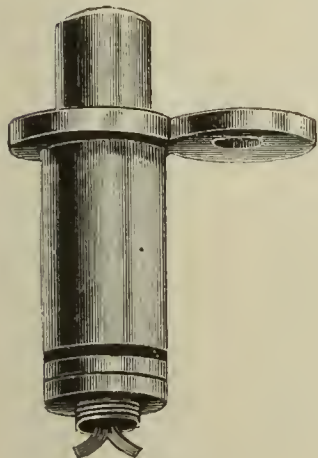
The economy of this combination is quite remarkable, since a water consumption is claimed in service of 23 pounds per horse power per hour, non-condensing.

The Ideal engine is the product of the Harrisburg Foundry and Machine Works, of Harrisburg, Pa., and was ordered and installed at the Bridgeport Copper Company by its representatives for New York and Boston, W. R. Fleming & Co., 203 Broadway, New York, and 620 Atlantic avenue, Boston.

Improved Door Spring.

Heretofore springs of this kind have been very ineffective owing to the imperfect connection made by a straight pin or flat contact, but in this spring this is overcome by slitting the wire and bending out the ends, as shown by cut, thereby making a taper, rubbing and positive contact.

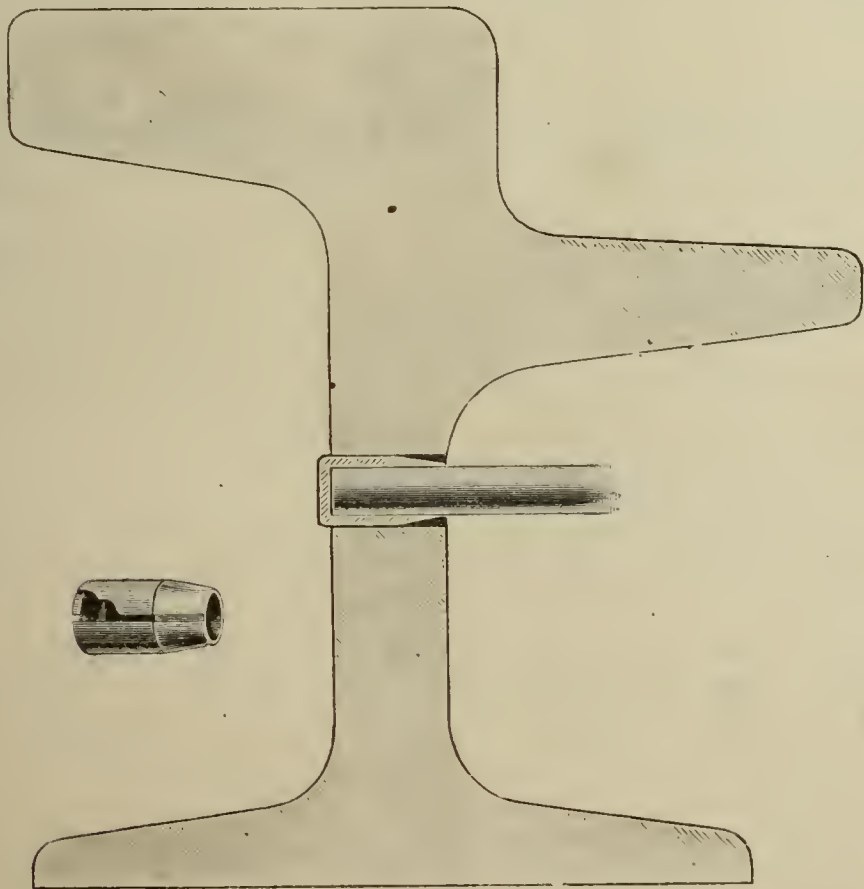
Owing to the small size, this spring can also be used on inside blinds, etc. This spring is made by Huebel & Manger, manufacturers of electrical goods, 286-290 Graham street, Brooklyn, N. Y. The work and material is of excellent quality, and the spring will undoubtedly prove popular.



DOOR SPRING.

Steel Bonding Caps.

The accompanying cut shows views of the new track bonding device recently brought out by the Ohio Brass Com-



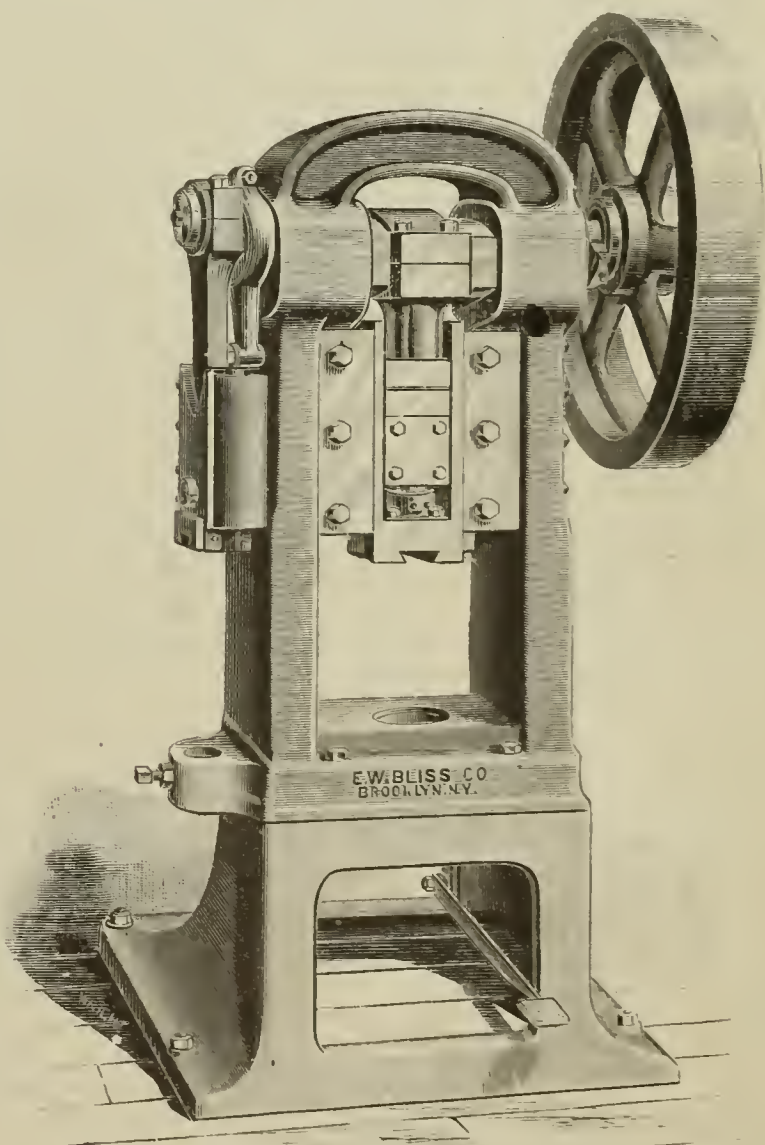
TRACK BONDING DEVICE.

pany, of Mansfield, Ohio. The steel bonding cap, as its name signifies, is a steel cap, which fits snugly over the end of the bonding wire and into the web or flange of the rail. The method of bonding tracks with this cap is as follows:

The end of the wire is passed through the hole in the rail, which is drilled 1-32 of an inch smaller than the outside diameter of the cap. The cap is then placed on the bonding wire and entered into the rail. A few blows from a hammer fasten it in place. The crimp extending the full length of the cap allows the shell to compress firmly over the wire and into the rail, making a perfect air and moisture proof joint. It can be used equally well with iron and copper wires of different sizes. The facility and quickness of bonding will no doubt bring it into favor.

Trimming Press.

We illustrate a press of late design brought out by the E. W. Bliss Company, Brooklyn, N. Y., intended for use in the forge shop where hot metal is to be trimmed. It was the intention of the designers to build a press that would meet as nearly as possible all the requirements for which a press of this class of work can be used. The press is fitted with the well known Bliss clutch and a patented adjustment in the slide, and has a supplementary slide in the side of its frame to be used in cutting off the work from the bar after it is forged and trimmed. This is considered a new feature in a press of this kind, and will be at once appreciated by persons using such machines. The construction of the machine is very strong, and every detail has been carefully studied. These presses are built in several sizes and are usually made with fly wheels, as forgings are usually required to be trimmed very quickly, and a high speed machine becomes necessary. This cut represents a press with a 4-inch stroke, 4-inch adjustment and 15 inches from bed to end of slide when up; the distance between uprights is 22



TRIMMING PRESS.

inches. This machine carries a 900-pound flywheel, the total weight being about 5,500 pounds. The dimensions can be modified to suit special requirements, if it is necessary. These presses can also be geared for cold trimming.

Financial Intelligence.

The Electrical Stock Market.

New York, March 3, 1894.

ELECTRICAL STOCKS have again come to the fore—General Electric, Western Union, Bell Telephone and Westinghouse serving to add not a little to the activity of this week's New York and Boston markets.

GENERAL ELECTRIC has scored a most substantial rise this week, the gain being 3 points. Insiders have been open in their expressions of bullishness, and, while admitting the poor character of last year's business, have made most cheerful predictions regarding future business. They base their hopes of prosperity on the extent to which the business of the General Electric Company has improved of late. The main buying of the stock has been for the account of a Broad street house with large foreign connections. Some time ago a request was made by this house for a statement of the company's condition and prospects for the benefit of foreign stockholders, and the information furnished was of so pleasing a nature that the foreign investments have been largely added to this week. It was pointed out to this house that the company is practically out of debt, the only obligation being endorsements on about \$1,000,000 of customers' notes discounted by the company; that collections have improved immensely, and that the general resources of the property have now been so much bettered that a dividend will soon be earned on the preferred stock. In fact, it is now stated that, while the dividend on the preferred will, for prudential reasons, be postponed at the coming directors' meeting, the full amount will be paid during the present year, thus paving the way for a resumption of dividends on the common stock. It is very easy, of course, to figure in this way, but less than \$1,600,000. This would allow the payment of the interest on the debenture bonds, 7 per cent. dividends on the preferred stock, as well as the accumulated dividend on the same, about \$150,000, and leave \$650,000, or about 2 per cent. on the common stock. It is very easy, of course, to figure in this way, but the stockholders will soon have to face the appalling showing that the coming annual report will make. The falling off in business from Feb. 1, 1893, to Feb. 1, 1894, has been tremendous; where the company formerly did \$15,000,000 of manufacturing business it last year did only between \$7,000,000 and \$8,000,000. The directors, it is understood, intend to present a direct statement of what has happened. They will make a full exhibit of the losses, scaling off assets, writing off and marking down of accounts during the past year. President Coffin and Director Twombly unite in denying that there will be a deficit of several millions, and that some plan will be devised to reduce the capital stock to represent the decrease in assets. It is nevertheless true that the assets behind the stock have greatly shrunk in value. First of all, over \$12,000,000 of the best treasury securities were handed over to the Street Railway and Illuminating Securities Trust for \$4,250,000, and the assets left over are not half as valuable as a year ago. Thus Fort Wayne stock was figured in the last annual report at \$12.50 a share; to-day it is worth about \$5 a share. And other securities have suffered in like manner. It will be interesting to read how the directors will explain the fact that, whereas on Feb. 1 last, the company had a surplus over immediate liabilities of about \$25,000,000, six months later it was practically bankrupt, and at present is hardly out of its difficulties. The advent of the annual meeting revives the report of a change in management. Gossip has it that much of this week's buying was for Vanderbilt account, and that a representative of that interest, in all likelihood Mr. H. McK. Twombly, will be President Coffin's successor.

WESTERN UNION TELEGRAPH, as was anticipated in these columns last week, has been put up by insiders. It is now understood that at the directors' meeting on the 14th inst. the full dividend will be declared. Knowledge of this has caused a scramble among shorts to cover, and added to this has been good buying for Gould interests. It is thought that the quarterly statement, soon to be presented, will show net results equal to nearly 12 per cent. upon the \$100,000,000 capital stock. How much faith insiders have in the property is demonstrated by the following remarks of Mr. Russell Sage: "The property is in excellent condition. We have spent a great deal of money on it, and look for better returns during the next six months than we have had in the past six months. When comparison is made with the spring statement, it will be found that notwithstanding the depression caused by the panic, the growth of the country has more than kept pace with the falling off in business. In other words, \$1,500,000 net would have been considered monumental a couple of years back. Western Union is a good property; one that is not likely to decline much, but will be sought after by investors who will be satisfied to buy it and hold it for the dividends that it yields and for the future returns that it will make."

WESTINGHOUSE ELECTRIC'S strength is again the subject of much favorable comment. It has been due to the bright business prospects. January net earnings alone are now estimated at between \$125,000 and \$150,000. The current fiscal year ends with

this month, and the annual report is expected to show a net income of upwards of \$1,800,000, or about 20 per cent. on the stock. Negotiations for several important contracts are now in progress, with every indication of a successful outcome. The directors declare this week a quarterly dividend of 1½ per cent. on the preferred stock, payable April 2.

BELL TELEPHONE stock has been weaker. The legislative attacks on telephone rates in New York and Massachusetts, together with the now published fact that future issues of stock will probably carry no subscription rights, have served to depress the price. The hearing on the petition for an increase of the capital stock has been postponed until the 7th inst. The statement of instrument output shows how the times affect this company. From Dec. 21 to Feb. 20 there was a gross output of 9,733, but 13,245 instruments were returned, leaving a deficit of 3,515. This compares with a net output in the preceding year of 4,852, a falling off of \$,367. The total number of instruments in use on Feb. 20, 1894, however, was larger than a year ago, being 564,482, against 556,591, a gain of 7,891 instruments.

THE UNITED ELECTRIC SECURITIES COMPANY invites proposals for the sale to the company of \$120,000 of its collateral trust 5 per cent. bonds. A balance sheet, as of Feb. 1, just issued shows: Assets—Stock, \$1,853,200; bonds, \$290,750; accounts receivable, \$58,452; notes receivable, \$41,763; total, \$2,244,166, but market value only \$1,000,000; \$6,627,000 underlying first mortgage bonds deposited to secure collateral trust 5s, less 20 per cent. reserve, \$5,301,600; accrued interest, \$98,265; cash on hand, \$37,916; total \$6,437,781. Liabilities—Capital stock, common, \$500,000; preferred, \$1,000,000; collateral trust 5 per cent. bonds, \$4,884,000; surplus, \$53,781; total, \$6,437,781. The company recently cut down its capital stock from \$1,000,000, of which the General Electric had over \$800,000, to \$500,000, to make up for the shrinkage in assets.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York.....	50	20	35
Detroit Electrical Works.....	10	2	3
Cleveland General Electric Co.....	—	85	90
East River Electric Light.....	100	—	65
Electric Con. & Supply Co., pref.....	15	15	16
Electric " " " com.....	15	15	17½
Edison Electric Ill., New York.....	100	93	98
Edison " " " 1sts.....	—	105½	105¾
Edison Electric Ill., Brooklyn.....	100	100	101
" " " Boston.....	100	112	115
" " " Chicago.....	100	145	150
" " " Philadelphia.....	100	115	120
Edison Electric Light of Europe.....	—	—	3
" Bonds.....	—	80	85
" Ore Milling.....	—	5	11
Fort Wayne Electric.....	—	4½	6½
General Electric Company.....	100	41¼	41½
" " " deb. 5's.....	—	80	81¼
Interior Conduit and Ins. Co.....	100	20	30
Mount Morris Electric.....	—	—	65
Westinghouse Consolidated.....	50	45	47
" " " pref.....	50	26½	27½
Western Union Telegraph.....	—	85½	85¾
American Bell Telephone.....	—	168	169

New Incorporations.

THE SHAMOKIN AND BEAR VALLEY ELECTRIC RAILWAY COMPANY, Sunbury, Pa., capital stock \$100,000, has been formed to construct and operate an electric railway. E. C. Hamilton, G. W. Smith and W. H. Ker are interested.

THE BASTRON WATER AND LIGHT COMPANY, Bastion, Tex., capital stock \$40,000, has been formed to furnish the public with electrical lights and water. P. O. Elener, T. A. Hasler and Louis Ehlers, all of Bastion, are the promoters.

THE LARCHMONT ELECTRIC LIGHT COMPANY, Larchmont, N. Y., capital stock \$15,000, has been formed to furnish electric light, heat and power. The promoters are C. H. Murray, William Murray, Larchmont Manor, and F. G. Senter, New York.

THE MEREDITH ELECTRIC LIGHT COMPANY, Meredith, N. H., capital stock \$5,000, has been formed to furnish electric light and power. A. W. Ives, Boston, Mass.; E. C. Mansfield, G. T. Sanborn, A. A. Kidder and J. S. Wadleigh, Meredith, N. H., are the promoters.

THE EAST BUFFALO ELECTRIC COMPANY, Buffalo, N. Y., capital stock \$1,000, has been formed to supply light, heat and power. J. J. Churchyard, 221 Summer street; Stephen Churchyard, 129 Munroe street, and S. A. Simons, 54 Irving Place, Buffalo, N. Y., are interested parties.

THE R. HAAS ELECTRIC AND MANUFACTURING COMPANY, Springfield, Ill., capital stock \$10,000, has been formed to manufacture electric appliances and to do a general electric business. Rudolph Haas, E. C. Haas and W. L. Blucke are interested parties.

THE SUBURBAN ELECTRIC LIGHT AND POWER COMPANY, Chicago, Ill., capital stock \$15,000, has been formed to manufacture and sell electricity for light, heat and power. A. F. Dexter, William Philipson and M. Gorton Carr are the interested parties.

THE SUPERIOR LIGHT, HEAT AND POWER COMPANY,

Chicago, Ill., capital stock \$50,000, has been formed to supply light, heat and power, etc. F. L. Goulding, L. J. Mosness and A. F. Wright are the promoters.

THE NEWBURGH ELECTRIC RAILWAY COMPANY, Newburgh, N. Y., capital stock \$150,000, has been formed to operate an electric railroad. H. C. Norton, B. B. Odell, Jr., and William D. Dickey, Newburgh, N. Y., are the organizers.

THE EASTERN ELECTRIC LIGHT, HEAT AND POWER COMPANY, Southampton, N. Y., capital stock \$15,000, has been formed to supply light, heat and power. J. H. Adams, 41 West 27th street, and R. B. Roosevelt, Jr., 26 West 52d street, New York, and F. S. Tainter, Southampton, N. Y., are the promoters.

THE NORTH SIDE ELECTRIC STREET RAILWAY COMPANY, Chicago, Ill., capital stock \$500,000, has been formed to construct and maintain a system of street railways in Chicago. F. W. McNallu, William Kilpatrick and August Rieke are the interested parties.

THE BEAVER MEADOW, TRESCKOW AND NEW BOSTON RAILROAD COMPANY, Hazleton, Pa., capital stock \$200,000, has been formed to construct and operate an electric railway. A. S. Van Wickle, A. M. Eby and C. J. Kirschner are the interested parties.

THE NORTHWEST FIXTURE COMPANY, Seattle, Wash., capital stock \$12,000, has been formed to manufacture and sell electrical apparatus and do a general merchandise business, etc. A. L. Kasson, J. G. Hawkins, C. Swawburg, N. W. Huggins and A. I. Stretcher are the promoters.

THE ELECTRIC POWER AND MACHINERY COMPANY, Jersey City, N. J., capital stock \$100,000, has been formed to manufacture and sell, etc., machinery pertaining to the utilization of electricity. The promoters are F. Mansfield, Jersey City, N. J.; C. P. Breese and J. L. Ludwig, New York.

THE ATCHISON TELEPHONE AND ELECTRIC LIGHT COMPANY, Atchison, Kan., capital stock \$50,000, has been formed to construct and maintain a telephone line and to erect an electric light plant. B. P. Waggoner, W. P. Waggoner, David Kelso and Ellsworth Ingall, all of Atchison, are the incorporators.

THE ELECTRIC INSPECTION AND REPAIR COMPANY, New York, capital stock \$15,000, has been formed to manufacture and construct, inspect and repair electrical apparatus. L. H. Starke, 210 East 113th street; J. J. McConnell, 47 Broome street, and F. C. Cannon, 848 Broadway, New York, are the incorporators.

THE SOUTH CALIFORNIA PRINTING TELEGRAPH COMPANY, Los Angeles, Cal., capital stock \$1,000,000, has been organized to build and operate telegraph lines, make, transmit and deal in electricity for light, heat and power. F. P. Flint, H. Lindley, J. J. Muir, W. F. Parker and J. C. Kays, Los Angeles, are interested.

THE ELECTRIC ILLUMINATING AND POWER COMPANY OF LONG ISLAND CITY, Long Island City, N. Y., capital stock \$50,000, has been organized to supply light, heat and power. E. A. Maher, 212 Lenox avenue, New York; C. Meyer, Maspeth, L. I., and D. H. Valentine, 16 Court street, Brooklyn, N. Y., are the organizers.

THE ELECTRICAL MANUFACTURING COMPANY OF AMERICA, Red Bank, N. J., capital stock \$300,000, has been formed to manufacture and construct electrical and mechanical apparatus of any description. W. J. Keys, Somerville, N. J.; W. L. Corliss, T. Davis, J. F. Bray, Red Bank, N. J., and U. T. Fackenthall, Brooklyn, N. Y., are interested parties.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
41 Park Row New York, March 2, 1894.

THE MASON ELECTRIC COMPANY is now moving from 1,391 Fulton street, Brooklyn, to 10 and 12 Fifth avenue, Brooklyn, where it will occupy larger quarters.

FREDERICK PEARCE, of 76 John street, is compiling a new catalogue, which will soon be published. It will contain a full list of all electrical specialties, with prices and illustrations. It is expected that the catalogue will be ready by March 15.

BROOKLYN, N. Y.—The department of police and excise in the Municipal Building, Brooklyn, calls for sealed proposals, to be received to March 13, at noon, for furnishing materials and supplies for the telegraph department, as per details, to be had of Leonard R. Wells, commissioner of police and excise.

MR. J. E. HAM, general sales agent for Kerite wires and cables, 203 Broadway, New York, reports that the 300 miles of Kerite cable constructed for the New York Central and Hudson River Railroad Company for signal service between Albany and Buffalo has been in service continuously and without interruption throughout the severe winter. Train dispatches and signal tower service during the recent storms were in no manner interrupted.

MR. U. T. FACKENTHALL, who severed his connection with the Electrical, Mechanical, Engineering and Trading Company, of New York, last January, has now formed the Electrical Manufacturing Company of America, and opened offices in the Havemeyer Building, 26 Cortlandt street, New York. The factory is at Red Bank, N. J. The company proposes manufacturing telephones, magneto bells, blasting machines, fire alarm apparatus, automatic machines and sterilizing apparatus. W. J. Keyes is the president, Eugene Fackenthall, vice president and general manager; Joseph F. Bray, secretary, and Thomas Davis, Jr., treasurer.

MR. WILLIAM B. VANSIZE, the patent attorney and electrical patent expert, has now established independent offices for the practice of his profession at 44 Broad street, New York City. Mr. Vansize has been engaged in electrical work since 1868, and has literally "grown up" with its various branches. He was admitted to the bar in 1879, and has since been continuously and exclusively employed by the great corporations successively organized to develop the telegraph, the telephone, the storage battery, electric light, power, and the electric railway, thus being active in securing many valuable patents and determining many contested patent questions. Now that his extensive experience is at more general disposal his clientage will greatly increase.

THE COMMERCIAL CABLE COMPANY some time ago contracted for a new ocean cable with Siemens & Brothers, of London. It is understood that the contract for the wire, amounting to 1,500 tons, was distributed between three manufacturers, one in England, one in Germany, and the other to John A. Roebling's Sons' Company, Trenton, N. J. Probably the most interesting fact in connection with the transaction is that the copper rods for drawing the wire for the English part of the contract are to be made by the John A. Roebling's Sons' Company, the latter, therefore, making one-third of the entire copper wire required. This company has practically completed its shipment of wire. The lot, taken as a whole, is probably the best lot of wire ever produced. None was passed at less than 99 per cent. of Dr. Matthiessen's standard. The average of all tests was 99.4 per cent. Only 104 pieces of wire were thrown out, and, with one exception, they were above 98 per cent., while the aggregate of all the wire actually shipped was 99.873 per cent.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., March 3, 1894.

MAYOR MATTHEWS has vetoed the order passed by the aldermen of Boston requiring the consent of the board to all street openings for laying and repairing electric wires and conduits in the city. He thinks such power should remain with the executive.

THE W. S. HILL ELECTRIC COMPANY, of Boston, came very near being burned out this week, or in any event sustaining serious loss and inconvenience to its rapidly growing business. Fire broke out early last Monday morning in one of their stock rooms, containing mostly files of documents and office stationery supplies, but before gaining much headway it was fortunately discovered.

THE COLUMBIA ELECTRIC COMPANY, of Worcester, recently did some very quick work in the wiring of the exhibition booths and installation of incandescent lamps in connection with the Food and Health Exposition, now in progress in that city. It accepted the contract on a Saturday and completed the installation by Monday morning at the opening of the exposition, and a very pretty installation it is. The company occupies an exhibit booth, and its display of electrical apparatus and supplies all of which are tastefully ornamented with an assortment of colored lamps and shades, attracts universal attention.

LINTON & SOUTHWICK, of Worcester, Mass., report business as unusually good with them in their particular line of electrical work. During the past year they have more than trebled their capacity, and have introduced several new features in the line of switches, of which they make a specialty. Both of these gentlemen possess valuable practical knowledge incident to central station requirements, are energetic and pushing, and those who know them well predict for them continued excellent business and a prosperous future. They claim for their switches that they are the best, cheapest, reliable and quick, qualities readily appreciated by electric light and railway plants. Certainly they are kept busy manufacturing them.

THE PETTINGILL-ANDREWS COMPANY, of Boston, has decided to enter the electric railway field more actively, and to that end has engaged the valuable services of Mr. Frank S. Cicott as manager of its railway department, who, as an electrical engineer, enjoys an enviable reputation. Mr. Cicott was formerly the Pacific Coast agent (resident) at San Francisco for Holmes, Booth & Haydens, from 1882 to 1889, leaving this firm to accept the management of the railway department of the Electric Merchandise Company, of Chicago, Ill. In 1891 he originated and started a tramway and railway paper in London, England, called the "Railway World," and still continues as a share owner and director in the board of the English publishing company.

Western Notes.

Branch Office—The Electrical World
100 Monadnock Block, Chicago, Ill., March 20, 1904.

THE WALLACE ELECTRIC COMPANY, of 104 Michigan avenue, has secured several valuable agencies, and is now busy with a new catalogue, which promises to be very handsome. It announces that its purpose is to conduct a business in electrical goods as manufacturers and manufacturers' agents, and not as general electrical supply dealers.

THE CENTRAL ELECTRIC COMPANY'S metal sheathed bushing, recently put on the market, conforming with the underwriters' requirements, has come into immediate popularity, and in explanation of the reason the Central Electric Company says that there is no other article of a similar nature offered to the trade. It is confidently expected that this bushing will take the place of glass, porcelain and vulcanized rubber.

THE ELECTRIC APPLIANCE COMPANY is pleased to announce to its friends and the trade in general that it is now prepared to supply original "Packard" lamps. This lamp will be remembered as a leading incandescent lamp for a great many years during the early days of incandescent lighting. Patent litigation compelled the factory to suspend work for a time, very much to the regret of all station managers who believe in using a high grade article.

MR. M. M. HAYDEN, who during the past seven years has been connected with, and of late years acting in the capacity of president and manager of the Law Battery Company, New York, has resigned his position as such, and will take charge of the Hayden-Booker Manufacturing Company at St. Louis, Mo. This company, a new one, purposes to manufacture and supply the trade with whatever they may require in the galvanic cell line, including the manufacture of glass jars, bushings, covers and zincs, something not done at present by any of the companies who are exploiting cells. Mr. Hayden is known throughout the electrical fraternity as a conscientious worker. The address of the Hayden-Booker Manufacturing Company is 2,140 De Kalb street, St. Louis.

THE JENNEY ELECTRIC MOTOR COMPANY reports through its Western office the following sales for the past two weeks: Two 30-kw., 110-volt dynamos for Chicago; 2 40-kw., 110-volt dynamos, same destination; 2 60-kw., 500-volt generators, Chicago; 2 30-kw., 110-volt dynamos for Washington, D. C.; 2 12-h. p., 110-volt motors, same; 1 25-h. p., 110-volt motor, for Michigan; 1 20-h. p., 110-volt motor, San Francisco; 1 30-kw., 110-volt dynamo, Missouri; 1 30-kw., 110-volt dynamo, Kentucky, and 1 50-h. p., 500-volt motor for Rochester, N. Y. The business of this enterprising house in other sections of the country is equally good, but their Chicago manager, Mr. A. H. Goode, has a way of securing orders that is interesting.

FISHER & PORTER is the name of another firm now attracting attention in Western electrical circles. With offices at 1,025 Monadnock Block, Chicago, they will hereafter carry on a contracting engineering business in the line of complete equipment of steam plants, giving special attention to large work. They have been made Western representatives of the Providence Steam Engine Company, sole builders of the "Improved Green engine," and of the Altoona Manufacturing Company, builders of the "H. A. Green engine." Handling engines of the highest grade, of both slow and high speed types, they are prepared to meet any demand for first-class work in this direction. They are making arrangements with other Eastern manufacturers as agents, and expect to be ready in other lines to take advantage of the incoming tide of business, of which they already see indications. Mr. H. F. J. Porter, who was first assistant mechanical engineer at the late Exposition during the period of construction, and afterward assistant chief of the machinery department, will bring into the firm a great deal of practical information, as well as a most thorough knowledge of steam engineering. Mr. Albert Fisher, the other member, has had a wide experience in the handling of steam engines, having at different times represented in Chicago the "Ball," "Watertown" and "Green" engines.

News of the Week.

Electric Light and Power.

MONETT, MO.—Bids are advertised for an electric lighting plant.

OAKLAND, IND.—A movement is being pressed to establish an electric light plant.

SPRINGFIELD, S. D.—The town of Springfield, S. D., has decided to put in electric lights.

MT. STERLING, ILL.—C. E. Brockman is in the market for a complete lighting plant.

LEAVENWORTH, KAN.—The matter of a municipal electric light plant is being agitated.

FLANAGAN, ILL.—A committee has been appointed to investigate the cost of electric lights.

NORWICH, CONN.—Solomon Lucas, of Norwich, is interested in the proposed electric road to Westerly.

GAINESVILLE, TEX.—Bids have been called for the construction of the new electric light company's plant.

LEAVENWORTH, KAN.—The citizens will vote in April in the matter of issuing \$30,000 in bonds for an electric lighting plant.

NEWTON, N. J.—The matter of waterworks and electric lights for Newton will come up at the town meeting on March 13.

PITTSBURGH, PA.—The Allegheny County Electric Light Company proposes to extend its wires to the Hazlewood district.

NEOSHO, MO.—An election will be held April 17 to vote in the matter of issuing \$12,000 in bonds for an electric light plant.

DENVER, COL.—The county commissioners are considering the matter of placing an electric light plant in the court house.

AMBLER, PA.—The proposition to issue bonds to the amount of \$15,000 for an electric lighting plant was defeated by nine votes.

MURPHYSBORO, ILL.—The city authorities are negotiating for the purchase of the electric light plant recently established in that city.

WILLIAMSPORT, PA.—Arrangements are now under way for the improvement of the old electric light plant for lighting the streets with electric arc lights.

SPRINGFIELD, MASS.—The committee on lighting streets has voted to award a contract to the United Electric Light Company for a five-year term.

CHARLOTTE, N. Y.—Citizens of Charlotte are discussing the matter of waterworks and electric lighting. A syndicate, represented by Michael Doyle, has offered to build the same.

BLACK ROCK, N. Y.—The Board of Public Works has been authorized to expend not more than \$350 in purchasing apparatus for testing gas and electricity.

SPRINGVILLE, N. Y.—Assemblyman Schoepflin has introduced a bill to authorize the village trustees of Springville to erect and operate an electric lighting plant.

TERRA ALTA, W. VA.—A committee of citizens has been appointed to ascertain how many will take electric lighting if a company is formed and a plant erected.

BROOKLYN, N. Y.—The roundhouse and repair shops of the Union Elevated Railway in Brooklyn, between Alabama and Vesta avenues, were burned. Loss, \$20,000.

RICHMOND, VA.—A bill has passed the Senate incorporating the Chesterfield Transit Company to build an electric railway from Richmond and Manchester to Petersburg.

The Electric Railway.

LOCKPORT, N. Y.—William T. Ranson, of Lockport, states that the proposed Lockport and Olcott electric road will surely be built this summer.

SUNBURY, PA.—It is stated that an electric road will be built this summer from Sunbury to Selinsgrove, but no names have yet been mentioned.

GLOVERSVILLE, N. Y.—Fire has gutted the main building of the Cayadutta Electric Railroad Company on South Main street. The loss will reach \$10,000.

CINCINNATI, OHIO.—The Madisonville and Cincinnati Street Railway Company has applied for a franchise over Columbian, Bramble and Central avenues.

HARRISBURG, PA.—The Beaver Meadow, Treseckow and New Boston Railway has been incorporated to build a railway in Carbon, Luzerne and Schuylkill counties.

TOLEDO, OHIO.—It is stated that surveys will be made this week for the proposed electric road from Toledo to Detroit. J. A. Dowson is promoter of the company.

MIDDLETOWN, CONN.—The selectmen have been petitioned by the Middletown Horse Railroad Company to grant permission to extend its tracks for an electric road.

MIDDLETOWN, N. Y.—The petition of the Middletown and Goshen Traction Company for right of way through Goshen will be heard at Goshen court house on March 8, at 7:30 P. M.

SYRACUSE, N. Y.—Directors of the Syracuse Street Railroad Company are making plans for their proposed extensions and contracts will soon be given out. W. R. Kimball will give details.

PAULSBORO, N. J.—The meeting in the matter of the proposed extension of the line of the Camden, Gloucester and Woodbury Electric Railway to Paulsboro has been postponed to March 3.

MEMPHIS, TENN.—The Citizens' Street Railway Company has assumed control of the East End Dummy line, and will substitute electricity as a motive power. General Luke E. Wright is vice president.

FALL RIVER, MASS.—Frank W. Brightman, of Fall River, was elected president, and Robert S. Goff, of Fall River, is clerk of the

Westport and Dartmouth Electric Railway Company, and work will soon be begun.

Personal Notes.

THE WILLIAM LANG COMPANY, of Brooklyn, N. Y., has been



E. F. GENNERT.

fortunate in securing the services of such able gentlemen as Messrs. E. F. Gennert, F. W. Belmont and J. F. Cunningham, who have resigned their positions with the E. P. Gleason Manufacturing Company and accepted the management of the William Lang Company. Mr. Gennert was second vice president of the E. P. Gleason Company, and during the twenty-two years of service with that firm has invented and perfected many gas appliances. When the electric light first appeared as a competitor of gas he devoted his attention to that line of work, and, with the assistance of Mr. Cunningham, the electric light department of the E. P. Gleason Company was established. In the first years of electric lighting this firm was almost alone as manufacturers of a number of electric light fittings, most of which were due to these gentlemen, and the older electricians will therefore welcome them as friends, while the younger members of the fraternity will value none the less their extended experience. The abilities of these gentlemen being so well recognized in electrical circles, their inten-



F. W. BELMONT.



J. F. CUNNINGHAM.

tion to produce a full line of staple electrical appliances, for which, besides, the factory of the William Lang Company is splendidly equipped, will meet with hearty support and the best wishes for their success. Mr. Belmont's ability as a financier is well known, and he will occupy the position of treasurer. Mr. Gennert will be vice president and Mr. Cunningham secretary. Mr. T. E. Conklin will serve as president.

Miscellaneous Notes.

MR. PENNOCK'S SLICK METHOD.—The following advertisement, signed by the Pennock Electric Company, recently appeared in a St. Louis paper: "Agents wanted everywhere to introduce an electric light that competes with gas at 5 cents per 1,000 feet. Applicants MUST ADVANCE \$1,000 for exhibition plant of 100 lights. Salary \$25 per week."

THE NEW ORLEANS ELECTRIC SOCIETY, at its second meeting on the evening of Feb. 21, was favored with an address from Mr. Charles H. Rockwell, secretary and treasurer of the Buckeye Electric Company, of Cleveland, Ohio, on the "Present Status of the Incandescent Lamp Litigation." At the next meeting, on March 2, Secretary H. Malochee will read a paper on "The Return Circuit for Electric Roads."

UNIVERSITY EXTENSION COURSE.—A class is about to be formed in mathematics for the New York electrical workers. Mr. Max Osterberg, of Columbia College, who has laid out a plan of instruction, will be in charge of the course. He intends to introduce the subject, commencing with arithmetic and gradually lead up to algebra and geometry, giving as much as is necessary for an electrician to know, in order that he may deal intelligently with the problems that present themselves to him almost daily in connection with wiring and other electrical work. The formation of this class is due to the desire of many attending the course of lectures

on practical electricity delivered at Cooper Union to become better acquainted with the phenomena of electrical science.

Trade and Industrial Notes

MR. FRANK H. STEWART, late of the firm of O. D. Pearce & Co., of Philadelphia, has been appointed agent for the Waterhouse arc lamp, Perkins switches and other specialties.

THE WALKER MANUFACTURING COMPANY, Cleveland, Ohio, is now busily engaged in getting out its first street railway generators and motors, and will soon announce the details of its system.

E. S. GREELEY & CO., 7 Dey street, New York, are sanguine as to the prospects in the near future for electrical business in general. Their own business has improved wonderfully recently, and at present the factory is behind on orders, while the Dey street storerooms are a scene of old-time activity.

THE STANDARD TURNING WORKS, Cambridgeport, Mass., although working only in wood, has a considerable trade with electrical manufacturing companies, and calls the attention of those who have not communicated with them that they have special facilities for turning out the highest class of turned work, such as switch handles, etc.

C. H. BARROWS, Willimantic, Conn., has issued a pamphlet describing his system of electric transit. The system of Mr. Barrows is for elevated tracks, and the inventor claims that by means of it electric carriages may be run at 20 miles per hour with 1,000 pounds of battery cells and a pair of 2-h. p. motors, transporting passengers, mails and light freight.

THE PERKINS ELECTRIC SWITCH MANUFACTURING COMPANY, Hartford, Conn., has leased the entire property and plant of Messrs. Waterhouse, Gamble & Co., and will continue the manufacture of the Waterhouse arc lamp, maintaining its previous excellent character and quality, and is now ready to fill orders for arc lamps for incandescent circuits.

THE F. E. BELDEN MICA MINING COMPANY sent out a unique invitation, printed on sheets of mica, inviting attendance at the dedication of its new mill at Rumney, N. H., on Friday evening, March 2, 1894, from 8 to 12:30. We regret that our duties in connection with the N. E. L. A. caused this tardiness in acknowledging the receipt of the invitation kindly sent to this office.

THOMAS C. WARLEY & CO., 11 South street, Philadelphia, exhibited samples of boiler scale in the red parlor of the Ebbitt House during the convention which were ample evidences of the efficacy of their boiler cleansing compound as a remover of scale, and many were the exclamations of surprise at such amazing results. Messrs. Warley & Co.'s neat circular was pocketed by many for future use.

T. E. CROSSMAN, the accomplished official stenographer of the American Street Railway, National Electric Light and American Waterworks associations, has located in the Franklin Trust Building, 166 Montague street, Brooklyn, where he is prepared to do stenographic work of all kinds. Mr. Crossman is a most thoroughly competent stenographer, as we have had opportunities of learning from the work done for The Electrical World during the last five years.

E. P. ROBERTS & CO. are preparing specifications for dynamo, wiring and fixtures for the Pilgrim Church, Cleveland, Ohio. About 750 lights will be used; a 500-light dynamo and an engine of about 65 h. p. to drive, in addition to the dynamo, a fan for the indirect heating system and for ventilation. The church is large, and has a very elaborate arrangement of Sunday-school rooms, and not only of parlors, dining rooms and kitchen, but also a gymnasium, bath, etc.

THE BELKNAP MOTOR COMPANY, Portland, Me., is meeting with much success with its woven wire commutator brush. The same company will soon enter into the manufacture of machines of 100 to 150 h. p. for railway generator work, and also of multiphase alternating machines. It contemplates a large extension of its works in the near future in order to do this work, as up to the present only direct current machines have been built, and none larger than 60 h. p.

THE CONSOLIDATED ELECTRIC STORAGE COMPANY, in a communication sent us in answer to a recent one published in these columns from the Electric Storage Company, denies that it has circulated objectionable matter in regard to the chloride battery, except giving in several instances the usual notice of infringement, as it is bound to do in order to secure a status in the courts. The letter further upholds the claim that the Brush patent covers the chloride battery.

THE HINE & ROBERTSON COMPANY, 57 Cortlandt street, New York, is sending its two handsome indicators to all sections in the United States and quite a number of foreign countries. It would surprise many to see some of the indicator cards taken before and after the valves of an engine have been adjusted by the use of an indicator. In many cases the change represents an economy of fully 25 per cent. in horse power and a cor-

responding economy in fuel. They are certainly great dividend earners.

MESSRS. CHARLES A. SCHIEREN & CO. have received the following letter from the president of the Union Ice Company, to whom they furnished belts last summer: "The two double perforated electric leather belts I purchased of you last summer for the Union Ice Company factory, Mentone, San Bernardino County, Cal., are doing splendidly. The 20-inch belt on a 26-inch motor pulley has a velocity of about 5,900 feet per minute. The 30-inch belt has a velocity of about 3,900 feet per minute. Each transmits 1,500 h. p., and are as perfect as when first put on."

THE GENERAL ELECTRIC COMPANY reports that business is extremely good, in spite of the hard times. At its Schenectady works its railway department is working full blast to turn out the numerous large orders recently received for General Electric 400 motor and multipolar generators. The fitting and appliance department, as well as its wire departments, are also full of busy workers, while the business in lighting apparatus is steadily on the increase. At Lynn the arc lamp and meter departments are more than busy with the newly developed apparatus. The Harrison lamp works report that it is thousands of lamps behind on its orders, even with its extensive facilities.

ELISHA B. STEELEY & CO., of Philadelphia, sole agents for clock systems for night watchmen and employees, reports business in general very good, and exceedingly so in employees' time recorders, of which this company make a specialty. These time recorders are being adopted with increasing rapidity by very many of the manufacturing interests of this country, and so great has been the demand for them that the manufacturers were compelled to increase their facilities in order to fill orders more promptly. These recorders are placed on trial, subject to approval. This company is also agent for the Eco magneto watchman's clock and the Warner electric time system.

THE BACKUS MANUFACTURING COMPANY, of Newark, N. J., has placed upon the market an electric fan, which is made in two styles, ceiling and column, and can be used on 110, 220 or 500 volts, and also on arc circuits. A special feature of the fan is its blade adjuster, which can be changed to any angle while the fan is in motion. This company, to better facilitate the manufacture of its products, has recently moved into its new factory, 174-182 Pennsylvania avenue. The building, built of brick, is two stories high, and 60x100 feet; it is equipped with the latest improved machinery and tools, and operated by a gas engine of the company's own manufacture. The specialties of the Backus Manufacturing Company are fans, motors, ventilators and gas engines.

THE ELECTRICAL AND MECHANICAL ENGINEERING AND TRADING COMPANY, 11 Broad street, New York, is sending a circular to the trade which describes its electrical railroad system with a complete metallic circuit fully utilizing the track to its maximum conductive capacity, and it claims that this system absolutely stops electrolysis of gas and water pipes, reduces drop of potential and raises the entire electrical railroad system to higher operative economy. In this circular is a photographic reproduction of a section of six-inch water main, showing the rapid electrolytic action of a railway current on underground pipes. Mr. J. H. Vall, the president and chief engineer of the company, was present at the National Electric Light Convention, where he read a paper on this subject.

MR. EDWARD M. BENTLEY, formerly the inventor and engineer of the Bentley-Knight Electric Railway Company, who has been for the past four years and a half in charge of the patent department of the Thomson-Houston Electric Company and the General Electric Company, will sever his connection with the latter company on March 1, and open an office at 40 Water street, Boston, taking up the work of expert in patent cases and solicitor of patents. The law firm of Bentley & Blodgett, with which Mr. Bentley, who is a member of the bar as well as an expert, has been connected, will be dissolved, and his former partner, Mr. G. R. Blodgett, will succeed him as head of the patent department of the General Electric Company, making his headquarters at Schenectady.

THE HORNBERGER ELECTRIC AND MANUFACTURING COMPANY, Elkhart, Ind., has received the following flattering letter from the Helzer company, of Philadelphia: "In reply to your communication, we beg to inform you that we have very carefully tested your new transformer, and the result of our tests convinces us that your transformer is equal in every way to the guarantees you have made us. We find our arc and incandescent lamps can be operated on it at the same time without change in the electromotive force, and there is apparently no change. We also find that it works satisfactorily either with one arc lamp or full load incandescent lamps, or with one incandescent lamp with full load of arc lamps. We believe this transformer solves the problem of maintaining two different potentials from the same transformer. In other words, running arc and incandescent lights from one transformer. If you desire to refer to us at any time, we shall be pleased to serve you."

WARREN WEBSTER & CO., with works at Camden, N. J., and Chicago office at No. 2 Canal street, Chicago, Ill., report among the many orders received for their Webster vacuum feed water heater and purifiers, one from the Pullman Palace Car Company, Pull-

man, Ill., for three more Webster vacuum feed water heaters and purifiers aggregating over 5,000 h. p., to equip their entire works; also for the Williams vacuum system of steam heating, so as to utilize their waste exhaust steam without back pressure upon engines for heating purposes. Past orders formerly received from this company amounted to 2,700 h. p., and were installed in their plant at Pullman, Ill., during the past four years. Warren Webster & Co. claim to have the best methods for correcting feed water for boilers and for utilizing exhaust steam for heating purposes without back pressure upon engines, giving the best results upon all points of economy. They built their present new works at Camden, N. J., last year, and are now commencing an extension of 60 by 65 feet in their wrought iron department.

ARC LIGHT, TROLLEY AND ARMOR CORD.—Braided cord has now become the standard for the suspension of arc lamps, and it is no less in demand for street car trolley cord and armor cord for covering field magnets of dynamos. The size most frequently used for hanging arc lamps is No. 12 ($\frac{3}{8}$ inch in diameter); for trolley cord, No. 8 ($\frac{1}{4}$ inch in diameter); for armor cord, No. 4 ($\frac{1}{8}$ inch in diameter). Waterproof finish is always applied to arc lamp cord and trolley cord unless otherwise ordered. The Samson Cordage Company, 115 Congress street, Boston, has long been noted for its celebrated "Samson" cord for the above purposes, and also furnishes its "Samson spot cord," which is the same quality and price as the plain "Samson" cord, but marked with a succession of spots of a different color from the body of the cord. This device is for the purpose of identifying at sight the first quality of cord. There is now on the market a quantity of low grade braided cord, which does not possess the strength or durability which is requisite for these purposes. All Samson cord is warranted of pure stock, perfect braid and to be entirely free from waste stock, and purchasers may have confidence that the spot is a guarantee of quality.

THE NATIONAL WATER TUBE BOILER COMPANY, of New Brunswick, in referring to the low bid on which it secured the contract for 1,800 h. p. of boilers from the city of St. Louis—nearly 20 per cent. lower than the next lowest bid and over 40 per cent. below the highest—calls attention to a significant clause in the contract. The specifications of the commissioners provided for a premium of \$250 on each of the six boilers for every one per cent. of efficiency actually reached by the boilers above a given per cent., with the same amount of forfeit for each one per cent. below. The condition was introduced for the express purpose of obliging each bidder to guarantee the economy of the proposed boilers, with a substantial money backing, the commissioners being the gainers, even though the premium should be large, as the higher the premium earned the greater the saving in the use of the boilers. The National company was the only one to make a considerable reduction in the contract price, with the expectation of making up the reduction by the large premium to be received in consequence of the great efficiency of their boilers. The conditions of the specifications of the commissioners were novel and shrewdly contrived to call out the relative degrees of confidence which the several makers have in their boilers, and the result of the tests to determine the amount of premium to be paid will be of unusual interest.

MESSRS. QUEEN & CO., Incorporated, of Philadelphia, attracted great attention at the convention with their display of "Acme" hot wire voltmeters, portable, switchboard and recording types, as also "Acme" portable testing sets, cable testing apparatus, etc. The "Acme" voltmeters are extremely compact and well made. They are accurate alike for alternating and direct currents, and are dead beat, without the use of a mechanical brake, this latter feature being possessed by no other standard alternating current voltmeter. A neatly prepared price list was distributed, which gave full particulars as to ranges, styles of mounting and prices. Instruments are supplied with single or double scales and with multipliers of any desired capacity up to 3,000 volts. Next to refined accuracy, the most important fact about the "Acme" voltmeters is the remarkably low prices at which they are offered, thus making it possible for every plant, however small, to have a strictly reliable testing instrument. The "Acme" portable testing set, samples of which were displayed, contains a Wheatstone bridge, rheostat, D'Arsonval galvanometer and silver chloride battery—all in a highly finished mahogany case 8 $\frac{1}{4}$ inches by 5 $\frac{1}{2}$ inches by 5 inches. It has a capacity of several megohms, and in addition to insulation tests is well suited to determining the resistance of dynamos, motors, lamp filaments and for general laboratory measurements.

THE WOODBRIDGE & TURNER ENGINEERING COMPANY, "Times" Building, has recently completed a contract of considerable importance for the Union Railroad Company, of Providence, R. I. Previous to the 1st of August the Union Railroad Company had in operation but 12 or 15 miles of electric railway. It now has an extensive system of nearly 100 miles in operation, covering not only the entire city of Providence, but much of the available territory round about it. The work of construction was begun about the 1st of July, and during the summer and autumn over 75 miles of overhead line work was completed ready for operation. About one-half of the line is constructed with iron poles, being mainly of the lattice type, though a considerable number of Waiworth poles have also been used. On the remainder of the line, both span and

bracket construction, Georgia pine poles are used throughout. The line construction embodies all the latest and best features in this class of work, the line equipment being furnished in part by A. & J. M. Anderson and in part by the General Electric Company, by whom the entire motor and generating equipment was supplied. The feeder lines are run on the poles, there being over 80 miles of feeder wire on the whole system, mostly 500,000 C. M. wire. The lines radiate in all directions from the central business section of the city, reaching to the towns of Riverside, Rumford, Pawtucket, Centredale, Auburn, Cranston, Olneyville and Lake-wood. The work of construction was entirely in the hands of Mr. Elmer Bell, the superintendent of the Woodbridge & Turner Engineering Company, and was pushed vigorously through to completion, so that the whole system was practically ready for operation by the middle of November.

THE PAGE BELTING COMPANY, Concord, N. H., states in regard to the St. Gaudens medal, that two law suits are now pending as a consequence of the controversy over the medal, one by St. Gaudens against the Page Belting Company for alleged damage to the artist, and the other brought by the Page Belting Company against Mr. St. Gaudens for alleged libellous language employed by the latter against the former. The officers of the company have made a further statement to the effect that their president and general manager, George F. Page, secured in October certified copies, duly signed, of the two awards made by the judges of belting at the Columbian Exposition, and that on the 8th of December he went to the mint in Philadelphia and was shown the St. Gaudens model of the proposed medal, which he examined in the presence of the officers of the mint and afterward reproduced it

from memory. The awards published are an exact reproduction of the language used by the judges. That the reproduction of the medal is a good one, the statement made by its president, is corroborated by the testimony of Treasury officials and Senators who have compared the published fac-similes and the original medal. The copies of the judges' awards were obtained, it claims, in a proper and legitimate manner. They were intended for publication. It was simply a question of when the first publication should be made. As for the design of the medal, that had been purchased by the United States Government. As exhibitors, two of these medals having been awarded to the Page company, and it claims a right to their use as soon as it could come into possession, in a proper and legitimate way, of either the medal itself or a copy of its design, and that is precisely what it did. The copies have been published for advertising purposes, exactly as was originally intended should be the case, as will be done by other exhibitors at the World's Fair who obtained medals and diplomas, so soon as they shall see fit to make the publications after they come into possession of the wording of the awards and copies of their medals.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

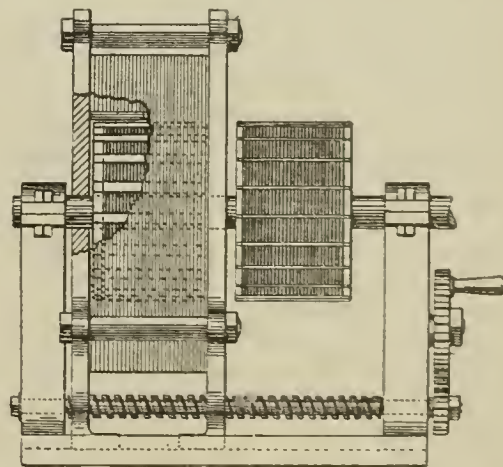
Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED FEB. 20, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

- 513,145. ELECTRIC SIGNALING BETWEEN RAILWAY TRAINS; J. J. Czepull, Lancaster, Pa. Application filed Aug. 8, 1893. The combination of a bar having contact pins in its opposite ends, conductors connected therewith, a movable contact bar bearing against the pins, and a key secured to the contact bar.
- 515,179. ELECTRIC RAILWAY CONDUIT; M. S. Towson, Cleveland, Ohio. Application filed Jan. 6, 1893. The combination of a slot rail and a conductor suspended therefrom by fastenings passing through the foot of the rail.
- 515,192. MATERIAL FOR INSULATING ELECTRIC WIRES; G. A. Cannot, London, England. Application filed Sept. 22, 1893. This consists of a coating of bitumen, peat fibre, spermaceti and tar.
- 515,205. ELECTRIC ARC LAMP; B. Ford, Johnstown, Pa. Application filed Dec. 8, 1892. This comprises a solenoid regulator, lever, friction spring, carbon, a tube to keep the carbon aligned and a magnet to actuate and release the carbon.
- 515,216. DYNAMO OR ELECTRIC MOTOR; L. Gutmann, Pittsburgh, Pa. Application filed Feb. 13, 1892. The combination with one or more stationary field magnets, one or more rotating armatures and a distance piece mounted on either or both machine elements.
- 515,238. TROLLEY CONDUCTOR AND SUPPORT; M. D. Law, Washington, D. C. Application filed Aug. 29, 1893. A conductor comprising rails of L shape in cross-section having supporting webs and contact flanges, the webs and flanges being overlapped at the meeting ends of the rails.
- 515,241. RHEOSTAT; J. B. Lyon, Brooklyn, N. Y. Application filed Dec. 22, 1891. A rheostat consisting of the combination of a resistance medium and a pair of electrodes geared together and movable with respect to each other.
- 515,254. RHEOSTAT; A. J. Shaw, Muskegon, Mich. Application filed Oct. 13, 1893. A resistance device consisting of an open frame and a wire band wound around the frame and connected at one end therewith, but insulated therefrom at all other points.
- 515,255. ELECTRIC ELEVATOR BRAKE; A. J. Shaw, Muskegon, Mich. Application filed Oct. 24, 1893. This comprises an electric motor, a brake, an electromagnet for controlling the brake, and means whereby the reversal of the motor is caused to vary the strength of the brake controlling magnet independently of the strength of the current delivered to the motor.
- 515,256. ELECTRIC ELEVATOR BRAKE; A. J. Shaw, Muskegon, Mich. Application filed Nov. 4, 1893. In combination with a motor and brake, a differential electromagnet for controlling the brake, and means for controlling the flow of current through the windings of the differential magnet.
- 515,274. INDICATOR FOR ELECTRIC CARS; H. C. Beckmann, St. Louis, Mo. Application filed Aug. 17, 1893. The combination of a fixed conductor with a swinging contact rod and an indicator carried by the car, electrically connected with a projecting rigid contact rod moving with the car.
- 515,280. RHEOSTAT; G. A. Brown, Muskegon, Mich. Application filed Aug. 19, 1893. A resistance body consisting of a strip of iron, with the mill scale or oxide upon it, folded back and forth upon itself in compact form.

- 515,281. ELECTRIC ELEVATOR BRAKE; G. A. Brown, Muskegon, Mich. Application filed Oct. 13, 1893. This consists in passing the reversible current of a motor through one winding of a differential brake magnet and through the armature of the motor in series.
- 515,286. ELECTRIC STEERING GEAR; F. L. Dyer, Washington, D. C. Application filed April 17, 1893. The combination with a steam steering engine of an electrical device for controlling the valves thereof, the electrical device consisting of a plurality of solenoids, the cores of which connect with said valves, and a controller for the solenoids.
- 515,304. RHEOSTAT; A. J. Shaw, Muskegon, Mich. Application filed Oct. 13, 1893. A resistance body consisting of a conducting band wound into a flat spiral, the folds of the spiral separated one from another by a layer of enamel.
- 515,308. ELECTRIC RAILWAY TROLLEY; C. J. Van Depoele, Lynn, Mass. Application filed Nov. 8, 1890. A trolley pivoted to a standard on the roof of a car and free to swing around the standard, a spring for pressing the trolley upward and a line connected with the arm above the pivot for moving the arm.
- 514,902. ALTERNATING CURRENT MOTOR; C. S. Bradley, Avon, N. Y. Application filed Sept. 27, 1892. An alternating cur-



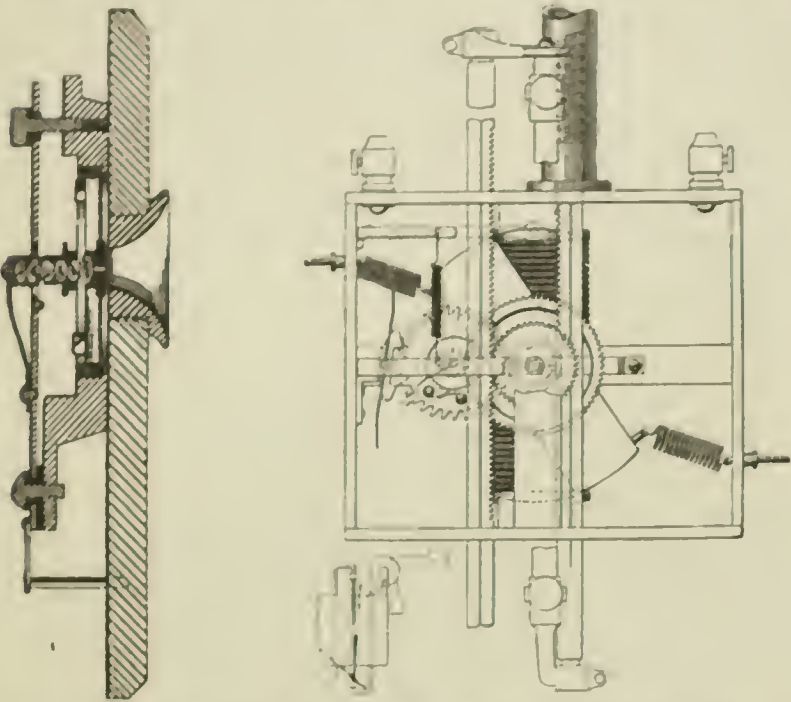
NO. 514,902.—ALTERNATING CURRENT MOTOR.

rent motor having a primary element, two secondary elements, one of high and the other of low resistance, and means for shifting the elements relatively, so that the primary may co-operate with either secondary. (See illustration.)

- 514,903. ALTERNATING CURRENT ELECTRIC MOTOR; C. S. Bradley, Avon, N. Y. Application filed Sept. 27, 1892. An alternating current motor having one element wound to develop progressively shifting poles, and the other element provided with a closed secondary circuit inductively related to the shifting poles, means for developing opposing electromotive forces in the secondary circuit and a common path of relatively high resistance forming a multiple arc circuit for currents due to the opposed electromotive forces.
- 514,904. ALTERNATING CURRENT MOTOR; C. S. Bradley, Avon, N. Y. Application filed Jan. 14, 1893. The combination

with a magnetic core wound to develop a rotary magnetic field and an armature provided with two windings, one having a circuit inductively acted upon by the rotary field and the other a synchronous circuit supplied through a rectifying commutator.

514,997. DYNAMO ELECTRIC MACHINE; C. F. Brush, Cleveland, Ohio. Application filed Jan. 14, 1879. An alternate current generator comprising two series of field magnets, coreless coils or



NO. 514,916 TELEPHONE. NO. 515,022 ARC LAMP.

folds mounted on a diamagnetic carrier, and a shaft having insulating material interposed between its sections.

514,913. CUSHION FOR TELEPHONE RECEIVERS; V. A. Cook, Averill Park, N. Y. Application filed Nov. 28, 1893. This comprises a compressible and elastic cushion, filled with air and a flexible material, a flexible ring attached to the cushion, and a metallic band to secure the ring against the face of the receiver.

514,916. TELEPHONE; D. Drawbaugh, Eberly's Mill, Pa. Application filed July 26, 1880. A diaphragm carrying two electrodes, insulated from each other, in combination with opposing electrodes held in contact with the first mentioned electrodes by an elastic pressure device.

514,920. TELEPHONE TRANSMITTER; P. Fitzsimons, Birmingham, Ala. Application filed June 14, 1893. This comprises a central block of conducting material, similar radial blocks and loosely mounted conducting pencils radiating from the central block to the radial blocks, a portion of the same being in circuit and a portion being idle.

514,925. ELECTRIC CABLE; T. Guillaume, Mulheim-on-the-Rhine, Germany. Application filed Oct. 6, 1893. This comprises a section of grooved insulating material adapted to receive in its grooves separate conductors, whereby the whole may be twisted into one circular cable.

514,932. TROLLEY WIRE SUPPORT; R. M. Hunter, Philadelphia, Pa. Application filed June 30, 1893. This comprises a trolley wire, a support soldered to the under side thereof, and a transverse supporting wire arranged at or about the level of the trolley wire for sustaining the trolley wire and support.

514,933. TRANSFORMER; F. S. Hunting, Fort Wayne, Ind. Application filed Feb. 25, 1892. This comprises a number of separate cores influenced respectively by currents of different phase and a secondary coil having a portion of its convolutions inclosing each core, the number of convolutions being apportioned according to the desired phase displacement.

514,960. ELECTRIC BELL ALARM; W. H. Orpen, Jr., Brooklyn, N. Y. Application filed April 23, 1891. This comprises a case having a journal box integral therewith, a recess in the back divided from the ringing mechanism by a wall and a partition separating the mechanism.

514,972. ELECTRIC RAILWAY SYSTEM; N. Tesla, New York, N. Y. Application filed Jan. 2, 1892. This comprises an insulated conductor supported in a slotted conduit, an insulated sheath or screen surrounding the conductor, a conducting plate or bar carried by an arm depending from the car into the conduit, and an electrical connection between the plate and the motor on the car.

514,973. ELECTRIC METER; N. Tesla, New York, N. Y. Application filed Dec. 15, 1893. The combination with a circuit of alternating currents of a meter composed of two conductors connected respectively with the circuit and separated by a rarefied gas substance.

514,975. ELECTRICAL ANNUNCIATOR; N. M. Watson, Detroit, Mich. Application filed July 7, 1892. The combination with an electric circuit of a magnet, a pivoted armature, a target actuated by the armature, and a movable spring catch for supporting the target in its visible position.

514,979. BATTERY; D. H. Wilson, Chicago, Ill. Application filed Sept. 8, 1893. In a primary battery, the combination of a zinc and copper plate, with their broad surfaces exposed to each other,

their exposed sides deeply corrugated and a solution in which the plates are immersed.

514,980. SWITCHBOARD SYSTEM; D. H. Wilson, Chicago, Ill. Application filed Sept. 8, 1893. A switchboard for an electric fence, consisting of a transmitting and receiving telephone, a lever upon which the receiving telephone is normally hung, conducting plates on the end of the lever, contact points adjacent thereto, a third contact point normally in contact with the lever, a telegraph instrument having a movable base, and connections whereby when the telephone and telegraph instruments are connected to the fence wires the connection of the wires with the generator is automatically broken.

514,981. CIRCUIT MAKING AND BREAKING DEVICE; D. H. Wilson, Chicago, Ill. Application filed Sept. 8, 1893. The combination of an induction coil with a circuit breaker in the primary circuit, the circuit breaker comprising a pivoted plate, to which is fastened a sealed mercury chamber with contact points of unequal length therein, the circuit breaker and induction coil being so related that when the latter is energized the mercury chamber is moved to break the circuit, and an adjustable spring and stop associated with the circuit breaker to regulate the rapidity of its motion.

515,020. ELECTRICAL CONVERTER; A. L. Riker, New York, N. Y. Application filed July 27, 1893. A converter core built up of a series of laminae of substantially the shape of the letter F, the parts being so proportioned that when two of them are placed together they form a continuous rectangular frame, with a strip extending centrally across the same.

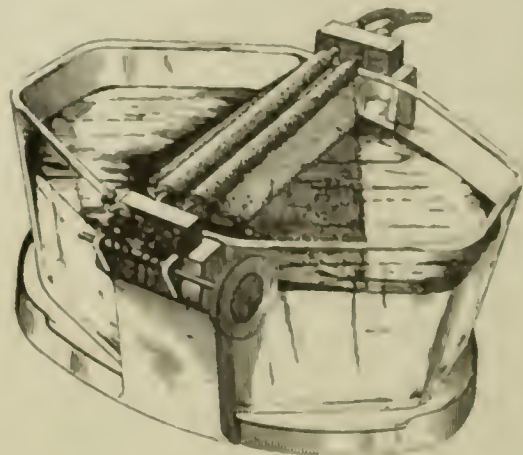
515,022. ELECTRIC ARC LAMP; S. W. Rushmore, Brooklyn, N. Y. Application filed Feb. 20, 1893. This comprehends the use of a single electromagnet in combination with an armature moving upon a central axis under the influence of both poles of the magnet and a short train of gearing mounted in a frame, which is pivoted on an axis coincident with the axis of the armature.

515,087. ELECTRIC DISTRIBUTION BOX; O. D. and M. A. Kleinstaub, Milwaukee, Wis. Application filed June 27, 1893. A series of contact sections in combination with a common support for the series, an inclosing casing for the same, and two lengths of cables, each containing a plurality of wires leading into the casing and making contact with the respective series of contact sections.

515,108. ELECTRICAL CIRCUIT CONTROLLER; R. Callender, Brantford, Canada. Application filed Nov. 2, 1893. A circuit controller having a series of radially disposed plungers adapted to be moved into electrical connection with a common conductor, in combination with a revolving arm carrying an electromagnet adapted to raise any of said plungers into their uppermost position.

515,109. ELECTRICAL CIRCUIT CONTROLLER; R. Callender, Brantford, Canada. Application filed Nov. 2, 1893. Two or more reed armatures having different periods of natural activity when put into motion by the closure of a circuit through a controlling electromagnet, in combination with means whereby two or more additional circuits are independently closed by the reed armatures at the termination of their individual vibratory period.

515,125. ARC LAMP; W. O. Meissner, Chicago, Ill. Application filed Sept. 11, 1893. The combination of a carbon rod with a clutch having two clamping edges rigidly united in one struc-



NO. 515,241 RHEOSTAT.

ture and adapted to alternately clutch and move the rod in either direction, and a magnet connected so as to control the clutch.

515,110. AUTOMATIC SIGNALING TRANSMITTER; R. Callender, Brantford, Canada. Application filed Nov. 2, 1893. This comprises a controlling commutator and a rotary circuit making and breaking device, timed to have a definite relative speed of rotation, means for giving the circuit closer any predetermined number of revolutions, and additional means for varying at will the number of circuit closures in each revolution.

515,297. ELECTRIC IGNITER FOR GAS ENGINES; J. Low and J. W. Gow, Steubenville, Ohio. Application filed May 13, 1893. This consists of a magnet having its core projecting into an engine cylinder and insulated therefrom, means for completing the circuit of the magnet, a contact on the piston influenced by the magnet, whereby a spark may be produced when contact is made and broken with the magnet core.

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In the growth of the paper in circulation, size and general improvement, the value of its columns for reaching those engaged in electrical pursuits has not failed to be appreciated by advertisers. The following table shows its steady onward march in this department of business. The first issue of

1880 contained 25 different adv'ts.	1887 contained 154 different adv'ts.
1881 " 28 " "	1888 " 175 " "
1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 289 " "
1884 " 82 " "	1891 " 325 " "
1885 " 100 " "	1892 " 316 " "
1886 " 138 " "	1893 " 317 " "

The first issue of 1894 contained 320 different Advertisements.

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RAPID TRANSIT FOR NEW YORK.

The plan recently submitted by ex-Mayor Hewitt for a rapid transit system for New York embodies the underground feature, and has met with almost unanimous approval from the public. As any underground road will almost undoubtedly entail the use of electricity as the motive power, all interested in the electrical industries have a distinct interest in furthering the Hewitt plan, and in assisting to get rid of the present incompetent Rapid Transit Commission, which is a stumbling block in the way of the adoption of any system. While the motives of the members of the commission may be proper, and the suspicion that they are mere puppets of the present elevated railway interests may be unjust, the fact remains that the public has lost all confidence in them, and their official existence is a menace to the success of any competent scheme of rapid transit. The adoption of electricity as the motive power for the proposed Hewitt system would give an impetus to that method of traction that would have a far-reaching effect, and hasten its adoption in other cities where its use has been discussed. The Rapid Transit Commission have made the statement that they have no power to carry out a plan like Mr. Hewitt's, but as they have the power to adopt an objectionable plan, the Legislature should lose no time in abolishing this unpopular body, and then proceed to give the attention to the scheme proposed which it merits and the needs of the public demand.

SOME MORE PHOTOMETRIC MEASUREMENTS.

A professor recently reported to the Brooklyn city government the result of his measurements of city street arc lights, which presumably were made in the open air, with the lamps *in situ*. He reports that the first five lamps measured varied from 976 to 1,634 candle power, and that of fourteen others but four showed the power required by contract; the lights on Eighth avenue and North street were found so poor that no measurements were taken; of 20 lamps in the Eastern District, only three were found to have a candle power in excess of 900, the others varying from 452 to 895 candle power. The question arises why the professor reported, for example, the 452-c. p. ray as the candle power of a particular lamp, and not the 690-c. p. ray, or the 1,299-c. p. ray; or, on the other hand, why he measured the 1,634-c. p. ray of one of the first lamps instead of its 452-c. p. ray, as in the case of one of the subsequent ones. Why didn't he give all the rays a chance and report, for instance, that the lamps whose vertical rays he measured had no candle power? To offset this report, the electric light company affected by it should secure the services of the professors who at Buffalo measured the candle power of 2,000-c. p. (nominal) lamps and reported that the "average candle power of the lamps" was above 2,000 c. p.—meaning, probably, the average candle power of the maximum ray. The electrical public is to be congratulated that the recent action of the Electric Light Convention, defining candle power in terms of watts, will put an end to these photometric absurdities.

THE FARADAY-MAXWELL-HERTZIAN EPOCH.

In this issue we print a third section of Dr. Pupin's remarkably interesting and able review of the evolution of the Faradic theory of electrical action, the great work of Maxwell being taken up in the present installment. It will be noted that Dr. Pupin has chosen the philosophical method of

treatment, tracing the gradual growth of the various fundamental ideas and showing the manner in which they were treated by the different workers in this great field. A lesson taught by the story of Faraday and Maxwell is the great importance of keeping the mind free from the trammels of authority and of academic methods of thought. It is perhaps not too much to say that the great conceptions of Faraday would never have had birth had he received a regular academic training, and that if Maxwell had not adopted the course he did in absorbing the knowledge of Faraday before submitting his mind to the influence of orthodox authority, his subsequent labors might have had but a tithe of their great value. Herbert Spencer, it is known, ascribes his original methods of thought to his escape from the orthodox course of mental training, and John Stuart Mill refers in strong terms to the danger of authority from its tendency toward the repression of originality. The history of thought shows that from Aristotle to the present all great advances have been due to those who rebelled against the tyranny of authority, and yet these are the very ones whose influence, while freeing the mind from one bondage has only resulted in submitting it to another. While every one is not competent to question the conclusions of a master, yet all should hold as a right the privilege to apply the test of fact and experiment even to the theories of Maxwell.

A BOLD VENTURE IN ELECTRIC RAILROADING.

That electricity makes it possible and practicable to build a railroad where the use of horses is out of the question and the use of steam is impracticable and too costly, is shown very well in the new, bold project which is reported from Switzerland, that unique little country whose grand and beautiful scenery is one of the chief sources of revenue to the people—and requires no artificial protection. Permission has just been asked from that government to build an electric railroad to the top of the magnificent Jungfrau, one of the grandest, highest and most admired of the snowclad Alps in the Bernese group. Those who have never seen this mountain may obtain an idea of the difficulties involved when they consider that it is a jagged mountain, on which avalanches are so numerous that the traveler on the opposite hills is often repaid by waiting to see one. Until not very long ago the ascent of this mountain was considered impossible, and a number of lives were lost in the numerous attempts, and even now it should be attempted only by expert climbers in company with expert guides, and requires two days for the round trip. To build a railroad on such a mountain is a project which only a Swiss would dare to make, and the able and fearless engineers which that little country has turned out leaves little doubt that the project can be carried out successfully, though we venture to predict not without the loss of lives in the attempt. Even the lower end of this proposed railroad, near the well-known and favorite resort, the Wengern Alp, is not very far below the eternal snow line, so that almost the entire road will be through the regions of the eternal snow fields; much of it, if not most of it, must therefore be tunnelled or protected from the frequent snowstorms and avalanches by a half tunnel under the solid rock. An isolated rocky prominence, 200 feet below the top and free from snow, is to form the upper terminal of the railroad, the rest of the journey to the top being made by an electric elevator, probably through a shaft. Some of the scant data at present at hand is given in our Digest. More than one scheme has been proposed to make the top of this mountain accessible to the numerous travelers whose nerve, muscle and purse are not equal to the requirements of the old-fashioned way of climbing this mountain. One of these, originating, we believe, in England, was to tunnel horizontally into the heart of the mountain, and from there up to the top by a vertical shaft. Electricity now

makes it possible to adopt a more feasible and less expensive plan over a much more picturesque and attractive route, using neighboring waterfalls in place of expensive coal. As the lower end of the route is already accessible by rack and pinion railroads, an invalid will then be able to ride in his chair from any city of the Continent to the top of the Jungfrau.

ALTERNATING CURRENTS.

We have several times referred to the difficulty of students in following the analytical treatment of alternating currents, and pointed out the objections to this method from its excessive complexity when the form of the alternating current curve departs from the simple sine form, as it must necessarily do in practice. Another serious objection is the manner in which physical facts are masked in the analytical treatment and their practical bearing obscured. We have recently published a number of articles based upon rational methods of treating the subject, among which are those of Kennelly, Ryan and Patten, and which together form, from this point of view, perhaps the best contribution to the literature of the subject yet made, whether in periodicals or books. In this number we print the first section of the Convention paper of Mr. C. F. Scott, referred to in our last issue, which is a further contribution of the same character, and one that will appeal particularly to practical central station men. It should be borne in mind that while all of the alternating current effects enumerated are of interest to those who wish to have an intelligent idea of alternating current working, many, such as hysteresis, resonance, Ferranti effect, capacity, etc., will have no bearing on every day practical work in connection with ordinary installations. On the other hand, the phenomena of self and mutual induction are of the greatest practical importance, and cannot be neglected. Perhaps every one who has had to do with alternate current wiring, in which tables calculated for continuous currents were used, has noticed singularities in drop. With the usual frequency employed in this country and with the large wires sometimes necessary in alternating current wiring, the inductive effect cannot be neglected, and it will be useful to the reader to apply to the drop curves in Mr. Scott's paper some data from an actual installation, that this point may be impressed upon his mind. The inductive drop, it is well to remark, should not be confounded with that caused by a true ohmic increase of resistance, due to the unequal distribution of an alternating current in a conductor. The increase of drop from the latter cause is absolutely negligible with conductors of the sizes ordinarily used and with commercial frequencies. The manner in which the inductive drop is affected by the disposition of conductors is clearly shown in the paper, and hereafter there will be no excuse for installing alternating current lines without reference to this point, as has heretofore almost universally been done. Some months ago an article in these columns on the points above referred to brought forth a number of inquiries from central station managers, from which it appeared that the effects of impedance, important as they are, were then almost, if not entirely, unknown to practical men. The paper of Mr. Scott is, therefore, a most timely one, and will, from the clear and simple manner in which the subject referred to is treated, as well as from the other practical information contained in it, be a boon to central station men, and of unusual value to students as a first introduction to a branch of electricity that is almost daily becoming of greater importance. Taken in connection with the articles of Prof. Ryan, now being published serially in our columns, and the paper of Dr. Bell, the second section of which appears in this number, and the recent articles of Kennelly and Patten, the reader may obtain ideas and information in regard to alternating current working which he could not get from all the books thus far published.

The Faraday-Maxwell-Hertzian Epoch.—III.

By M. I. PUPIN.

Faraday did not form a new school of physicists during his lifetime. His ideas were too original, his view of the phenomena of electricity was far too different from the generally accepted views of his time to gain him a large following, even among his own countrymen. His generation recognized the supreme value of his discoveries; it failed to appreciate the full meaning of the aims of his speculation. It was reserved for the next generation to grasp this meaning and to explain it in terms of the language of the existing mathematical theories. It was by no means an easy task for the next generation to perform. It required a peculiarly constituted mind; a mind combining in itself the mental qualities of a physical investigator and a mathematician. Maxwell was a perfect representative of this rare combination. When his attention was first drawn to Faraday he

difference between Faraday's way of conceiving phenomena and that of the mathematicians, so that neither he nor they were satisfied with each other's language. I had also the conviction that this discrepancy did not arise from either party being wrong. I was first convinced of this by Sir William Thomson, to whose advice and assistance, as well as to his published papers, I owe most of what I have learned on the subject."

Maxwell was barely twenty when he first took up the study of Faraday. Sir William Thomson was twenty-four when he first announced, in 1845, in a paper "On the Elementary Laws of Statical Electricity" ("Papers on Electrostatics and Magnetism," article II.), his strong inclination toward the view of Faraday. But Thomson was too far advanced at that time in the great scientific activity of those days. He played too prominent a part in the establishment of the principle of conservation of energy and the mechanical theory of heat to allow Faraday's researches to occupy his



was fortunately still out of the hearing distance of the seductive voice of the old "direct-action-at-a-distance theories"; I say fortunately, for, as Hertz¹ observed once in his characteristic way, he who once strayed into the magic circle of these remained a captive there. Maxwell was born in June, 1831; Faraday announced his first discovery in electromagnetic induction in November of the same year. William Thomson, now Lord Kelvin, was then only ten years old. "Before I began the study of electricity," said Maxwell,² "I resolved to read no mathematics on the subject till I had first read through Faraday's "Experimental Researches on Electricity." I was aware that there was supposed to be a

attention completely, although many an investigation of that date shows clearly the strong influence which Faraday's discoveries and views exerted upon him. Maxwell threw his whole young heart and soul into his study of Faraday's "Experimental Researches." It was only a year after he took his degree at Cambridge when his first essay "On Faraday's Lines of Force" appeared. By considering the motion of an imponderable, incompressible fluid, Maxwell drew in this essay a masterly picture of Faraday's lines of force, showing their bearing upon the various phenomena of electricity, and added to it a mathematical commentary of rare elegance. This picture makes the whole region covered by Faraday's researches appear in sharply defined outlines, especially to the eyes of those who prefer to view things in the intense light of mathematical analysis. "We have all acquired," said Maxwell in this essay, "the mathematical

¹Hertz on "The Relation Between Light and Electricity." Lecture delivered before the 62d Convention of Naturalists and Physicians at Heidelberg, 1890.

²Treatise on Electricity and Magnetism. Vol. I., preface, p. 2.

conception of * * * attractions. We can reason about them and determine their appropriate forms or formulæ. These formulæ have a distinct mathematical significance, and their results are found to be in accordance with natural phenomena. There is no formula in applied mathematics more consistent with nature than the formula of attractions, and no theory better established in the minds of men than that of the action of bodies on one another at a distance. The laws of the conduction of heat in uniform media appear at first sight among the most different in their physical relations from those relating to attractions. The quantities which enter into them are *temperature*, *flow of heat*, *conductivity*. The word *force* is foreign to the subject. Yet we find that the mathematical laws of the uniform motion of heat in homogeneous media are identical in form with those of attractions varying inversely as the square of the distance. We have only to substitute *source of heat* for *centre of attraction*, *flow of heat* for *accelerating effect of attraction* at any point, and *temperature* for *potential*, and the solution of a problem in attractions is transformed into that of a problem in heat."

"This analogy between the formulæ of heat and attraction was, I believe, first pointed out by Prof. William Thomson."

"Now, the conduction of heat is supposed to proceed by an action between contiguous parts of a medium, while the force of attraction is a relation between distant bodies, and yet, if we knew nothing more than is expressed in the mathematical formulæ, there would be nothing to distinguish between one set of phenomena and the other."

"It is by the use of analogies of this kind that I have attempted to bring before the mind, in a convenient and manageable form, those mathematical ideas which are necessary to the study of the phenomena of electricity."

"By referring everything to the purely geometrical idea of the motion of an imaginary fluid, I hope to attain generality and precision, and to avoid the dangers arising from a premature theory professing to explain the cause of phenomena. If the results of mere speculation which I have collected are found to be of any use to experimental philosophers, in arranging and interpreting their results, they will have served their purpose, and a mature theory, in which physical facts will be physically explained, will be formed by those who, by interrogating Nature herself, can obtain the only true solution of the question which the mathematical theory suggests."

These remarks contain what may be called the *Maxwellian programme* of reformation of the science of electricity. *The use of analogies forms the fundamental feature of this programme.* Maxwell remained faithful to it throughout his whole life. But it must be well understood that he did not remain faithful to any particular analogy. They were all temporary structures to be torn down like the scaffolding of a new edifice as soon as they had done their duty. The first analogy was the notion of an imponderable, incompressible fluid. By means of the tubes of flow he explained graphically what Faraday meant by lines of force. Having once clearly defined by this particular analogy the idea of lines of force, he applied it to the "theory of dielectrics," "of permanent magnets," "of paramagnetic and diamagnetic induction," of "magnecrystalline induction," etc., etc. When he came to the application of the idea of lines of force to the discussion of electric currents produced by induction, there his analogy seemed to fail him. It could give him no picture of what Faraday called the *electrotonic state*. This circumstance undoubtedly caused him considerable disappointment, for it is well known that Maxwell looked upon this state as one of the fundamental quantities in the electrical science

and made it appear in the list of his fundamental equations. The discovery of a mathematical function representing in every respect Faraday's electrotonic state seems to have been considered by Maxwell as the crowning effort of his first essay. He called it the electrotonic intensity; in his later writings he changed the name, but this very change reminds us that he had changed the analogy, by means of which he gradually unravelled the mysteries of Faraday's visions in electricity. Faraday's electrotonic state of a closed linear conductor is known to-day among engineers as the number of lines of force interlinked with the conductor; hence the rate of variation of that state is the same thing as the rate of change of the interlinked lines of force, and therefore it is equal to the electromotive force induced in the conductor. But this is not exactly the same thing as Maxwell's electrotonic intensity, and the distinction seems to me to be exceedingly important. According to Maxwell, and Maxwell interpreted Faraday, that electromotive force is induced in the space occupied by the linear conductor whether the conductor be there or not; hence it must be due to some process going on in every element of that space; the presence of a conductor there offers only a convenient means of measuring that electromotive force by simply connecting the ends of the conductor to an electrometer. To give a mathematical expression to the process going on in every element of the space occupied by the wire, when there is a variation of the magnetic lines of force, Maxwell discovers a function, the electrotonic intensity, which has definite numerical values and definite directions at every element of the wire, and whose rate of variation in the direction of the elements equals the electromotive force induced in that element. The components of this function he calls *electrotonic functions* or *components of electrotonic intensity*.

"We have * * * obtained in the (se) functions," said Maxwell, "the means of avoiding the consideration of the quantity of magnetic induction which *passes through* the circuit. Instead of this artificial method, we have the natural one of considering the current with reference to quantities existing in the same space with the current itself."

Some physicists, and among them Hertz,² have objected to the presence of the vector potential in Maxwell's fundamental equations on the ground that such equations should express relations between experimentally measurable quantities, and not between purely mathematical functions like the vector potential. Hertz eliminated the vector potential from his representation of the Faraday-Maxwell theory of electricity; but it seems that this very elimination takes away the warm colors from the picture which Hertz in his theoretical writings gave us of the ideas of Faraday and Maxwell. In a note appended to a later essay, Hertz acknowledged that he did not consider very carefully all of Maxwell's writings when he wrote the essays named in the foot note below. His principal source of information concerning Maxwell's theory of electricity was the great treatise. It would naturally follow, then, that the full bearing of the vector potential upon Maxwell's theory of electricity escaped his eagle eye. This bearing is somewhat obscured by the vast amount of material contained in the treatise, which has little or nothing to do with the Faraday-Maxwell theory of electricity. The vector potential (which is only another name for the electrotonic intensity), giving, as it did, a mathematical expression to the belief in the real physical existence of what Faraday called the electrotonic state, was considered by Maxwell as one of the most important, if not the most important, quality in the whole range of physical quantities discovered by Faraday. It exists in a conductor even if there be no observable force acting between this conductor and the surrounding magnetic field; as, for instance, when a conductor through which no

¹ Electric Waves, article XIII.

² Electric Waves, article XIV., note 35.

current flows is placed in a constant magnetic field. It manifests itself just as the existence of matter manifests itself to our senses; that is, through a reaction, similar to the inertia reaction of matter, with which the conductor opposes a change in its electrotonic state. This reaction is measured by the induced electromotive force. Maxwell saw clearly that the experimental proof of the actual existence of the electrotonic state meant a severe blow to the direct-action-at-a-distance theory and an approach to the realization of Faraday's visions, to which I referred above. For since there is no apparent force acting upon a conductor through which no current flows when that conductor is in the vicinity of a magnet, it follows that the old theory which starts with the fundamental laws of action of forces between bodies will expose all its weakness when it attempts to account for the current induced in a neutral conductor. He had no confidence in his own experimental skill at that time. "I hope," said he, in the essay under consideration, "to render it evident that I am not attempting to establish any physical theory of a science in which I have hardly made a single experiment * * * " But he as much as assured the readers of his essay that he would assist the experimental investigation to complete what Faraday had left unfinished, and that is to produce all the necessary "experimental data for the direct proof of the unknown state."⁵ In what the promised assistance was to consist may be gathered from the following lines of the same essay:⁶ "In this outline of Faraday's electrical theories, as they appear from a mathematical point of view, I can do no more than simply state the mathematical methods by which I believe that electrical phenomena can be best comprehended and reduced to calculation, and my aim has been to present the mathematical ideas to the mind in an embodied form as systems of lines or surfaces, and not as mere symbols, which neither convey the same ideas nor readily adapt themselves to the phenomena to be explained. *The idea of the electrotonic state, however, has not yet presented itself to my mind in such a form that its nature and properties may be clearly explained without reference to mere symbols,*" and, therefore, I propose in the following investigation to use symbols freely and to take for granted the ordinary mathematical operations. *By a careful study of the laws of elastic solids and of the motions of viscous fluids I hope to discover a method of forming a mechanical conception of this electrotonic state adapted to general reasoning.*" (See Prof. W. Thomson "On a Mathematical Representation of Electric, Magnetic and Galvanic Forces," "Canb. and Dub. Math. Jour.," January, 1847.)

The reference to Thomson's paper is made clearer in the course of the essay by the following statement:⁸ "With respect to the history of the present theory, I may state that the recognition of certain mathematical functions as expressing the 'electrotonic state' of Faraday and the use of them to express electrodynamic potentials and electromotive forces is, as far as I am aware, original; but the distinct conception of the possibility of the mathematical expressions arose in my mind from the perusal of Prof. William Thomson's papers 'On a Mathematical Representation of Electric, Magnetic and Galvanic Forces' * * * and his 'Mathematical Theory of Magnetism,' 'Philosophical Transactions,' Part I., 1851, article 78," etc. One more quotation from the same essay will suffice to complete the demonstration of the importance which in his first essay and in all his later essays Maxwell attached to the electrotonic state. He closes in this essay his mathematical discussion of this state as fol-

lows: "The discussion of these functions⁹ would involve us in mathematical formulae, of which this paper is already too full. It is only on account of their physical importance as the mathematical expression of one of Faraday's conjectures that I have been induced to exhibit them at all in their present form. By a more patient consideration of their relations, and with the help of those who are engaged in physical inquiries, both in this subject *and in others not obviously connected with it,*" I hope to exhibit the theory of the electrotonic state in a form in which all its relations may be distinctly conceived without reference to analytical considerations."

To sum up briefly: Maxwell's first essay on Faraday's view of the electric, magnetic and electromagnetic phenomena contains, first, the programme of the method by means of which he proposed to formulate ultimately Faraday's conjectures and speculations into a physical theory of electricity. The introduction of physical analogies as aids to mathematical reasoning forms the characteristic feature of this programme. Second, it contains the first of Maxwell's analogies; that is, the analogy of the steady flow of an imponderable, incomprehensible fluid. This analogy solves a twofold purpose: on the one hand it gives a clear geometrical picture of Faraday's lines of force, and on the other hand, it demonstrates that phenomena which are reducible to actions and reactions of the contiguous parts of a continuous medium can lead to the same relations which are obtained by applying Faraday's idea of lines of force to the interpretation of the phenomena of statical electricity, permanent magnetism, magnetism of induction, uniform galvanic currents and electromagnetism. Third, it calls our attention to the great importance which Maxwell attached to the new state of matter discovered by Faraday, the so-called electrotonic state, in consequence of which a magnetic field reacts against external influences which tend to change it, just as a body reacts in consequence of its inertia; it gives a mathematical expression for this state in form of the so-called electrotonic intensity, a vectorial quantity which varies from point to point of a circuit, both in direction and in intensity, and whose rate of time variation along any element equals the electromotive force induced in that element by the variation. Fourth, it contains Maxwell's promise of a new analogy in which a mechanical conception of the electrotonic state, adapted to general reasoning, will be exhibited by means of the behavior of elastic solids and the motion of viscous fluids. A reference to William Thomson's famous essay of 1847 gives an intimation of the probable form of the new analogy.

(To be continued.)

Belt Preservative.

The following empirical formula for a machine belt preservative is due to "L'Industrie": Warm in a covered vessel to a temperature of 50° C., 1 kilogramme of essence of India rubber broken up into pieces and mixed with 1 kilogramme of essence of turpentine. After the rubber has melted, add 800 grammes of colophony; stir until this too is dissolved, then add 800 grammes of yellow wax. In another vessel put 3 kilogrammes of cod liver oil, and 1 kilogramme of tallow; heat this mixture until the tallow melts, and then pour it into the first vessel, stirring continually until the mass cools and solidifies. Belts, the working faces of which are occasionally treated with this compound, are said "to acquire greater solidity, and slipping at the pulleys is avoided."

Telegraphing Without Wires.

Mr. Preece, in a recent paper, gave it as his opinion that it would be quite easy to speak between France and England across the Straits of Dover, without any metallic connection.

⁵"On Faraday's Lines of Force," Scientific papers of Maxwell, vol. 1., pp. 188-189.

⁶p. 187.

⁷These words are put in Italic by the writer for obvious reasons.

⁸p. 209.

⁹The electrotonic functions.

¹⁰These words I choose to put in italics, because they seem to suggest that Maxwell at that time already had the electromagnetic theory of light in his mind's eye.

Polyphase Transmission.*

BY CHAS. F. SCOTT.

ALTERNATING CURRENT PROBLEMS.



HE alternating current when first introduced for lighting presented many new problems to the electrical engineer. Numerous difficulties and dangers were predicted by the theorist, but in ordinary service most of these have fortunately lain dormant. These difficulties are apt to appear, however, when alternating current work is attempted on a large scale. The introduction of large units, heavier currents, higher potentials or power service is apt to increase the effects of self-induction and capacity so that they will now demand careful consideration. The impetus which electrical engineering is receiving from the introduction of the polyphase system, which brings with it large units and long distances, naturally directs attention to the general problem of alternating current transmission and distribution.

A complete and exhaustive solution of this problem is by no means a simple one, and the attempted solutions generally lead to formulae and diagrams which are possibly even more perplexing than the phenomena. If even the electrician who devotes all his energy to new problems can scarcely keep abreast of the times, it is not surprising that the practical engineer and station manager become perplexed and confounded at the apparently erratic phenomena observed in practice or described in print. Theoretical articles appear on variation in wave form, harmonics, so-called Ferranti effects, increased resistance in conductors with alternating currents, hysteresis, peculiar magnetic circuits, resonance, oscillations, lag, capacity, self-induction. Many of these articles, although evidently intended to be of service in engineering, show apparently no adequate appreciation of the practical bearing and relation of the subjects treated. Consequently the average engineer becomes bewildered and perplexed, and concludes that theoretical explanations are of little value to the practical man. There are, however, many of great practical importance, which admit of fairly simple statement and explanation. The particular element to be considered in the present paper is the transmission circuit.

EXPERIMENTS ILLUSTRATING SELF-INDUCTION.

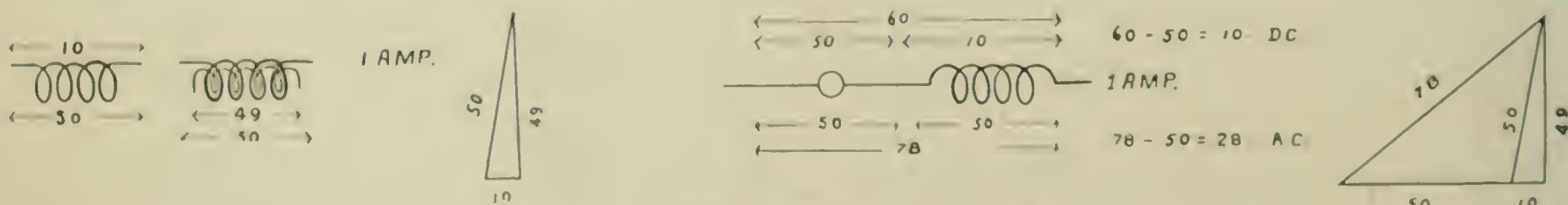
One of the fundamental characteristics of alternating current work is self induction. The effect of self-induction is most readily shown by a simple experiment. A wire having a resistance of 10 ohms may be wound in a coil. Ten

60 volts across the circuit, and the E. M. F. required for alternating current is 50 volts across the coil and 50 volts across the lamp, which gives, not 100 volts, but 78 volts measured across the two in series (Fig. 2). If two lamps be placed in multiple and connected in series with the coil, 2 amperes will require for continuous current 20 volts on the coil and 50 volts on the lamps, or 70 volts across the circuit. For alternating current the E. M. F. on the coil is 100 volts and on the lamps 50 volts, and on the circuit across the two in series the E. M. F. is 120 volts (Fig. 3).

The two lamps which are in multiple may be placed in series with a second coil so proportioned that an E. M. F. of 50 volts will send 1 ampere alternating current through the combination, and a continuous current of 1 ampere would be caused by 35 volts. This combination may be treated as a unit and may be used to replace the single lamp in the above test (Fig. 2). If this combination be placed in series with the first coil, the E. M. F. required for sending the continuous current through the circuit will be 10 volts on the coil and 45 volts on the circuit. If the alternating current of 1 ampere be sent through the circuit, 50 volts will be required across the combination and 50 volts across the coil, the same as with the single lamp, but the E. M. F. across the circuit is no longer 78 volts, but has increased to 95 volts (Fig. 4).

The important facts to be noted in these experiments are: (1) That the sum of the alternating E. M. F.s. on the elements in series is greater than that required on the terminals; (2) that the alternating E. M. F. for supplying the lamps in series with a coil is greater than the continuous E. M. F., and (3) that the difference between the two becomes greater as the number of lamps is increased (Figs. 2 and 3). It is also to be noted (4) that if the same alternating current be supplied through a coil, first to a lamp alone and then to a combination, including lamps and a coil, a higher E. M. F. is required when the combination is used (Figs. 2 and 4).

These relations, which seem rather perplexing, may be illustrated in a very simple way by diagrams. In the case of the coil alone, in which 50 volts are required for producing 1 ampere alternating current and 10 volts for 1 ampere continuous current, these two E. M. F.s. may be represented by the hypotenuse and one side of the familiar right angle triangle. The remaining side represents the counter E. M. F. in the coil. If a second wire had been wound in this coil in parallel with the first, it would be found that when 1 ampere is passing there is an E. M. F. on the terminals of the second, or idle wire, of 49 volts (Fig. 1b). This E. M. F.



FIGS. 1 AND 1b.

volts will send a continuous current of 1 ampere through this coil. An alternating current of a certain frequency will require 50 volts for producing 1 ampere through the same wire (Fig. 1a). In the diagrams the numbers above the circuit are for continuous current and those below are for alternating current. If a 1-ampere, 50-volt lamp be placed in series with the coil and a current of 1 ampere be passed through the two in series, the E. M. F. required for continuous current is 10 volts on the coil and 50 volts on the lamp, or

is caused by the field produced by the alternating current. An equal E. M. F. is, of course, induced in the wire carrying the current, as the two wires occupy virtually the same position. This counter E. M. F. is seen to correspond with the third side of the triangle. Suitable measurements would show that this counter E. M. F. occurs later than the current through the coil, and that its maximum value occurs when the current is passing through its zero. This relation is shown in the diagram by the 90-degree relation of the lines representing counter E. M. F. and the volts required for sending continuous current through the line.

*A paper read before the National Electric Light Association, Washington, D. C.

SELF-INDUCTION IN CIRCUITS.

An ordinary circuit may be considered as a choke coil in which there is a single turn. The action in this case is very similar to that illustrated above with a coil of many turns. The effect of self-induction in a circuit may be most

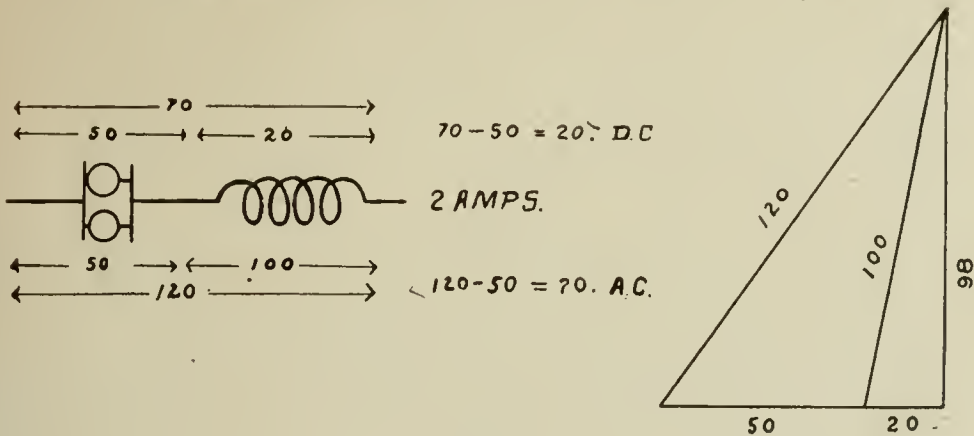


FIG. 3.

readily understood by some simple diagrams. A current of say 5 amperes is delivered at 100 volts over a circuit of one-fifth of an ohm resistance. The self-induction of the circuit is such that 5 amperes generate a counter E. M. F. of 10 volts. Both continuous and alternating currents are used, and the generator E. M. F. is in each case adjusted to give 100 volts at the load.

The load consists, first, of five incandescent lamps. A coil of high self-induction is then added, which increases the current from 5 to 5.1 amperes. One of the lamps is then cut out and replaced by coils of such a self-induction as to give a total of 5 amperes. Then all of the lamps are cut out and coils substituted of such a number as to take 5 amperes at 100 volts. The E. M. F. required on the generator and the resulting drop, or difference of E. M. F., at the dynamo and at the load are given in the diagrams and in the following table:

	Continuous Current.		Alternating Current.		
	Fig. 5.	Fig. 6.	Fig. 7.	Fig. 8.	Fig. 9.
Current in line.....	5	5	5.1	5	5
Current in lamps.....	5	5	5	4	0
Current in coils.....	0	0	1	3	5
E. M. F. on load.....	100	100	100	100	100
E. M. F. on line.....	1	10	10	10	10
E. M. F. on generator....	101	101.5	102.5	106	110
Drop-total	1	1.5	2.5	6	10

It is to be noted that with exactly the same circuit for supplying five lamps with the same amperes at the same E. M. F. there is an increase of drop between generator and load when continuous current is replaced by alternating current. This drop is much less than the volts required for

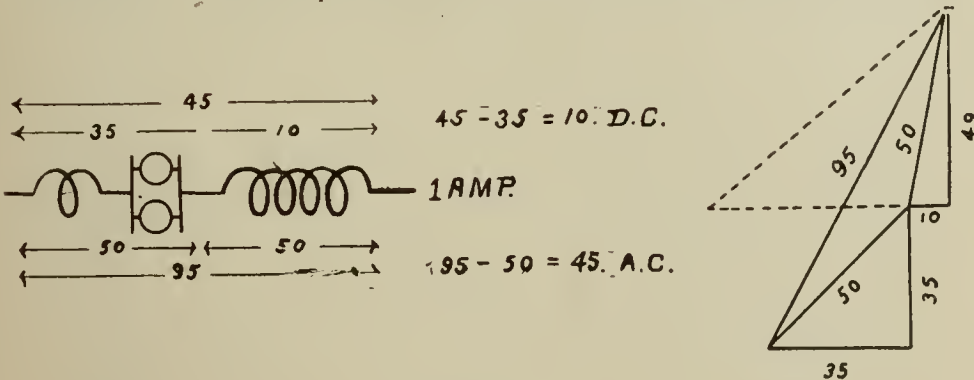


FIG. 4.

sending the alternating current through the line, and it, moreover, increases enormously as the load becomes even slightly inductive. Thus, when the current is increased only 2 per cent. (from 5 to 5.1 amperes, Figs. 6 and 7) by the addition of inductive load to the lamp load, the increase of drop due to self-induction is increased from 1-2 per cent. to 11-2 per cent., or an increase of threefold. When the load consists of four lamps and coils are added in multiple to take a total of 5 amperes, or the same as that taken by the five lamps from the generator, the drop is four times the

drop when five lamps alone are in circuit. If the remaining four lamps be replaced by coils, the drop does not increase in proportion, but from 6 to only 10 per cent. The effect therefore of a slight self-induction in the load causes a much greater proportional drop than the presence of a large self-induction. A counter E. M. F. of 10 per cent. is not at all likely to occur in a 100-volt line carrying small current. The figures given, however, serve as an illustration of the percentage variations which are liable to occur in other parts of the system.

DROP IN CONTINUOUS AND ALTERNATING CURRENTS.

The word "drop" in continuous current calculations has a perfectly well defined meaning. In the case of the five lamps which take 5 amperes at 100 volts through a circuit of one-fifth of an ohm, as illustrated in Fig. 5, the drop is: (1) the difference between the E. M. F. at the generator and at the lamps, or 1 volt, which is 1 per cent.; (2) it is the E. M. F. required for sending the current through the line;

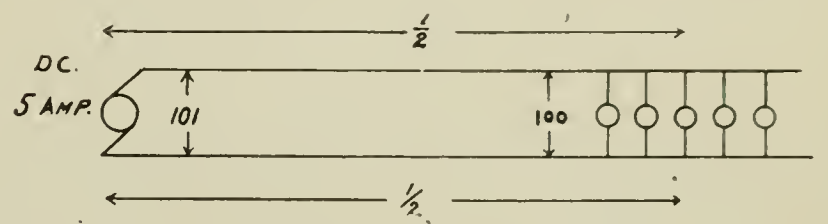


FIG. 5.—101 — 100 = 1.

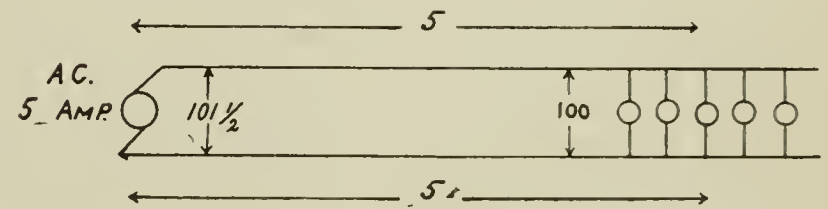


FIG. 6.—101 1/2 — 100 = 1 1/2.

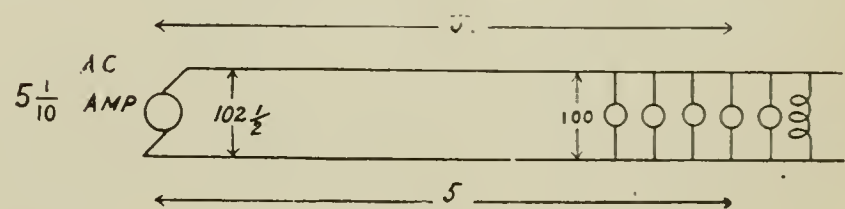


FIG. 7.—102 1/2 — 100 = 2 1/2.

this is equal to the current multiplied by the resistance, and is the E. M. F. which would be required for sending the current through the line if the load be short circuited; (3) a drop of 1 per cent. means also that the energy lost in the line is 1 per cent. of that delivered by the generator; (4) a loss of 1 per cent. in the line also signifies that the energy delivered is 1 per cent. less than that supplied by the generator.

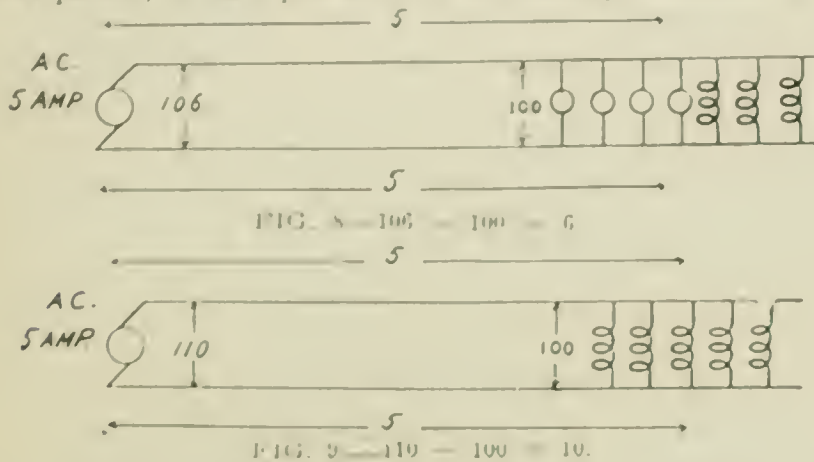
In alternating current work the same uniformity does not exist; for example, in the experiments with the same five lamps and the same line: (1) the generator pressure was 101.1-2 volts, or 1-2 per cent. higher than that of the lamps; (2) the E. M. F. required for sending a current through a line short circuited is 10 volts, or 10 per cent.; (3) the energy lost in wires is $C^2 R$, or 5 watts, which is 1 per cent. of the energy when five lamps are supplied. If four lamps and low resistance coils are connected to the circuit, the energy delivered is, say, 400 watts and the loss is 11-4 per cent.; (4) if the coils alone are supplied and their combined resistance is equal to that of the circuit, or one-fifth of an ohm, then the losses in load and line are equal and the actual line loss is 50 per cent. The apparent energy at the generator is 550 watts (110 volts and 5 amperes) and the apparent energy delivered is 500 watts (100 volts and 5 amperes), so that the apparent loss is 9 per cent.

It is therefore evident that the several elements commonly

referred to as drop or per cent. loss with continuous current are so modified when alternating current is used that it is possible for no two of them to have the same value. Moreover, with alternating current, none of these elements may have the same per cent. value as that for continuous current on the same circuit.

LOSS AND REGULATION.

The two vital factors in the line are loss and regulation. The losses are $C^2 R$, and should be expressed in watts or horse power, or as a per cent. of the energy delivered to the



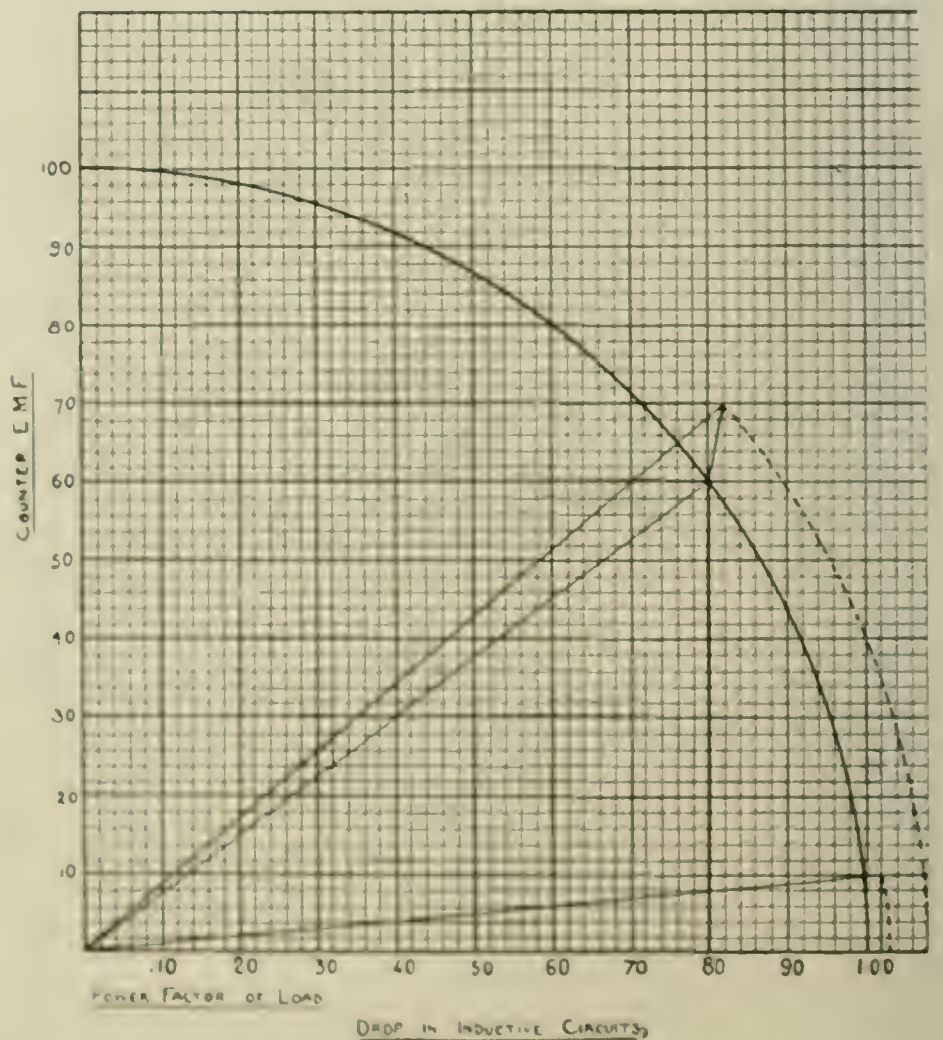
line. The practical point in regulation is the difference in E. M. F. at the generator and at the load. When these two factors are known, it is generally immaterial what E. M. F. might be required for sending current through a short circuited line. The word "drop" is applied to the difference in E. M. F. between the generator and the load. The regulation is generally expressed in per cent. of generator E. M. F., but in this paper the E. M. F. at the load will be considered 100 per cent., as this is the element to be kept constant while the E. M. F. of the generator is variable, depending upon the load and other elements.

The regulation, or drop, in the alternating current circuit is dependent largely upon the counter E. M. F. of the line. The factors which practically determine the counter E. M. F. of the line are size of wire, distance between wires, length of circuits, frequency and current. Mr. A. E. Kennelly has given very complete curves (American Institute of Electrical Engineers, April, 1893) for determining the impedance of pole lines. The impedance factors given may be used for finding the current through a given line which is short circuited at one end when the E. M. F. and frequency are known. The impedance factor of the line for supplying five lamps, described above, is 10, as the alternating E. M. F. is ten times the continuous E. M. F. for the same current when the line is short circuited. The word "drop" is applied in Mr. Kennelly's article to the volts required for overcoming impedance in a circuit, and the impression that this is the same as the drop in continuous current circuits was not corrected in the paper, nor was this most practical point raised in the discussion. The relation between impedance and drop was, however, demonstrated mathematically in a communication after the meeting. The figures given in connection with the foregoing diagrams show very clearly that a circuit having the same impedance may have a drop between the generator and the load of from 1.1-2 to 10 per cent., depending upon the character of the load. Impedance, therefore, does not determine regulation.

CALCULATION OF DROP IN ALTERNATING CIRCUITS

The regulation of a circuit is in general determined by two elements—the counter E. M. F. of the circuit and the self-induction of the load. The counter E. M. F. of a line depends upon the size of wire, the distance between wires, and increases directly as the length of the circuit, the current and the alternations. The counter E. M. F. of a line has been calculated for a number of cases, which are likely to occur in practice, and the results are given in Fig. 2. The drop, or difference, of potential between generator terminals

and the load terminals, due to the counter E. M. F. of the line, depends, as has been shown, upon the self-induction of the load. The latter is best expressed by a power factor, or a factor by which the product of the amperes and volts giving the apparent energy must be multiplied to give the true power in watts. The power factor for incandescent lamps is 1.00, or the apparent energy is equal to the true energy. The power factor for converters loaded with incandescent lamps is usually over .99. The factor for unloaded converters varies from .50 to .80, and in open magnetic circuit converters, notably the "hedgehog," the factor may be as low as .05. The drop due to self-induction on the line (which, plus the ohmic drop, will give approximately the total drop), corresponding to various power factors of the load, is given in Figs. 12A and 12B. The curves show that if the power factor be 100 per cent., as it is with incandescent lamps, the inductive drops for various counter or inductive E. M. Fs. are .02 per cent. for 2 per cent.; .08 per cent. for 4 per cent.; .18 per cent. for 6 per cent.; .32 per cent. for 8 per cent.; .5 per cent. for 10 per cent.; 1.2 per cent. for 15 per cent., and 2 per cent. for 20 per cent. The curves show that the drop increases very rapidly at first if the power factor becomes less. These relations may be elegantly determined by a simple diagram on section paper ruled in tenths. Draw an arc through a quadrant with a radius of 100. At a distance from the centre on the horizontal, equal to the power factor of the load, erect a perpendicular and extend it to the arc. This line represents the counter E. M. F. of the load, and its value read directly on the scale gives the counter E. M. F. in per cent. of the E. M. F. upon the load. From the intersection of the arc draw a horizontal line outside the circle equal on the scale divisions to the per cent. in terms of the



E. M. F. on the load which would be required for sending the normal amperes continuous current through the line resistance. From the end of this horizontal draw an upward vertical equal to the counter E. M. F. of the line expressed in per cent. of the E. M. F. on the load. A line from the centre to the upper end of this vertical represents in direction and magnitude the E. M. F. which must be

impressed on the circuit. If from the same centre an arc be drawn through this point to the base, the scale divisions on the base between the two areas measure the total drop caused by the line in terms of the E. M. F. on the load. See Fig. 1C.

SELF-INDUCTION IN TRANSFORMERS, ETC.

Self-induction exists in line, generators, transformers, secondary wiring, and sometimes in the load. In each case the effect of the self-induction upon regulation depends largely upon the self-induction of the total load which it supplies. Thus, the regulation of a generator depends upon the total

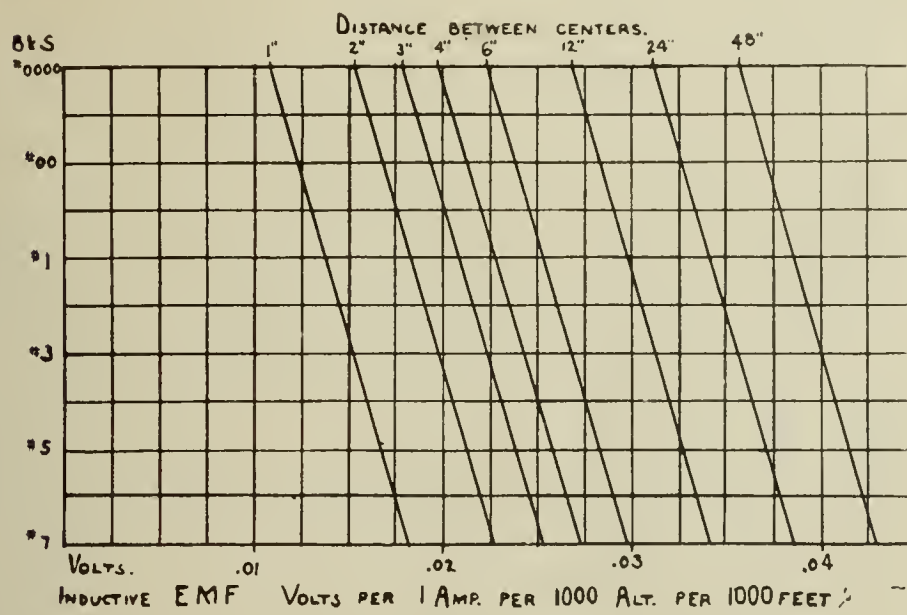


FIG. 11.

self-induction of the line, transformers and load. Again, the regulation of a line supplying transformers depends both upon the self-induction of the transformers, as well as that of the useful load. The same analysis and diagrams which have been used above in connection with the line will apply to the transformers and approximately to the regulation of the generator.

An ordinary transformer has a primary self-induction and

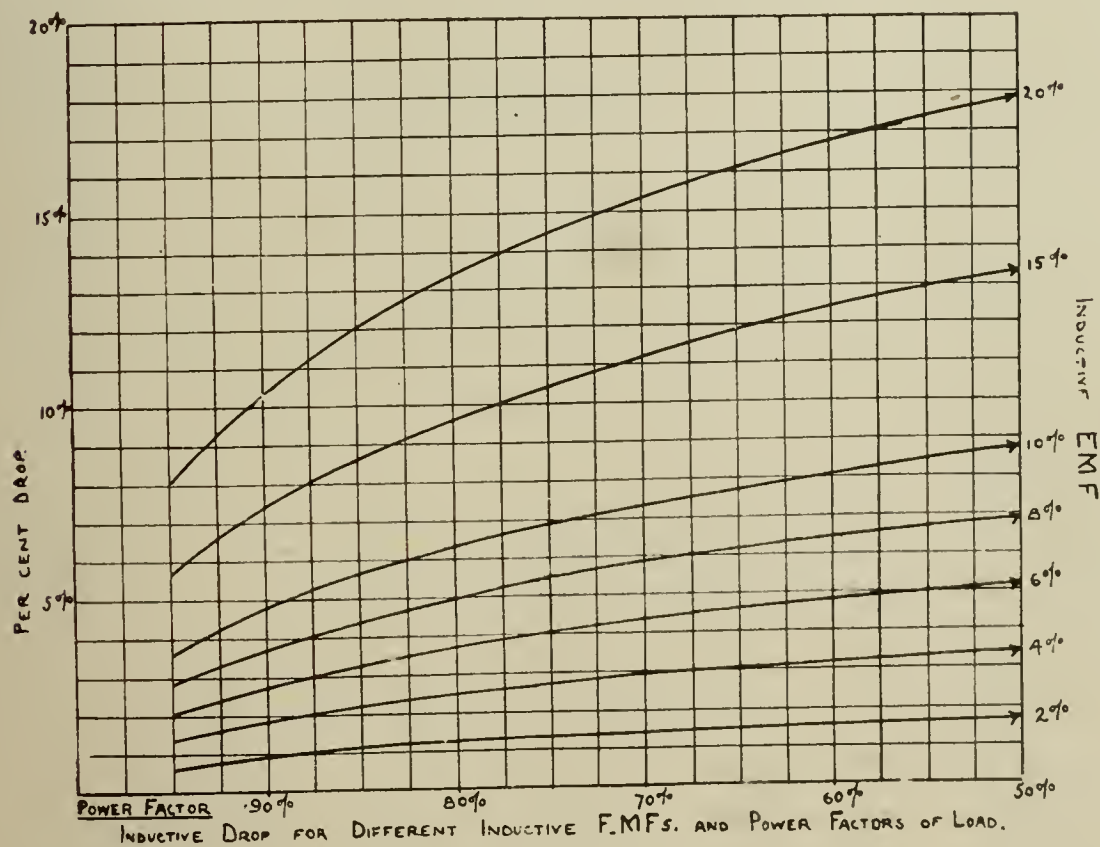


FIG. 12A.

a secondary self-induction and a mutual induction, which become a ready source of a very complicated and perplexing analysis when the complete action is described in theoretical terms. Practically, however, the action of the self-induction in the transformer may be expressed in a very

simple way, and it is readily seen that this self-induction has a very important bearing upon the regulation of the transformer. The regulation of the transformer is very similar to that of a line, as explained above. If the secondary coil be short circuited, the E. M. F. on the primary may be adjusted so that the normal full load current passes through the apparatus. This E. M. F. corresponds very closely to the E. M. F. required for sending current through a short circuited line, and in ordinary transformers is practically equal to the counter E. M. F., and may be considered equal to it.

A transformer may be taken for experiment in which the E. M. F.s. are 1,000 volts and 100 volts. If 5 volts, or 1-2 per cent., is required for sending through the primary a continuous current equal to the normal full load current of the transformer, and if a similar E. M. F. in the secondary is 1-2 a volt, or 1-2 per cent., then the ohmic loss in the transformer is 1 per cent. and the drop in pressure at the secondary terminals between no load and full load will be 1 per cent. if the self-induction be negligible. If, however, there is a self-induction so that 100 volts, or 10 per cent., is required for sending the normal current through the primary when the secondary is short circuited, then the drop in pressure is in general greater than 1 per cent., depending principally upon the character of the load. The load may be non-inductive, as lamps, or it may be more or less inductive. The experiments described above, in which a line had the same per cent. ohmic and inductive characteristics as the converter just described, apply to the converter as well as to the line. The drop on such a converter, therefore, may vary from 1-2 to 10 per cent. when delivering its rated current. Arc lamps, or fan motors, will produce a very much greater drop than incandescent lamps. The power factor of an alternating current arc lamp varies considerably, but in a number of cases has been found between 85 and 90 per cent. The drop, when incandescent lamps are replaced by arc

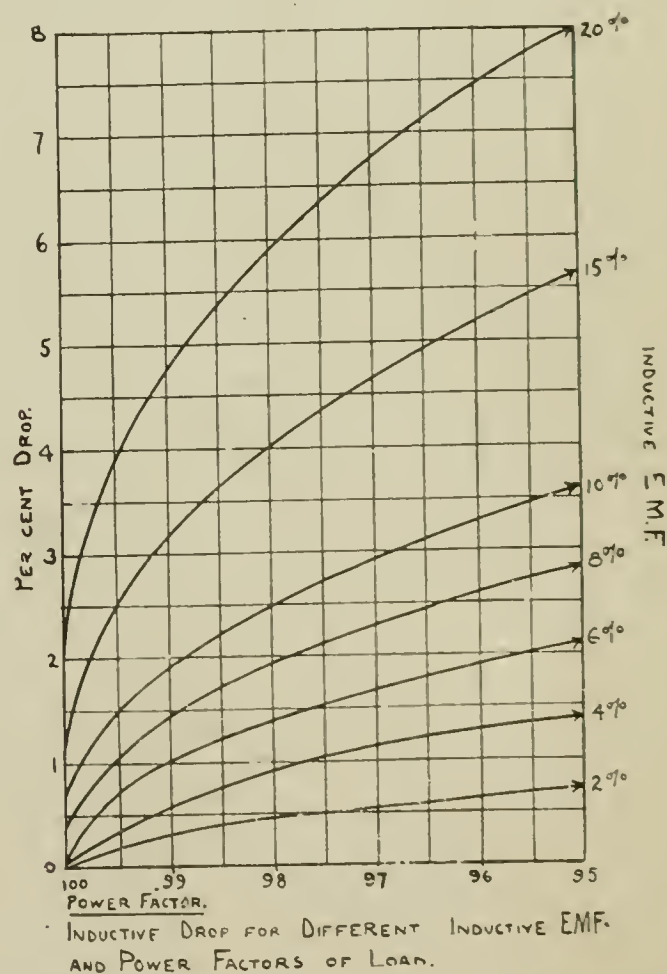


FIG. 12B.

lamps on the transformer just described, increases from about 1-2 to 5 or 6 per cent.

A secondary line, if it carry a large current, may have a counter E. M. F. of several volts. This may not be enough to increase appreciably the drop in the line between the

transformer terminals and incandescent lamps. But the transformer, however, delivers current to the secondary circuit and to the lamps, so that the regulation of the transformer may be affected by the self-induction of the secondary circuit. Cases have occurred in which transformers of a very old type possessing high self induction were supplying very large secondary currents and the resulting drop in the transformers was increased several per cent. For example, a circuit of No. 0000 B. & S. wire supplying 100 amperes to 50-volt lamps at a distance of 100 feet has an ohmic drop of 2 per cent. The constant for counter E. M. F. of this circuit, if the wires be 6 inches apart, is .022. The volts at 16,000 alternations are $.022 \times 100 \times .1 \times 16 = 3.52$, or 7 per cent. of 50 volts. The inductive drop in the line corresponding to 7 per cent. is .25 per cent. The power factor of the aggregate service of the transformer is the second side of a right angle triangle, of which 7 is one side and 100 is the hypotenuse. This is 99.7, which is the power factor of the total load on the transformer. If the inductive E. M. F. of the converter be 10 per cent., the inductive drop is 1.2 per cent.; if 20 per cent., the inductive drop is 3.4 per cent., and if 30 per cent., the inductive drop is 7 per cent. The aggregate drop in the converter and secondary circuit in the latter case would be, say, 2 per cent. for ohmic drop in transformer, 2 per cent. ohmic drop in line, 7 per cent. inductive drop in transformer, and .25 per cent. inductive drop in line, or a total of 11.25 per cent. The necessary ohmic drop is 4 per cent. and the inductive drop resulting from self-induction in transformer and line is therefore 7.25 per cent. If the number of alternations be reduced to 7,200, the inductive drop would be reduced from 7.25 per cent. to 11.2 per cent.

ORDINARY TESTS UPON TRANSFORMERS.

The practical bearing of the self-induction of a transformer upon its regulation and the exact relation between the two does not seem to be clearly recognized, and even Dr. Hopkinson and Dr. Fleming, who have made very exhaustive tests upon transformers, comparing different methods of testing and different types of transformers, have not brought out this point. Attention is given to the exact form of the current wave, and measurements upon the iron losses are attempted within very close limits of error. Their measurements upon the regulation of the same transformer, however, vary from 2 per cent. to 2.4 per cent., or one measurement is one-fifth greater than the other. The presence of slight induction in the secondary load would have caused a very considerable increase, and it is probable that the difference in the measurements made were due to difference in the self-induction of the instruments used or in the load at the time the tests were made. No note is made of the effect of the self-induction of the load upon regulation, although regulation is one of the most vital points in the practical use of transformers. Even the temperature at which the drop was measured is not stated, although the resistance of a transformer when continuously working may be 20 per cent. greater than when cold. The elements of practical importance in a transformer are (1) the iron loss, in respect to the efficiency; (2) the regulation, in respect to the satisfaction of service; and (3) the temperature to which the insulation is subjected, as affecting the life of the transformer. In the ordinary test by theoretical men the iron loss is measured to a very high degree of refinement, although the iron loss in transformers is the one thing which cannot be controlled, and is certain to vary 10 or 15 per cent. in commercial manufacture of transformers of the same size. The wave form of E. M. F. on different dynamos, or the difference in form under different conditions of load on a circuit, may make the loss under different commercial conditions vary several per cent. This renders more refined measurements of no practical use unless the conditions are stated. The temperature of the iron also affects the loss. The full load

efficiency is usually given as if it had a great deal of importance, whereas the losses in copper during 24 hours ordinarily amount to but a trifling per cent. of the total losses. The regulation and the temperature to which the insulation is subjected, and which it is able to stand, are generally not mentioned in reports of tests. The usual investigations and the papers published on the alternating current transformer may, perhaps, accurately express many facts in complicated formulæ, but the practical bearing of these points in every day working seems to be totally ignored.

MUTUAL INDUCTION.

If two circuits be run on the same pole line they act as a transformer, in which one circuit carrying current may act as a primary and induce E. M. F. in the other as a secondary. If the latter circuit is connected with the same dynamo and is delivering current, its E. M. F. will be slightly raised or slightly lowered by the effects of the first circuit. Conversely, the second circuit will have similar effect upon its neighbor, raising or lowering its pressure by a slight amount. If the two circuits be connected to different dynamos which are running at slightly different speeds, then

● ●	16000 ALT.	.035	VOLTS
	7200 ALT.	.016	VOLTS
○ ○	16000 ALT.	.015	VOLTS
	7200 ALT.	.0065	VOLTS
○ ○ ● ●	16000 ALT.	.070	VOLTS
	7200 ALT.	.032	VOLTS
○ ○ ● ●	16000 ALT.	.006	VOLTS
	7200 ALT.	.0027	VOLT.
● ○ ○ ●	16000 ALT.	.112	VOLTS
	7200 ALT.	.050	VOLTS

FIG. 13a, b, c, d, e.

the E. M. F. induced by one circuit upon the other will sometimes increase and at other times decrease the E. M. F. of the circuit, depending upon whether the two currents at a given moment are flowing in the same or in opposite directions. This fluctuation may cause variations in the intensity of the lights supplied. It is readily detected in the service of some central stations, and is of course most marked at time of full load, as the induction of one circuit upon another depends upon the strength of current carried. The fluctuation due to this action may be readily distinguished from that due to slipping of belts or irregularity in engine speed, as the induction effect is due to the difference in alternations between two machines, and the speeds of the two machines are apt to vary slightly from time to time, giving a gradual variation in the rate of fluctuation of the lamps. The fluctuation due to mutual induction of lines occurs only at the end of the line, and is not observed in the station, while the other causes affect the station lights also. The number of

volts E. M. F. set up in one circuit by a parallel circuit depends upon the current, the distance which the lines are parallel and upon the relative positions of the four conductors. The distance between wires may be six inches or six feet without affecting the mutual induction, provided the relative positions be unchanged. Several dispositions of circuits are shown in the accompanying Fig. 13, and the number of volts per thousand feet at 7,200 and at 16,000 alternations which are induced in either circuit by one ampere in the other are given in connection with each figure. The number of volts required for producing objectionable flickering in the light depends upon the voltage of the lamps in service, the efficiency at which they are run and the general surroundings in which they are placed, notably the relation of lamps to reflectors, white walls, etc., and the general disposition of the customer.

An E. M. F. of 1-2 per cent. induced in one circuit by another can in some cases be detected, and usually more than 1 or 2 per cent. will cause objectionable flickering.

METHODS OF REDUCING MUTUAL INDUCTION AND SELF INDUCTION.

The mutual induction is reduced by bringing the wires in each circuit close together and separating the circuits. The effect of this mutual induction may be neutralized by crossing one of the lines at its middle point, so that induction in the first half of the line is counteracted by the induction in the second half. It is readily noted that the effect of self-induction in a circuit is reduced as the wires are brought close together, or if each conductor be divided into several wires in multiple and separated. The effect of self-induction is diminished as the number of alternations is reduced. The following points are also to be noted in connection with inductive drop: If the power factor be nearly 100 per cent., the inductive drop increases as the square of the counter E. M. F. If the E. M. F. of the circuit be increased and the same power be delivered over the same circuit, the per cent. counter E. M. F. decreases as the square of the E. M. F. delivered, and the inductive drop decreases approximately as the fourth power. If the number of alternations be decreased, the counter E. M. F. decreases directly and the inductive drop decreases as the square. The inductive drop at 7,200 alternations is less than one-fourth of that for 16,000 alternations for ordinary power factors.

CAPACITY IN LINES.

The static capacity in ordinary lines is usually small, and its effect is not of importance unless the line be very long or the pressure be very high. The general effect of capacity in the line or of connecting condensers to the line is to lessen the current from the generator which is required for supplying inductive load and to reduce the drop due to self-induction. The use of condensers for this purpose may lead to very considerable gains in circuits where the self-induction of line or of load becomes considerable. If an inductive circuit or transformer supply current to condensers, the E. M. F. may increase instead of decreasing, as it does with inductive load.

(To be continued.)

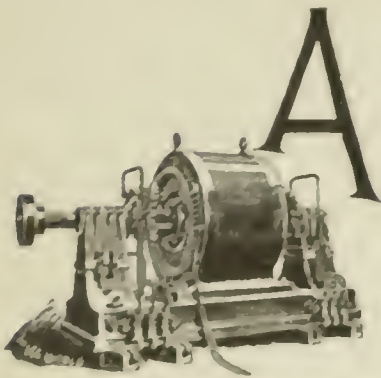
The Electric Light in London.

(From our own Correspondent.)

A very lengthy but interesting paper was recently read on matters connected with the electric lighting of the city of London by Major General C. E. Webber. The discussion, though brief, was, like that on Prof. Forbes' recent paper, somewhat heated; it is to be hoped that this warmth is not to be characteristic of all future debates at the Institution of Electrical Engineers. The origin of the rise of temperature was some by-the-way remarks of Major General Webber on the financing of the city lighting. When it is stated that a pioneer company was formed in February, 1891,

to provide £25,000 for the purpose of carrying out the contract with the city authorities until the public could be induced to subscribe, and was dissolved in the following October, carrying off as a reward for its public spirit a profit of some £50,000, it will be seen that a few remarks on finance matters were not uncalled for. The system on which the city lighting is carried out consists, as no doubt many of your readers are aware, in generating current at 2,000 volts at a station on the south side of the river and transmitting it by concentric rubber insulated cables drawn into wrought iron pipes to a number of transformer sub-stations within the city area, and distributing thence on the three-wire system. The low pressure networks attached to the sub-stations are electrically independent, although the sub-stations themselves are interconnected on the primary side. General Webber gave some valuable information with regard to subways, of which there are several examples in the city, and his experience does not tend to confirm the demands of those municipal enthusiasts who would have huge tunnel light subways constructed, regardless of expense, in every street of the metropolis, and gas, water, telephone, telegraph, electric lighting and pneumatic mains forced into them. Such subways General Webber has found to be of some use for trunk conductors, but out of the question for distributing mains. The system of underground mains generally adopted for distribution purposes within the city has been the three-way, triangular-shaped, steel-sheathed bitumen casing. A careful canvass of the city has elicited the fact that in a first-class block there is about .25 of a light per square yard of ground space, and that from 50 to 75 per cent. of the existing lights may reasonably be expected to be replaced before long by glow lamps. Working on this basis, the total number of 8-c. p. glow lamps that the city company will have to provide for will be 340,000. General Webber gave detailed drawings of the transformer sub-station constructed in the churchyard of St. Bene's Sherehog, in which considerable ingenuity seems to have been displayed in making the maximum use of the minimum space, and in providing against infiltration of water and foul air. One point which may perhaps be of interest on your side of the water is that instead of running their mains straight up the main streets of the city and tapping them at intervals with house connections, the shops abutting on the main streets have been approached as far as possible from the rear, thus avoiding the necessity of constantly opening up the thoroughfare of some of the busiest streets of the world to make house connections. The glass chosen for the lanterns for the street arc lights is stated to be "rippled" glass of .145 inch in thickness, absorbing 21.73 per cent. of the light, this being found considerably less absorbent than opal or ground glass. Of the 900 street glow lamps which it was proposed to run in series, and which were to range from 100 to 200 watts each, only a few have, up to the present, been erected in Basinghall street. General Webber is very half hearted in his support of street glow lamp lighting, but nevertheless put forward a workmanlike design for a street glow lamp, wall bracket and lantern. In the discussion that followed Messrs. Kapp, Esson, Alexander Siemens, R. E. Crompton and Prof. Silvanus Thompson took part. Mr. Kapp was very anxious to discover how the transformers, which are placed in the lowest part of the sub-stations, were going to be kept dry. Mr. Siemens advocated lead-covered, iron-armored cables laid direct in the ground, and thought that the necessity for hollow cored cables where alternating currents were concerned was much exaggerated. Mr. Crompton, as usual, showed that the whole thing could be carried out much better on the low pressure system and by using his various patented contrivances. There was a general consensus of opinion that street glow lamp lighting was not such a hopeless affair as General Webber was inclined to think.

Three-Phased Plant at Concord, N. H.

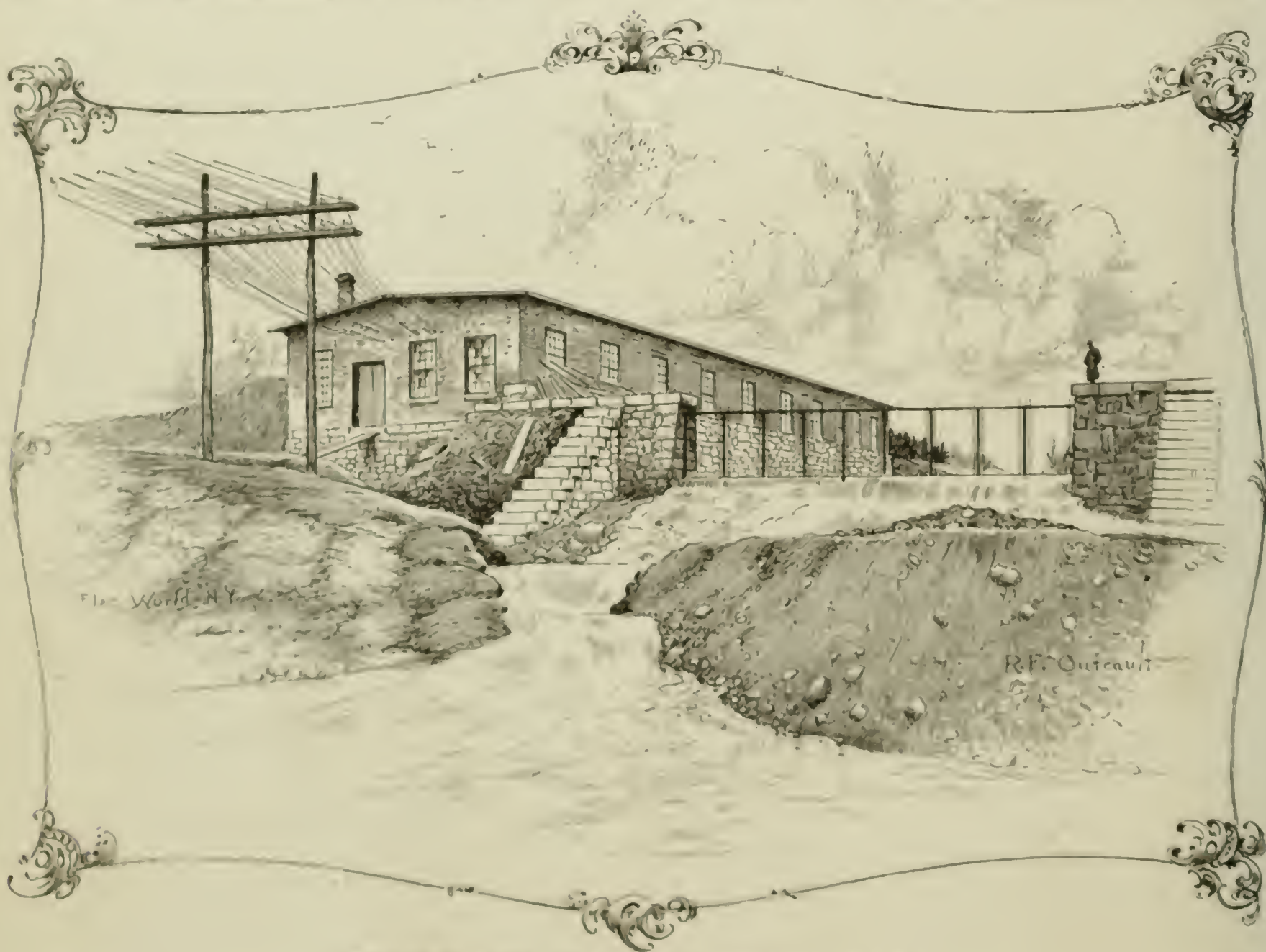


As the first to adopt the three-phased system, the plant of the Concord Land and Water Power Company, Concord, N. H., has, perhaps, attracted more attention than any recently installed. Business was commenced by this company about two years ago with a small steam arc lighting plant. A year ago it acquired the gas company's electric plant, and this was soon followed by the addition of all the electric power business of the street railway company, so that it now has the entire electrical field. The company has just completed a large hydraulic and electric plant, located at Sewalls Falls, in the city of Concord, which was the only undeveloped fall on the Merrimac River.

The dam flows the water nearly thirteen miles, and the twenty-two feet of fall obtained gives an average of 5,000

feet per second. The cribwork is composed of 10-inch by 10-inch and 12-inch by 12-inch timber, the top layers being Georgia pine, covered with 5-inch Georgia pine plank, armored with 3-8-inch steel plates. The water makes five separate falls on the dam structure, and leaves the lower apron with very little momentum, and as a result does not scour. About 1,500,000 feet of timber and 20,000 cubic yards of rubble stone were used in the dam proper, and 5,000 cubic yards of hammered granite were required for the abutments, guard walls and head gates.

The gates are five in number, about 10 inches by 12 inches each. The rigging is novel, ball bearings being used, and the friction so reduced that one man can easily operate them. They were designed by Mr. John R. Freeman, of Boston, Mass., who is consulting hydraulic engineer for the company. The water flows through a canal about 1,000 feet long, 75 feet wide and 12 feet deep, to the power house, where it passes through a large rack to the forebay and thence through five 81-2-foot penstocks to the wheels.



THREE-PHASED PLANT AT CONCORD, N. H.

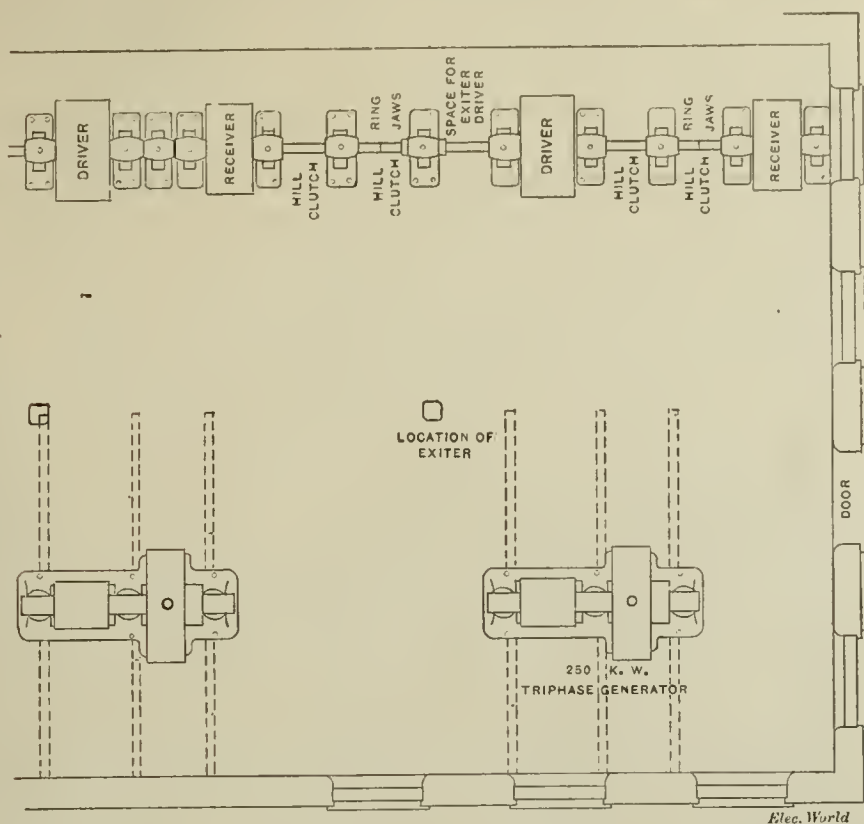
h. p. The dam is a magnificent structure, 22 feet from foundation to crest, 67 feet from the down stream to the up stream face, and is designed to carry safely, in cases of extreme flood, a sheet of water over its entire surface ten feet thick. The normal flow is about two feet. The dam is what is known as a crib structure, and considered the finest of its kind in the country. It was designed by Mr. E. F. Smith, of Philadelphia, and is constructed with timbers placed cob-house fashion, thoroughly bolted together, the interstices being hand packed solid with granite, making a stone dam, held together by the cribwork, instead of cement. Four rows of sheet piling extend from one abutment to the other, and each row is puddled with gravel. The up stream face of the dam is planked and puddled, while a curved steel

Each penstock supplies a pair of 39-inch Rodney-Hunt turbines, each pair of which gives 400 h. p., making a total of 2,000 h. p. at the power house, leaving 3,000 h. p. available for manufacturers who may desire to locate on the company's land. Horizontal turbines are used, with draft tubes, thus avoiding gears, the power being transmitted from each pair of wheels to the shafting in the generator room by belts. The shafting is arranged with quills and clutches, so that any wheel or section of shaft may be run independently of any other. The pulleys on the shafting and water wheels are very heavy. The idea of using flywheel inertia as a factor in the regulation of water power for electric work is being tried here for the first time, with great success.

The view of the interior of the power house is from a pho-

tograph taken some time ago, and shows but one of the large triphased generators. There are to be six of these, two being in operation at the present time. There are also 70 50-light Thomson-Houston arc generators.

The large generators are of 250 kw. capacity and separately



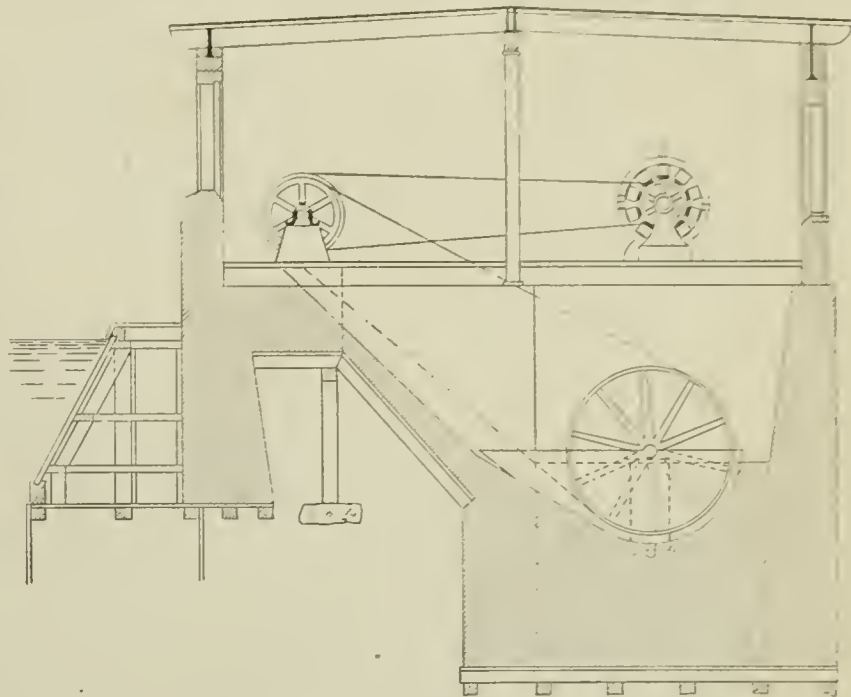
PLAN AND ELEVATION OF CONCORD STATION.

excited. There are ten poles and the ends of the pole pieces are laminated. The speed is 600 revolutions per minute. They are driven by a 36-inch belt, there being a ring oiling bearing on each side of the pulley. The main frame, a single casting weighing nearly eight tons, includes the base and lower half of the field and the bearings. The armature is of the toothed type, and the windings are Y connected, somewhat similar to the Thomson-Houston arc armature. Current is taken from rings by three sets of copper wire brushes 1-2 inch by 2 inches, two brushes to a set. The total weight of the machine is 16 tons. The exciters are 5 kw. 125 volt Edison bipolar machines. These large generators are belted to quills and connected to the shafting by special Hill clutches, the shafting, pulley, etc., being furnished by the Kidder Machine Company of Franklin, N. H. The pulleys are novel, neither key nor set screw being used; the hubs are bored out tapering, and a split sleeve which fits both shaft and taper, forced in by means of bolts, extending through hub, clamps them to the shaft. These pulleys run perfectly true, adjust themselves to slight variations in size of the shaft, do not slip, and may be taken off very readily and quickly. The shaft and quill bearings are all fitted with oiling rings; in fact, every bearing in the power house is self-oiling.

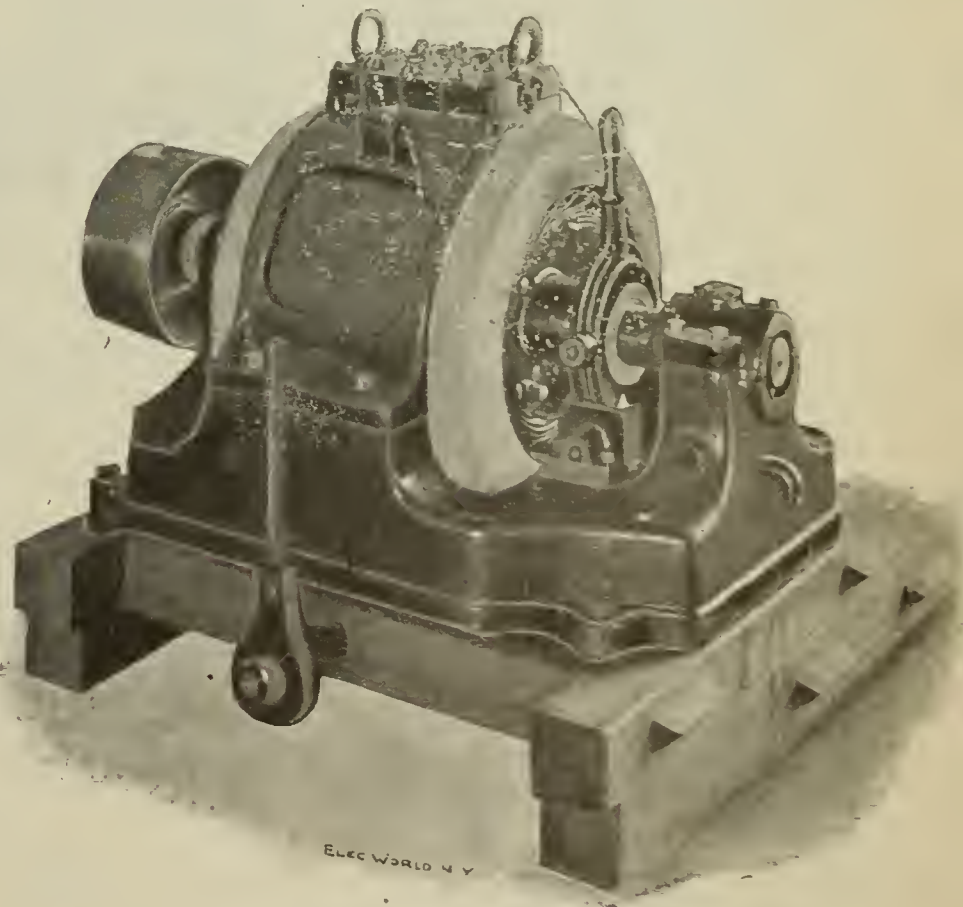
The current is generated at 2,500 volts, and a Weston voltmeter reads direct from the line with a multiplier instead of the usual transformer. Carpenter rheostats are used. The switchboard is of the skeleton type. Acoustic synchronizers are provided for parallel running. Type "F" transformers were specially designed for the frequency, with more iron in the cores and oil as an additional insulation.

As will be seen from the cut, the building is a plain, substantial brick structure, mill construction being followed in its design; every window is double, both sets of sash being hung on cords and balance weights. The roof consists of 3-inch matched plank spiked to rafters, one inch of lime mortar, one-inch pine boards, and on top of all a five-ply tar, felt and gravel roof. No provision has been made for heating, and the building is so constructed that the heat thrown off by the generators, which run continuously, has been found to be sufficient. The wires are led out of the building through porcelain tubes set slanting in the brick

walls, and nothing inflammable is used. The first span of the line after leaving the power house is 475 feet, across the river, and this is accomplished in a novel manner; one set of the span poles is shown in the view of the power house. Silicon bronze wire is used on this span, each wire being three feet from any other and the centre sagging 25 feet from the ends of the span. The ends are tied to seven deep groove, double petticoat, glass insulators, placed in a zigzag.



four one and three the other side of each wire, on locust pins, with a tie nearly seven feet long. The poles are 40 feet long and 12 inches in diameter at the top, and the arms are made by bolting an 8-inch by 8-inch by 25-foot Georgia pine stick on each side of the pole, with a 6-inch by 10-inch piece placed flatwise between, thus giving room for the pins:



THREE-PHASED MOTOR.

large bolts extending through the pole and arms are guyed to anchors.

The mains in the city are all cross-connected and fused, so that any section may be cut out for repairs, as the current is on continuously. Feeders tap the lines at points of heaviest load. The power and lighting circuits are separate, but are sometimes fed by the same generator.

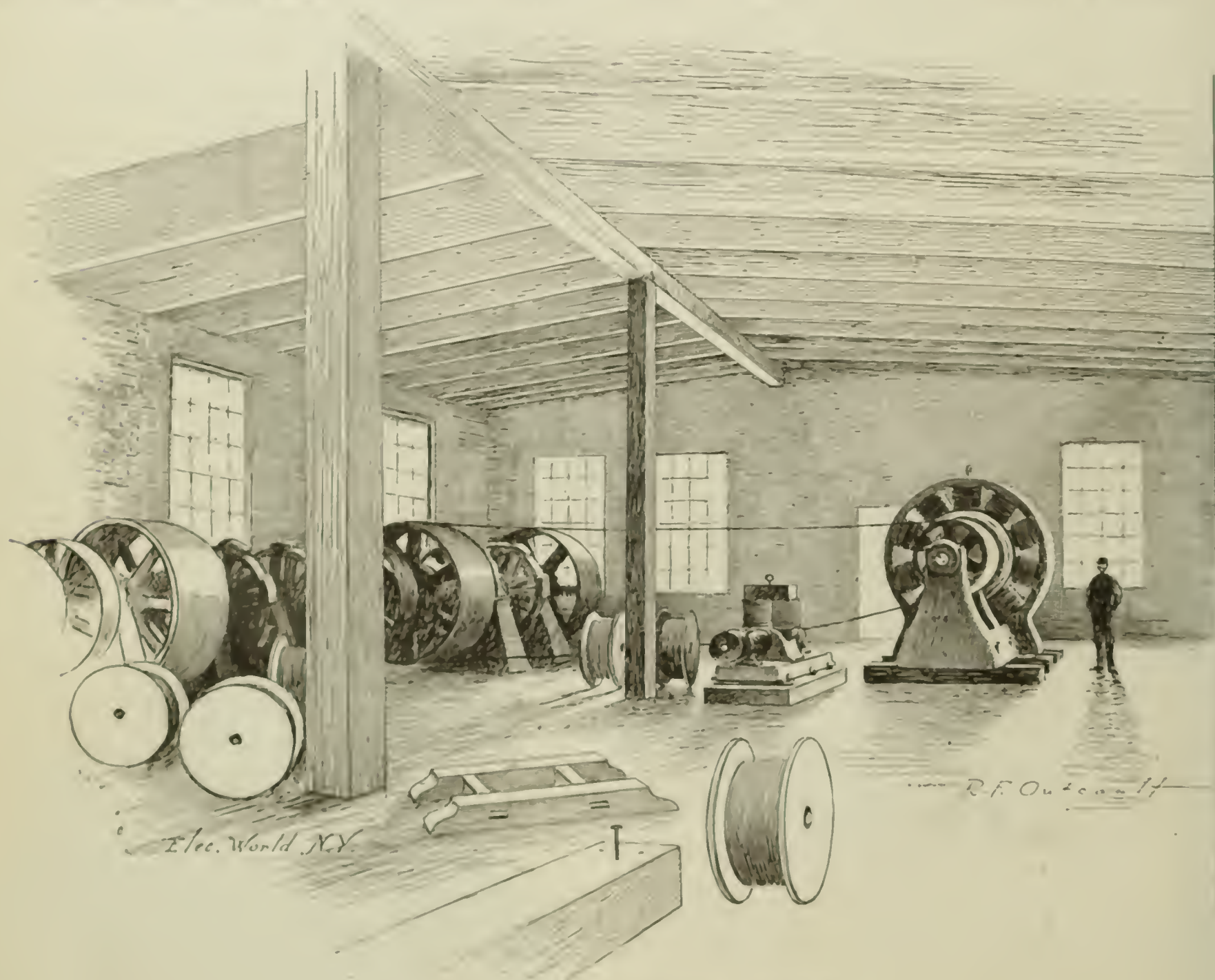
The line runs to the centre of the city, about three miles away, where triphased current of a frequency of 50 is de-

livered to the mains at 2,200 volts pressure. It is transformed to 110 volts and delivered to consumers for arc and incandescent lighting, power, heating and cooking. All current is sold by meter, the rate for lighting being 20 cents and for other uses 10 cents per kw. hour. The company at present supplies nearly 300 arc and 5,000 incandescent lights, 400 h. p. for motors and 30 kw. for heating and cooking apparatus. At the public city cooking school instruction is given exclusively on electric cooking apparatus.

The accompanying illustration shows one of the three-phased motors. The voltage in the primary, or stationary, windings is 110, while that in the secondary, or rotating, 15. The resistance of the secondary, to facilitate starting, is short circuited, when the motor attains speed by a switch in the shaft, operated similarly to a friction clutch, with a small lever. The starting torque is said to be three times the

The company has just commenced to furnish current for the Western Union Telegraph lines from Nashua to White River Junction, the novel feature being that both positive and negative current is supplied from one machine—an exciter. To do this, four lamps were placed in series across the machine terminals, grounding the wire that connects the two middle lamps, all of which were 32-c. p., 110-volt incandescents. Then by connecting to each machine terminal the telegraph company was able to dispense with a large room full of batteries.

All the electrical apparatus for the plant has been furnished by the General Electric Company. Mr. George F. Page, the organizer and moving spirit in this enterprise, is president of the Page Belting Company, which has furnished all the belting. Mr. H. J. Odell, the popular treasurer of the company, is president of



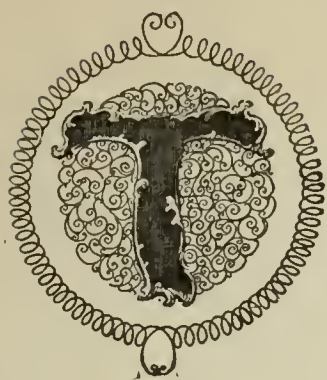
INTERIOR OF CONCORD STATION.

running torque, and the motors start like a direct current shunt machine, with equal commercial efficiency. The apparent and actual watt curves run very close together, except at small loads. The sizes up to 15 h. p. have four poles and run at 1,500 revolutions, while the 20 h. p. and 25 h. p. have six poles and make 1,000 revolutions. The speed is dependent on the speed of the generator, but is not affected by variations in voltage within certain limits. On overloading they do not stop immediately, but gradually slow down as a shunt motor. Mr. E. F. Carpenter, the superintendent of the plant, is authority for the statement that in the case of a 5 h. p. motor driving a dynamo with a load of 9 h. p., the motor current was reversed and in just four seconds by a stop watch the motor was at speed running in the opposite direction, apparently as unruffled as if it was its usual treatment.

the Franklin Needle Company, and a very able financier. Messrs. Winthrop Coffin, Jr., J. C. R. Peabody, F. W. Prescott, A. A. Glasier, J. E. Fernald, C. F. Page, C. C. Danforth and F. S. Streeter constitute, with the above, the board of directors. The power house mechanical and electrical features of the plant are the design of Mr. Eugene F. Carpenter, electrical engineer, who has been general superintendent of the company since its incorporation. The work of construction at the falls has been carried out under Mr. Daniel Ulrich, of Newark, N. J., engineer in charge of the work. The first earth was moved on Aug. 1, 1892 and the machinery was put in motion the first time Feb. 28, 1894, the young son of the superintendent turning the gate. The machinery was put to work at once without the usual nursing process, and the first hot bearing has yet to make its appearance.

Practical Properties of Polyphase Apparatus.—II.*

BY LOUIS BELL.



HIS method of compounding polyphase generators seems to promise ready applicability to the largest machines and very close automatic regulation of the voltage. The arrangement may be varied, but the underlying principle must remain the same—the automatic variation of voltage on the polyphase end of a rotary converter in response to the varying output

of the generator by means of varying inductances obtained from coils in the main circuit, and acting either directly or reversely to govern voltage applied to the rotary converter. In practice, the method works quite satisfactorily and effectively. It permits of very close regulation of the voltage for all loads at the machine, or of over-compounding at the distant end of the line, and that even with severely inductive loads. I have tried a number of experiments to determine the best working conditions of this method of compounding, and the results are most striking.

A record of experiments made after this paper was written is illustrated in Fig. 2. The generator was first run with a non-inductive load at 114 volts initial. The output was driven up to 261.2 kilowatts and the voltage at the end was 116.0 (A). It had varied slightly in the earlier portion of the curve, the extreme variation from the initial voltage being a couple of volts. That was with a poor machine, and lacked the good results that could have been obtained had the compounding arrangement had less work to do. Now we tried the same machine under inductive load (B). The initial voltage was again 114 and it was arranged to over compound, so that at 30 kw. we got 148 volts. The device over compounds just as handily as it compounds for uniform voltage, and, furthermore, I may say, that by proper

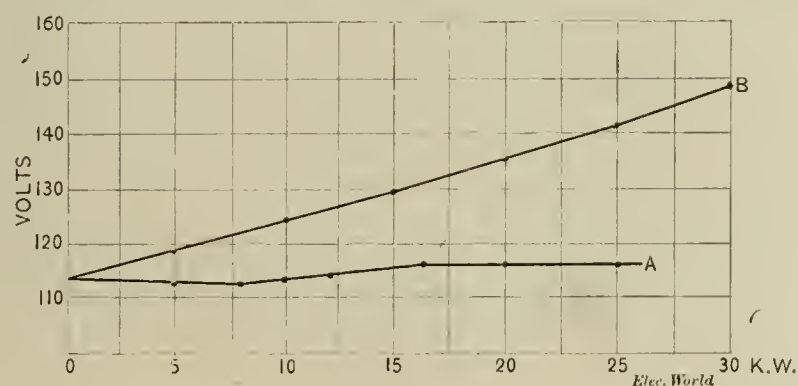


FIG. 2.

adjustment of the inductive coils and the rotary converter, it is possible to make the machine compound closely or over compound, either for inductive load or non-inductive load, or for a load which is varying, sometimes non-inductive and sometimes inductive. The very act of the shifting of the phase due to running with an inductive load may be made to help the rotary converter overcome the lagging current, as was the case in the example I have just given, where the voltage rose somewhat like 25 volts on a heavy load consisting of induction motors running very light.

All this matter of regulation is of particular moment in installations intended mainly for power purposes where the variations in load are apt to be considerable. Where, however, these variations are extreme I do not believe that any automatic apparatus can altogether obviate the necessity of watchful and intelligent hand regulation, especially when water wheels are the prime movers. It should be remembered, however, that the variations in voltage which pass

altogether unnoticed in ordinary service and are practically of little account are much greater than would be at first sight supposed. An evening passed in any station operated by water power teaches a useful lesson in this respect. Quite considerable occasional variations, particularly if slow, are far less objectionable than repeated or periodic ones of much less magnitude, such as are produced by "hunting" in a governor or overmuch fussing with the regulating devices. A governor should be "dead beat" even if something of sensitiveness is sacrificed to that end.

Polyphase, like other alternating current generators, make good synchronous motors. In fact, they are decidedly better than others for this purpose, in that they are self-starting with more or less facility, and do not go out of step quite so easily as the single phase machines. They are, as it were, more flexible. They start really as induction motors; that is, they may properly be regarded as induction motors having a revolving primary element and a non-laminated fixed secondary without windings, exerting torque simply by virtue of induced currents in the pole pieces.

Naturally they cannot start very efficiently under these conditions and for motor purposes it is much better somewhat to modify the structure, so as to provide secondary windings or other devices to approximate the effect of a genuine induction motor. Nothing very complicated in this line is necessary, and it is quite easy to produce a synchronous motor that will be self-starting even with a considerable load of shafting. In the Redlands triphase plant, for example, the motor of 150 h. p. is belted to a short countershaft mounted in a timber frame and carrying two large pulleys. The smaller of these drives by a 36-inch belt a wooden wheel 18 feet in diameter mounted on a crank shaft that drives two large ammonia compressors. A pulley on this shaft is belted back to the framework aforementioned, and drives a force pump for the ice making machinery, a circulating pump for the water jackets of the compressors, and a small ice elevator. All this machinery is brought promptly up to synchronism by the motor without the intervention of clutches. The starting torque is thus quite sufficient for most ordinary uses to which a large motor is likely to be put.

The synchronous type of polyphase motor is especially adapted to large units. Being a non-laminated structure, it is easier to build and somewhat cheaper than an induction motor of the same size would be, and furthermore it possesses the advantage of introducing no lagging current whatever into the line, except at the moment of starting. While this lagging current is not of great moment on ordinary lines, it may as well be avoided where by so doing a machine equally as good and cheap can be obtained without any additional complications. With large units, too, there is generally less need of a very great starting torque, and consequently induction motors are far less necessary in the large sizes than in the smaller ones. There is no practical difficulty whatever in building or operating these large synchronous self-starting motors, and they are likely to come into extensive use.

INDUCTION MOTORS.

Perhaps the most striking characteristic of the polyphase system is the use of the polyphase induction motor, obviating, as it does, necessity for moving contacts and enabling the ready employment of forms of winding which give remarkable immunity from the ills to which continuous current motors are heir. In all that has been said about these motors there has been an unfortunate absence of exact data, particularly as regards their ability to start under heavy loads, the current required at starting, the current required when running light, the lag factors, light and loaded, the variations of speed under varying load, and other charac-

*Abstract of a paper read at the eighty-third meeting of the American Institute of Electrical Engineers, Jan. 17, 1894.

teristics which are of direct practical importance in the use of such apparatus.

The induction motor consists essentially of two laminated structures, one fixed and the other revolving, and each wound symmetrically for phases more or less in number, according to the system on which the machine is to be employed. It may be considered as a transformer with its magnetic circuit imperfectly closed, and of which one member is free to revolve. For mechanical reasons I think it is generally preferable that the primary element which receives the higher voltage should be fixed, and the low voltage, secondary element, movable. By this arrangement, too, all necessity for moving contacts is avoided. For certain specific purposes the reverse of this plan may now and then be advisable.

As to the general properties of these machines, I can hardly sum them up better than to say that they behave in a manner strikingly like well designed shunt wound continuous current motors, having, however, the advantage of being simpler and of having no commutator. Even their efficiency is closely similar to that of continuous current motors of the same size both as regards its maximum value and its value under moderate loads. The hysteretic losses and those due to parasitic currents are, however, a source of inefficiency that has to be carefully considered in order to reach a satisfactory result.

These losses are located in large measure in the primary element of the motor, and would apparently indicate the desirability of making this the revolving, and naturally smaller, part of the machine. The advantage, however, of using a very simple and substantial winding on the revolving element is too great to forego for the sake of a little saving in hysteresis.

Induction motors can be made to start readily under load, yielding, when properly designed for the purpose, a starting torque up to four or five times the full load running torque. Even more than this can be obtained if it be needed, but for most practical purposes running torque is quite sufficient, and it is perhaps best generally not to design motors with abnormal starting powers in view, regarding such rather as special types. As in continuous current work, a motor fitted for unusually heavy strains is not necessarily the best all around machine.

For everything except extraordinary requirements such as may be sometimes met in hoisting, a uniform design and rating may be conveniently kept, as it is very easy to regulate the torque and the current required to produce it within wide limits by varying the resistance included at starting in the secondary circuit. I know of no motors without such a starting resistance that are capable of giving any considerable starting torque without an enormous initial rush of current, and even were one designed to secure a good torque without armature resistance, it would be almost certain to exhibit various other undesirable qualities that would more than offset the advantage.

The office of the starting resistance is two fold: First, it limits the possible current in the armature so that it will not beat back the induction from the field; that is, it sets a limit on the armature reaction. Second, it limits also the lagging in phase of the armature behind the field. There is a particular resistance best suited to each case, for which the torque is a maximum, at the given voltage. Any variation from this value will diminish the torque, the current meanwhile rising or falling according as the resistance is diminished or increased. This critical resistance should be found and used whenever it is necessary to start under abnormal loads. At a certain second value of the armature resistance the torque per ampere will be a maximum, and this determines the best resistance to be used for cases where a large static torque is not necessary. Somewhere between

these points will be found the best working resistance for practical purposes. The first point named does not call for impracticable current, nor the latter for inconvenient torque if the motors be properly designed.

In using a starting resistance I prefer to fix it within the armature spider and so to avoid all need of collecting rings. Save for this device, moving contacts of some sort must be used either to lead the primary current into the revolving element or to connect the resistance to the secondary, either of which procedures is objectionable, particularly the latter.

There is no subject connected with polyphase work which has been the theme of more hasty conclusions and ill-advised criticism than the current required by polyphase motors in starting. The popular verdict pronounces it enormous, an opinion generally derived from hearsay or from experiments with poorly designed motors, often with armatures of the squirrel cage type, than which nothing is more ineffective in starting, if the motor be decent in other respects.

Nothing can be more grossly exaggerated than this common idea of immense starting currents. The best way to refute it permanently is to give exact experimental figures. The annexed curves (Fig. 3) will show very plainly the facts

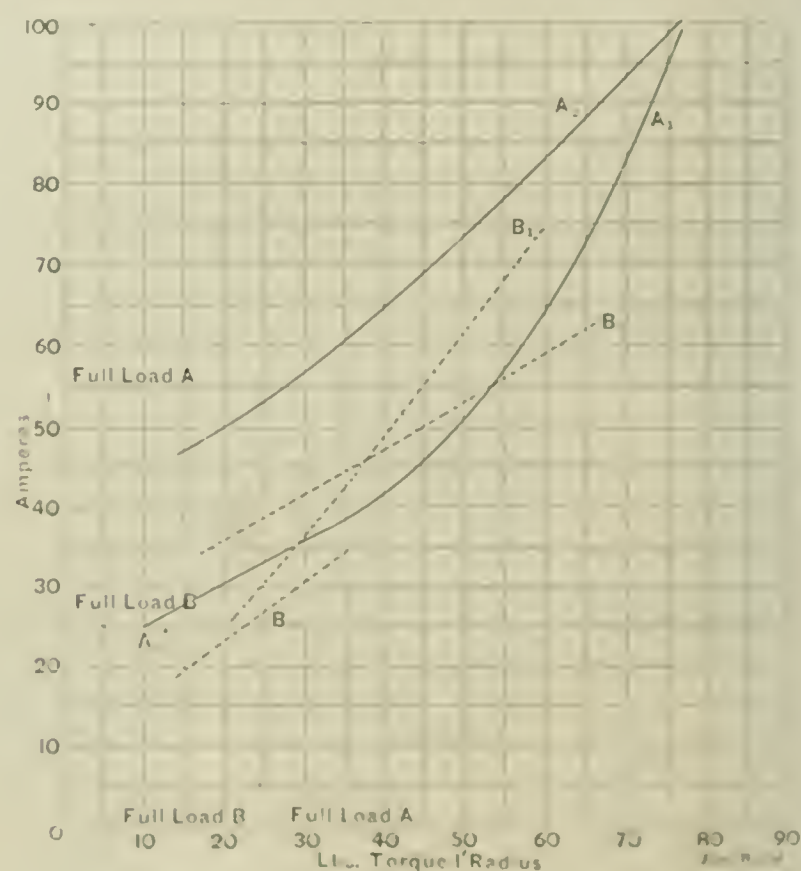


FIG. 3.

in the case. The torques given are genuinely static, being obtained by fitting a horizontal brake beam to the shaft of the motor and resting a stud on the beam upon a platform scale. The resistances used were of manganin strip. The currents were obtained from a current indicator standardized from a Siemens dynamometer, and the readings were made after the pointer had come to rest, a precaution very necessary, as the instrument was not at all dead beat. The current thus obtained is a true maximum for the given torque, the armature being permanently clamped at rest.

In Fig. 3 the relation between starting torque and current is very clearly shown, as well as the importance of the starting resistance. In the figure the curve A_1, A, A_2 belong to a 10-h. p. triphase induction motor, and B_1, B, B_2 to a similar machine of 5-h. p.

A_1 shows the effect of varying the resistance in the secondary on the relations between starting torque and current, the voltage being kept normal and constant. A_2 shows the variation of torque with current for a given fixed resistance, the voltage being varied, and the resistance being such as to give heavy torque. A_1 is the same as A_2 , etc.

cept that the resistance was such as to give very moderate starting currents. Full load torque was 35 pounds.

B_1 , B_2 , B_3 are similar curves from a 5-h. p. triphase motor, the full load torque being 17.5 pounds. Now examine the curves. Instead of abnormal currents being required in starting, each of the motors under examination will develop full running torque on considerably less than full load current. At full load current, in fact, each of them gives some 50 per cent. more than running torque. And this condition of things is not in the least exceptional—it will be true of any properly designed motor, unless it be intentionally adjusted to have a very great starting effort at normal voltage, as shown in Fig. 4, which is a curve from a 10-h. p. motor. Here curve A shows the relation between current and torque with a carefully adjusted resistance, and curve B the same relation without armature resistance. In this latter case we have reproduced just the state of affairs that is encountered when one attempts to start an induction motor by a rheostat in the primary circuit. A comparison of A and B tells its own story as to the advisability of this procedure. The results are never comparable with those obtained with a resistance in the secondary under similar conditions. It may be well here to note that an ohmic resistance cannot be replaced by an inductive resistance for the purpose under consideration, as the armature

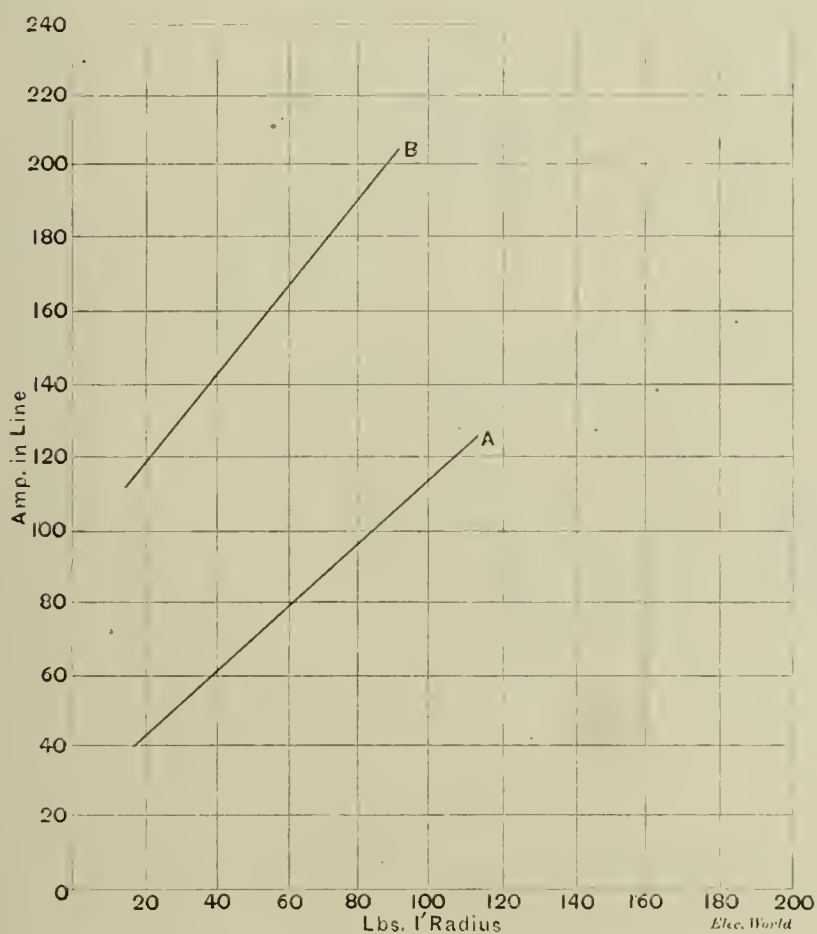


FIG. 4.

current is thrown thereby so much out of phase that no even tolerable results can be obtained. In leaving the subject, I need only say that there is no particular difficulty in constructing a polyphase motor that will give any torque that can reasonably be asked, and with a starting current by no means disproportionate to the result obtained.

The next thing that comes up for consideration is the power factor which may be expected in polyphase motors. By the power factor we mean the ratio between real and apparent watts which measures the angle of lag introduced by the motor. It goes without saying that a high power factor is desirable both on the ground of requiring less current capacity in the lines and generators and on account of less inductance in the circuit, and consequently less trouble in keeping up the proper voltage. In motors of various designs the power factor is probably the point in which there is the greatest and most serious variation.

Fig. 5 gives three curves showing the variation of power

factor with load in three typical three phase motors. Curve A is the power factor of a 15-h. p. four-pole motor designed to run at 50 cycles. Curve B is from a 5-h. p. motor of closely similar design. Curve C is from another 5-h. p. motor it is 75 per cent., and in the other 79 per cent.

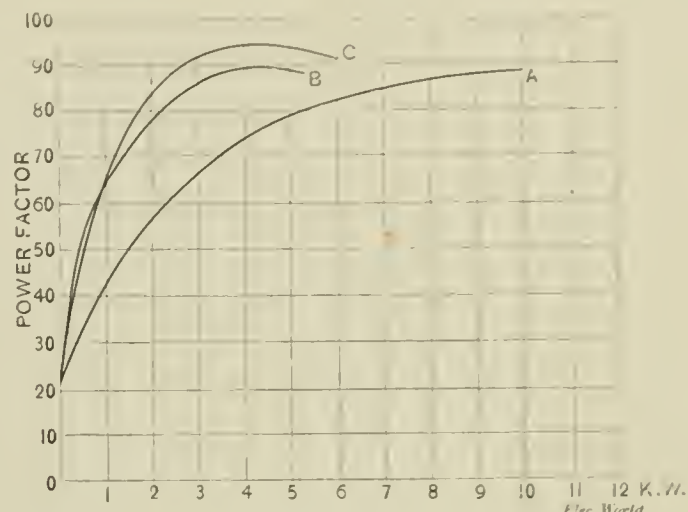


FIG. 5.

factor with load in three typical three phase motors. The last curve shows what may be accomplished by designing with special care for a high value of power factor.

Now the points to be noticed in these curves are the following:

First. That in all three motors at and near full load the power factor is closely in the vicinity of 90 per cent.—in curve C fully 94 per cent.

Second. The power factor even at half load is still good. In the 15-h. p. motor it is 84 per cent.; in one of the 5-h. p. motors it is 75 per cent; and in the other 79 per cent. In fact, the half load values for the power factor, as here shown, are greater than the full load power factors of European three phase motors which have been described up to date. The Dobrowolsky 5-h. p. three phase motor* has a full load power factor of but .68, while the power factor of a small Oerlikon motor (as described by Mr. Kapp from actual tests) is but 74 per cent. at full load. We must not, however, attach too much practical importance to very high power factors, for the reason that those shown in Fig. 5 are already within the range of first-class commercial work. Perhaps we may better investigate the relation of this power factor in actual operation by reference to Fig. 6, which shows the relative currents required at different loads by three sizes of three phase motors. Curve A is for a 5-h. p. motor, curve B for a 10-h. p., and curve C for a 15-h. p. For convenience we will call the ordinates total amperes required.

Suppose now we have a dynamo running an exclusively

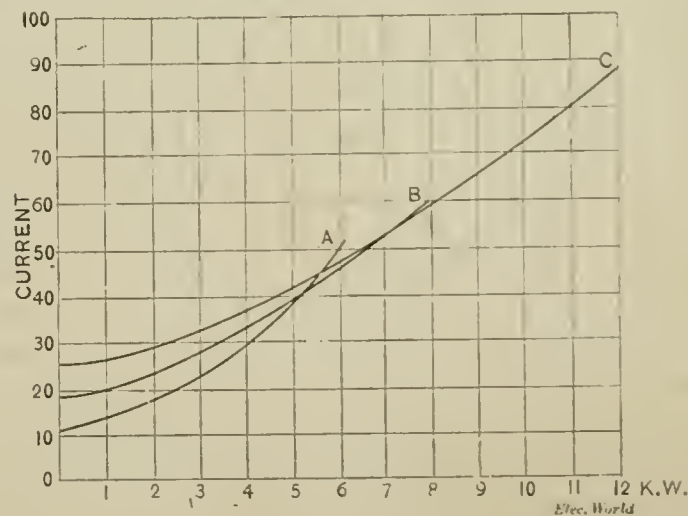


FIG. 6.

motor load composed of these three sizes of machines, and let us see what will be the actual conditions when the motors

*The Electrical World, April 22, 1893

are running fully and partly loaded. Let us suppose the load to consist of ten 15-h. p., ten 10-h. p. and twenty 5-h. p. motors running at full load. The current demanded (as by the curves on Fig. 6 for this combination) is 1,950 amperes, and the average lag factor will be at least 88 per cent., which could readily be raised to 90 per cent. if it were desirable to pay special attention to that feature of design.

At half load the aggregate current required would be 1,125 amperes—57 per cent. of the full load amperes—and the average power factor 81 per cent. Even at one-third load the condition of things is by no means as serious as it might be, inasmuch as the aggregate current is 890 amperes—45 per cent. of the full load amperes—and the power factor is still 72 per cent. The generator can readily take care of any of these loads without serious trouble from the lag introduced on the line, and even supposing that the total generator capacity be taken at 200 h. p. instead of 350, the aggregate capacity of the motors, it would still be able to operate all the motors at half or one-third load without unreasonable over-excitation on account of the lagging current, as may readily be perceived by reference to figures for excitation and the lagging current which I have previously given.

Of course it is possible to reduce the lag factor perceptibly by the employment of condensers, but it is certainly an open question whether so long as it is practicable to obtain power factors in the vicinity of 90 per cent., and even above it, without using condensers, the extra gain is worth the extra complication. There will certainly be some value of the power factor which it will not pay to increase by adding condensers—just what value it is hard to predict until condensers have come into more general use. Even if condensers be used, they will not necessarily bring up the power factors, at moderate loads, to any very startling figures.

(To be continued)

How Shall We Operate an Electric Railway Extending 100 Miles from the Power Station?

In a paper presented at the last meeting of the American Institute of Electrical Engineers Mr. H. Ward Leonard considered the question of operating an electric railway 100 miles from the power station. The assumption was made that there exists a very economical source of power, possibly a water power, so situated that the length of railway to be operated in either direction is 100 miles.

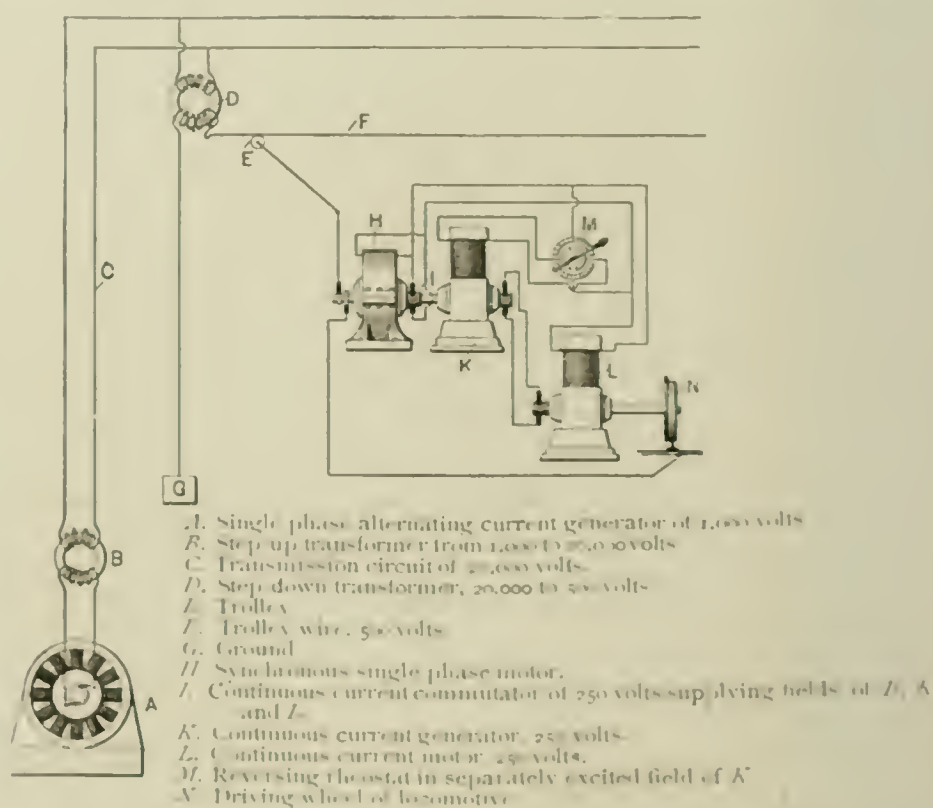
The following features seem desirable, if not essential, in such a railway: 1. A single trolley contact shall be used for supplying current to the locomotive. 2. The E. M. F. upon the trolley shall not exceed 500 volts. 3. There shall be no apparatus in motion and requiring attention between the power station and the locomotive. 4. No commutator, rheostat or controlling device on the locomotive shall be subjected to a higher E. M. F. than 250 volts, and there shall be no sparking on any of the apparatus under any normal conditions. 5. The entire control of the locomotive in either direction shall be effected by the movement of one lever. 6. The load shall be started from dead rest by an amount of energy taken from the source of supply which shall not exceed one-quarter of the energy required to operate at full speed on the level. 7. The retardation of the load in coming down grades, and in stopping, shall be effected by converting the motors into generators, which shall feed back current to the line, and thereby assist the power station in operating other locomotives. 8. The motors must be reversible when operating at full speed, without damage to the motors or other apparatus. 9. The efficiency of the system from power on the generator shaft to the drawbar pull of the locomotive shall be at least 50 per cent. 10. The

locomotive shall produce at least 500 h. p., when operating at a speed of 80 miles per hour.

For such great distances, in order to operate with a loss in conductors of 20 per cent., the initial E. M. F. must be 20,000 volts, in order to make the cost of copper \$20 per kw., which is about the best figure for cost of copper under the conditions. The alternating current must evidently be used, and as there is but one trolley contact, it must be single phased.

The system proposed, which is diagrammatically shown in the accompanying illustration, is briefly as follows:

Starting with standard 1,000-volt, single-phased alternators in the power station, the potential is raised to 20,000 volts by step-up transformers. At suitable points, say every two miles, the potential is transformed down to 500 volts. Now, with this current, a synchronous alternating motor can be operated, but cannot be regulated in speed, reversed, or started under load. It is evident that some form of gearing between the synchronous motor and the axle will solve the problem. Let the synchronous motor drive a



OPERATION OF LONG DISTANCE ELECTRIC RAILWAYS.

direct current generator and use the current thus generated to supply the motors connected with the axles of the locomotives. This portion of the system is the same as the well-known Leonard system, as applied to elevators. Regulation is secured by varying the field of the generator supplying the motors and by weakening, strengthening or reversing the field of this machine any desired speed or direction can be obtained. The continuous current generator should have its field separately excited. The propelling motors can be series, shunt or separately excited, but the best results will be obtained by separate excitation. To secure exciting current for the alternating motor and the fields of the continuous current generator and motor, it will be best to drive by means of the alternating motor armature, and if desired in the same field, a continuous current winding connected to a commutator, from which will be led the current for exciting the fields of all three machines. The fields should be wound for 250 volts, and this same voltage used for the continuous current armatures.

Suppose now the locomotive to be at rest. The synchronous motor is running and driving the generator armature at full speed in a field of no intensity; hence the propelling motors receive no current. The first contact upon the rheostat in the generator field circuit is now made, and let the resistance in the rheostat be such as to produce say 25 volts

at the generator brushes. This 25 volts will supply a very large current to the motor armature at rest in its saturated field, and consequently will produce a sufficient torque to start the entire load and continue to move it at a slow speed. There is now being used 25 volts and say 2,500 amperes in this circuit; this means 62,500 watts, and disregarding transformation losses for simplicity, this means a current of 125 amperes from the trolley. When operating at the rate of 500 h. p. at full speed there will be needed say 1,800 amperes and 250 volts in our propelling circuit, which is 450 kw., and means roughly 900 amperes from the trolley. It is evident, therefore, that the load can be started with but a small fraction of the energy required for operation at full speed, and that there will be no danger of throwing the alternator out of step by applying but one-sixth of its full load.

If operating at full speed, and it is desired to bring the locomotive to rest, the strength of the generator field is rapidly reduced by manipulating the rheostat in its field circuit, so as to reduce to zero the current exciting this field; the E. M. F. produced by the generator then rapidly falls below the counter E. M. F. of the motors, which are being driven in a constant field by the momentum of the moving load, and the motors consequently become generators and supply current to the former generator, which now becomes a motor, and driving the alternator, feeds current back through the trolley, thereby not only bringing the locomotive smoothly and rapidly to rest, but saving the energy usually wasted upon the brake shoes.

Under this arrangement, if steam engines are used as the source of power, the engines are not subjected to the violent fluctuations ordinarily met with in electric railways, and the capacity of the engines, generators and conductors can be much reduced over usual requirements.

Concerning a Change of Policy in the Administration of the Patent Office.*

BY PHILIP MAURO.

The views presented by the author are called forth by the announcement of a rumor that the present Commissioner of Patents had decided to inaugurate a change of policy in his office in the treatment of applications for patents where the margin of novelty is small or the exercise of invention doubtful. The old rule, unwritten, but tacitly recognized, has been when substantial doubt exists to give the applicant the benefit, and it is this rule which it has been said is to be reversed.

The particular point of inquiry is whether the examining corps of the Patent Office has been so lavish, lax and imprudent in the issue of patents, particularly where the novel improvement said to be patentable was of doubtful character, that the public interests have been detrimentally affected, and, if so, what are the particular evils that have resulted from this undue liberality and how far should the Patent Office shift its ground in either direction in order to avoid this? It is the author's belief that there is no ground whatever for the apprehension of damage to the public or to individuals by reason of undue liberality on the part of the patent examiners, and that the work of the bureaus, as a whole, has been characterized by fairness, just discrimination and due appreciation of the rights of inventors, with perhaps a leaning rather in the direction of the illiberality which of recent years has emanated from the bench. The only basis, the author states, for any opinion in regard to laxity in the Patent Office has been that many patents have been held void or illegal by the courts deciding that the subject matter was not patentable or did not rise to the dignity of invention or involve the exercise of mechanical skill. Mr. Mauro holds that, without depreciating the qualifications of

the judges, the patent examiners, as a rule, are better qualified to pass upon the patentability of inventions than Federal judges; that the question is one of fact, and a decision that a particular mechanical expedient or departure does not involve invention can have little or no effect or value beyond settling the question in that particular case, and therefore does not involve questions of law beyond expounding the meaning of the statute or declaring legal principles, as to which the voice of the court is the only authority that can be recognized. In the case of most of the patents which have been found void by the courts, new evidence, not accessible to or overlooked by the examiners, has been presented; so that in but a small number of cases can it be said that the decision of the latter has been reversed by the courts. The conclusion, therefore, is that decisions of this kind constitute no reflection upon the work or the judgment of the Patent Office, and no justification for any change of policy in the direction indicated.

The effect of illiberality would be to prematurely stifle and suppress what might be productive of benefit, and thus work injustice to meritorious inventors and at the same time injure the public by depriving them of the advantage accruing from the granting of a patent for the use of a novelty, however trivial, for it is by the accumulation of small changes that the industrial arts advance.

The vague nature of the term "inventive faculty" is referred to and the danger pointed out in requiring examiners to rigidly apply this test to inventions. It is argued that patents should be granted for what appear on the face even trivial inventions, as otherwise they would bury in the Patent Office what might be nurtured into something useful to mankind; and there is every ground for assurance that if the inventor succeeds commercially, the courts will be ready enough to take away his patent if his invention has not the magnitude thought necessary.

The tendency to trim down each patent to its narrowest dimensions is severely condemned. The grant of a patent to an applicant for more or other than he can sustain before the courts profits him nothing and deprives the community of no right. On the contrary, the failure of any inventor to secure a grant to the full extent of his right is occasion for profound concern. If by the exercise of unusual watchfulness and careful scrutiny the issuing of a few hundred worthless patents may be prevented, the result is creditable to the administration, but can hardly be regarded with satisfaction as to the practical benefit accomplished. The discovery and remedy of a single case of injustice would seem to be a far better basis for a claim upon public gratitude.

The author argues that the duty of the Patent Office under the law is to investigate and decide the novelty and utility of claims, and not to decide whether the inventive faculty has been exercised or not, and regrets the tendency developed quite recently in the latter direction. A tribute is paid to the Patent Office for the great service rendered to inventors through its elaborate investigations, to the end that they may not expend money and time in claiming things really old or really patented. The object and merit of the examining system is that it apprises inventors of the state of the art, and thus prevents them, not from imposing on the public, but from deluding and injuring themselves. If with the results of the examiners' researches before him and with but a slender margin of novelty remaining, the inventor risks the unfavorable judgment of the courts and is willing to pay a fee for a patent of doubtful value, the author can conceive of no possible reason why the Commissioner of Patents should interpose objections. The time consumed in searching for and studying decisions which serve only to cloud a subject already hopelessly obscure could more profitably be employed in those searches for novelty for which the office was created, and for which, out of the pockets of inventors, the Commissioner and examiners are paid.

*Abstract of a paper read at the 84th meeting of the American Institute of Electrical Engineers, Feb. 21, 1894.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE
PRINCIPAL FOREIGN
ELECTRO-PHYSICS.

ELECTRICAL JOURNALS.
BY CARL HERING.

Dielectric.—A description of several pieces of apparatus made with this insulating material (see Digest March 3), which is made of a mixture of sulphur and paraffine, is given in "La Lum. Elec.," Feb. 10. An electrophore, 8 inches in diameter and 1 inch thick, gave a spark of over 3.4 inch, and when once charged retained its charge for a long time; the material can be readily worked and polished, and even admits of having screw threads cut into it.

Conversion of Light into Sound.—The "Zeit. fuer. Elek.," Feb. 1, mentions a patent for an apparatus resembling the Bell radiophone, in which an intermittent beam of light, focussed on a glass vessel containing lampblack, produces audible notes; Mercadier has attempted to use this apparatus for a multiple telegraph system.

Thermo-electric Diagram for Pure Metals.—A paper by Mr. Steele is published in the "Phil. Mag." for February; he claims that the results published by Prof. Tait, which have been accepted as the most reliable, are not quite correct; a diagram of the connections and the results of the tests are given.

Propagation of Electricity.—The January number of the "Bul. de la Soc. Int. des Elec." mention an Academy paper by Mr. Poincare, in which he starts with the so-called telegraphic equation between the self-induction, the resistance and the capacity and deduces mathematically the form and the velocity of the perturbation.

Velocity of Propagation of an Electric Perturbation.—An abstract of Mr. Blondlot's paper is given in the Foreign Abstracts of the Institution of Civil Engineers.

Speed of Propagation of an Electric Disturbance.—The paper by Mr. Blondlot, mentioned in the Digest some time ago, is abstracted briefly in the Lond. "Elec. Rev.," Feb. 23, the illustration being also given.

Reflection of Electric Waves.—An illustrated communication by Messrs. Burkland and Sarasin is given in the "Phil. Mag." for February.

Calculation of Electromagnetic Forces.—"La Lum. Elec.," Feb. 10, reprints an abstract of a paper by Mr. Vaschy, in which he shows how the expressions in his former paper can be simplified considerably by the introduction of two fundamental relations.

Theory of Electromagnetic Phenomena.—Mr. Vaschy's mathematical paper, in which he gives a method of explaining electric phenomena independently of any hypotheses, is published in full in the January number of the "Bul. de la Soc. Int. des Elec."

Similarity Between Electric and Magnetic Fields.—"L'Elec.," Feb. 17, reprints a Physical Society paper by Mr. Curie on this subject.

A Fundamental Formula for Magnetic Induction.—The "Elek. Anz.," Feb. 15, reprints an article by Mr. Schwartz on this subject.

Photographing the Spectrum of Lightning.—The Lond. "Elec. Rev.," Feb. 23, describes briefly a method of Mr. Meyer in "Wied. Ann.," volume 5, page 416, in which he

uses a diffraction grating instead of a spectroscope; the method has been used with some success.

Capacity of Condensers for Alternating Currents.—The Lond. "Elec.," Feb. 23, abstracts briefly the article by Dr. Sahulka, mentioned in the Digest Jan. 20.

Electromagnetic Properties of Parallel Conductors.—An article by Mr. Steinmetz is abstracted in the Foreign Abstracts of the Institution of Civil Engineers.

Electricity of Drops.—The Lond. "Elec.," Feb. 23, abstracts very briefly a paper of Prof. J. J. Thomson on this subject.

MAGNETISM.

Magnetic Field in a Cylindrical Coil.—Prof. Minchin's Physical Society paper on the calculation of the magnetic field of a current running in a cylindrical coil is published in the "Phil. Mag." for February.

Magnetization by Very Small Forces.—The Lond. "Elec. Eng.," Feb. 23, abstracts briefly a paper of Mr. Culmann in the "Elek. Zeit.," and mentioned some time ago in the Digest.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Resistance Box for High Voltage Currents.—An illustrated description is given in the "Elek. Zeit.," Feb. 15, of the Edelmann resistance box; it consists of 10 coils of 10 ohms (?) each, and is intended for alternating currents of 3,000 volts; the coils are, as usual, connected in series and end in a row of contact blocks, which may be connected to a bar by means of a pair of plugs connected together by a rubber covered, flexible wire; two pair of plugs are used, so as to avoid opening the circuit when changes are made.

Curved Scale of Galvanometers.—The "Elek. Zeit.," Feb. 22, gives an illustrated description of a scale for a reflecting galvanometer made of celluloid and carried in a frame which enables it to be bent to the arc of a circle of any desired radius, the correction due to the use of a flat scale is then no longer necessary.

Influence Machine.—According to "La Lum. Elec.," Feb. 17, Dr. D'Arsonval described before the International Society the improvements of Mr. Bonetti, consisting in abolishing the sectors and in the addition of two new brushes; tests of two machines showed that the output is increased from three to four times and the reversing of polarity is not to be feared; it then becomes necessary to charge the machine, but this is easily done by placing the finger at any point near the circumference of one of the external plates; it is also easily reversed by a similar process. He states that Mr. Wimshurst has now adopted these improvements in his machine.

A New Form of Induction Balance.—The "Jour. of Inst. Elec. Engs.," for February contains the abstract of a paper by Mr. Wien; the arrangement consists of a Wheatstone bridge, two arms of which are coils having self-induction and the other two inductionless resistance; a piece of metal brought near one of the coils disturbs the balance, which is restored by the adjustment of a secondary coil inside the

other coil, the time constant of the metal piece being equal to that of the compensating secondary coil.

Induction Apparatus.—In the "Elec. Tech.," Feb. 15, Dr. Krieg gives an illustrated description of a simple method of constructing induction coils.

Potentiometer for Alternating Currents.—Mr. Swinburne's method, mentioned in the Digest Jan. 6, is described in the "Phil. Mag." for February; two cuts are given.

Instruments for Measuring Resistance.—In their serial in the Lond. "Elec. Eng.," Feb. 23, Messrs. Niblett and Ewing describe briefly the Wheatstone bridge with earth return.

Testing the Magnetic Qualities of Iron.—The Lond. "Elec. Eng.," Feb. 23, reprints an Institution paper by Dr. Kapp, in which he describes a practical apparatus for testing iron in dynamos and transformers. A cut is referred to, but not given, and we will defer making the abstract, as the cut may be published in some of the other journals next week.

The Mance Method for Determining the Internal Resistance of Accumulators.—In "La Lum. Elec.," Feb. 17, Mr. Perrin gives a mathematical discussion of this method, showing why it is often unsatisfactory, and suggests an improvement in which a resistance is placed in series with a galvanometer and in which the battery is also connected to a separate resistance representing its normal load, so that the measurement is made under the normal working conditions.

Measuring Apparatus.—In the "Jour. Teleg.," Jan. 25, Dr. Tobler describes a number of the newer forms of measuring instruments used in telegraphy.

Measuring the Power in Three-Phase Circuits.—Dr. Froelich's article is abstracted briefly in the Foreign Abstracts of the Institution of Civil Engineers.

Calculating the Coefficient of Self-Induction.—"L'Elec.," Feb. 10, reprints an Academy paper of Mr. Potier; it is of a mathematical character and refers to one particular case.

Absolute Measurement of the Flow of Electricity from Points.—An article by Mr. Precht on this subject is abstracted in the Foreign Abstracts of the Institution of Civil Engineers.

Mechanical Equivalent of Heat.—An abstract of Mr. Blondin's paper (see Digest Sept. 16 and 23) is given at some length in the February number of the "Jour. Inst. Elec. Eng.,"

Resistance of Pure Copper Wire.—Mr. Lagarde's article, mentioned in the Digest, is abstracted in the "Jour. Inst. Elec. Eng.," for February, in which two tables of constants are given.

Conductivity of Certain Solutions.—The "Elek. Zeit.," Feb. 22, abstracts briefly a paper by Mr. MacGregory from the "Wied. Ann."

Theory of Units.—In a Presidential address by Mr. Francken, published in "Bul. de l'Assoc. des Elec. Montifiore" for February, he discusses at considerable length the subject of units.

DYNAMOS AND MOTORS.

Alternating and Multiphase Currents from Continuous Current Armatures.—In the first part of an article by Mr. Friese in the "Elek. Zeit.," Feb. 15, he discusses systematically and clearly the E. M. Fs. obtained when a continuous current armature is provided with sliding contact connections for delivering alternating or multiphase currents of any number of phases. He assumes that the sums of the E. M. Fs. in the successive windings, when used as a continuous current machine, give a true sine curve, and that there is no phase difference between the current and the E. M. F., which would be the case in using it for incandescent lamps. Assuming that the E. M. F. for continuous currents is E , then if two diametrically opposite points are connected to sliding contacts, a simple alternating current will be obtained whose period is

equal to the number of revolutions and whose E. M. F. will be equal to $0.707 E$; the armature will then consist of two halves in parallel; if by a cross connection they be connected in series, the E. M. F. will be equal to $1.414 E$ but forming in that case an open circuit armature; returning to the closed circuit armature, if 4 connections be made at 90° , the two currents, each from two diametrically opposite points, will each have an E. M. F. equal to $0.707 E$, the phase difference being 90° ; if each pair of connections 90° apart be used, a four-phase current will be obtained, the effective E. M. F. of each of which will be equal to $0.50 E$; if three currents 120° apart are used, the effective E. M. F. will be equal to $0.612 E$; for five-phase currents, $0.416 E$; for six-phase currents, $0.3526 E$; for eight-phase currents, $0.271 E$, and for twelve-phase currents, $0.183 E$. He also gives a general equation, a table of the results, an experimental verification and a graphical method for determining these constants.

In a continuation of the article in the issue of Feb. 22 he gives similar figures for open circuit armatures—that is when the armature is divided into separate portions, the beginnings of which are all connected to a common point—but the figures refer to the voltage between successive ends, and not to this common point unless so stated. For four portions and two circuits (two diametrically opposite portions connected in series), giving a two-phase current, the E. M. F. will be equal to $1 E$. It is immaterial whether the circuits are connected to a common point or not, but if so, the voltage between this point and the end of a circuit is $0.5 E$; for a three-phase current the voltage is $1.06 E$, and from the common point $0.612 E$; for four-phase currents, $0.707 E$, and for the common point, $0.5 E$; for five-phase currents, $0.489 E$ and $0.416 E$; for six-phase currents, $0.3536 E$, which is the same whether taken at this end of the winding or between the ends and the common point; furthermore, in this case there is no difference between the closed circuit and the open circuit connection; for eight-phase currents, $0.2075 E$ and $0.271 E$; for twelve-phase currents, $0.0947 E$ and $0.183 E$. In conclusion he gives the general formula and the graphical solution; the article is to be continued.

Iron for Armatures.—The Lond. "Elec.," Feb. 23, in an editorial discusses unfavorably the recent paper of Mr. Schultz, abstracted in the Digest Jan. 20, in which he showed that paper insulation between armature discs was useless; the editorial concludes from this that it is useless to laminate the iron at all and questions the results. (In this editorial the conclusions appear to be entirely wrong, as the question which Mr. Schultz decided had reference to insulation and not to lamination, and he states it definitely; no one, and especially not Mr. Schultz, would for a moment suppose that it was futile to laminate the iron; he shows, in fact, that it is very necessary to do so; as we understand it, he has shown that the contact resistance between the plates forms sufficient insulation, therefore making the paper useless; nowhere in the original article is it even inferred that it is futile to laminate the iron, and this editorial is, therefore, very misleading.)

Dynamo Design.—Mr. Edgcumbe, in a practical article in the Lond. "Elec. Rev.," Feb. 23, describes the calculation of a dynamo by working out an actual example for a small series machine; (although the calculations are of a simple nature, he assumes a number of different dimensions and figures, which one who has not had considerable experience with dynamos might not be able to do); he first calculates the total number of lines, and from this the cross-section of the armature core, then the number of layers, then the magnets and their winding, and finally the losses; he shows how the calculations will differ in the case of a shunt ma-

chine and in the case of a motor; in conclusion, he gives very briefly several tables which simplify such calculations. Among the constants which he gives are the following: For the density in the armature, 8,000 lines per square centimetre; for the field cores, 10,000; for magnetic leakage, 20 per cent. loss for a two-pole horseshoe type with drum wound armature; for calculating the hysteresis losses by the Steinmetz formula he assumes the constant 0.004; he ignores the loss due to eddy currents, which are small.

A Difference Between Dynamoes and Motors.—The "Elek. Zeit.," Feb. 15, publishes a paragraph forming an addition to the article abstracted in the Digest last week; it gives the results of a test showing experimentally that the shifting of the brushes is much greater, in this particular case more than twice as great, when used as a generator than when used as a motor.

Starting Resistance for Motors.—A device by Siemens & Halske is illustrated in "L'Elec.," Feb. 3; it consists of two carbons, like an arc lamp, the upper one being moved up by a solenoid, which, with the arc, is in series with the motor; on starting the motor an arc will immediately be formed, which, as the motor comes up to speed, will be diminished and finally extinguished, the normal current for the motor not being sufficient to draw the carbons apart.

Irregularities in the Action of Dynamos.—The translation of this article is concluded in the Lond. "Elec. Rev.," Feb. 23; in the same issue Mr. Slater discusses the article unfavorably.

Dynamo Attendants and Their Dynamos.—The serial by Mr. Gibbings is continued in the successive numbers of London "Electricity."

Electrically Driven Lathe.—In the "Elek. Zeit.," Mr. Schultz gives a well illustrated description, including working drawings and a full view, of a lathe driven by an electric motor; the motor is under the lathe below the tool rest, and drives the spindle by means of a variable friction gear and toothed gearing; the motor runs at a constant speed, the only resistance required being that for starting.

Transportable Electric Pump.—The "Elek. Echo," Feb. 3 gives a short illustrated description of a pump made in Germany.

Dynamos for Lecture Purposes.—The "Elek. Rund.," No. 9, illustrates a number of different forms in a full-page illustration.

Patin & Locomotor Dynamo.—"L'Elec.," Feb. 10, gives a well illustrated description of this dynamo, which consists essentially of eight radial magnets forming the armature, each of which is connected in five successive parts to as many commutator bars; the magnets appear to form the smaller part of the whole magnetic field.

Carl-Helmer Alternator.—The description from the French is abstracted at some length in the Foreign Abstracts of the Institution of Civil Engineers.

ARC AND INCANDESCENT LIGHTS.

Arc Lamps on Constant Potential Circuits.—In "L'Elec.," Feb. 3, Mr. Leroy discusses this subject by means of a diagram and shows that in the case of a single lamp the arc is stable only for a certain fixed resistance in series with the lamp, and the lamp should therefore not be adjusted for candle power by varying the resistance placed in series with it; in discussing two lamps in series, he shows how each is dependent on the other, and concludes that as there is only one condition under which they will run normally, only those carbons should be used for which the constructor has adjusted the lamp, and after the resistance has been once adjusted it should never be altered; he also calls attention to the importance of properly adjusting the carbons in their holders.

Street Lighting.—In an editorial on this subject the Lond. "Elec.," Feb. 23, compares gas, arc and incandescent lighting; it concludes that where electric energy costs less than 8 cents per kilowatt hour and gas costs 62 cents per thousand cubic feet, or in this proportion, the competition of incandescent lamps with gas lamps becomes practicable; it estimates that, light for light, the cost of the incandescent light is, roughly, six times that of the arc; it does not recommend diffusers, but thinks that the use of small arc lamps has not been given a fair trial, and suggests the use of 5 and 6 ampere arc lamps, with large positive and small negative carbons, run in series of 5 on the outer wires of a three-wire system.

Search Lights on the Manchester Canal.—The Lond. "Elec. Eng.," Feb. 23, mentions, but does not describe, a powerful search light, making night navigation possible; it is said to cause no inconvenience to vessels coming in the opposite direction, but it does not describe how this is accomplished.

Parabolic Reflectors.—"La Lum. Elec.," Feb. 10, gives an illustrated description of the Schuckert apparatus for making these reflectors.

Projecting Lamp.—An illustrated description is given in the "Elek. Echo," Feb. 3.

Properties of the Alternating Current Arc.—The experiment of Mr. Claude, mentioned in the Digest last week, is described more in detail, with the aid of three illustrations, in "La Lum. Elec.," Feb. 10.

Alternating Current Arc.—The investigation of Mr. Blondel, abstracted in the Digest last year, is abstracted in the Foreign Abstracts of the Institution of Civil Engineers.

Arc Lamps.—In Mr. Richard's serial in "La Lum. Elec.," he describes and illustrates a number of arc lamps and appliances.

Cored Carbon Litigation.—The "Elek. Rund.," No. 9, contains a note on this subject.

Arc and Incandescent Lamps.—Mr. Baineville's article, mentioned in the Digest Sept. 23, is abstracted briefly in the Foreign Abstracts of the Institution of Civil Engineers.

Multiple Filament Lamps.—Mr. Leconte, in "L'Elec.," Feb. 17, shows that this form of lamp was first patented in France in the year 1883.

Contact Lamp.—"L'Elec.," Feb. 3, gives an illustrated description of the Schroeder lamp, in which a carbon rod is fed upward by means of mercury against a piece of iridium.

TRANSMISSION OF POWER.

Power Transmission in Norway.—According to the Lond. "Elec.," Feb. 23, it has been proposed to transmit some 20,000 h. p. from two waterfalls to Christiania, a distance of about twenty-five miles; the voltage will not exceed 20,000, and the idea is to use bare wire on poles carefully guarded along their whole length; in the city it will be reduced to 100 and 400, and is to be used for power in the different industrial establishments, both large and small, for street railways, local railways and local steamers; also for lighting the city; it may be completed before the end of 1895; the estimated cost is about one and one-half million dollars.

Transmission of Power at Niagara Falls.—The complete paper of Prof. Forbes, together with the discussion, is given in the February issue of the "Jour. of the Inst. of Elec. Eng.," a number of the illustrations appear to be published here for the first time.

ELECTRIC RAILWAYS.

Helmann Locomotive.—The Lond. "Elec. Rev.," Feb. 23, discusses this system; after ridiculing it, it does not agree that the reciprocating parts are abolished; it claims that 100 miles an hour, which has been obtained in America with ordinary locomotives, can also be obtained and with greater

safety by English locomotives; the unbalanced counterweight can be gotten rid of entirely by the use of three cylinders, the central one having moving parts of double the weight of each of the outer ones; it thinks too much stress is put upon the adhesion, as it is only at low speeds that a single pair of drivers is insufficient; every claim regarding the advantage of having no direct connection between the engine and the driving wheels, it states, could also be had with less loss of efficiency by a system of rope driving.

According to "L'Elec.," Feb. 10, a weight of 530 tons, including the locomotive, was started on a curve of about 400 feet radius, and it is claimed that 630 tons, not including the locomotive, can be started if the eight motors are connected four in series. Mr. Lea, in the Lond. "Elec. Eng.," Feb. 23, gives a vertical cross-section of the high speed vertical exciting engine.

Proposed Alpine Electric Road.—According to the "Elek. Zeit.," Feb. 22, it is intended to build an electric road from the Scheidegg to the top of the Jungfrau, one of the highest and most magnificent of the snowclad Alps; (the greater part of this road would be above the eternal snow line); owing probably to the frequent avalanches, a great part of it will be in tunnels or half tunnels, as on the well-known Axenstrasse; the road will terminate on a plateau free from snow, almost 14,000 feet above the level of the sea and about 200 feet below the top; for this last portion there is to be an elevator; the total length is about 7 1/2 miles; the power for the current is to be furnished by the mountain streams; the first portion of the road is to be finished in two years, and the rest in the following two years; it is to cost one and one-half million dollars; a neighboring water power of 1,840 h. p., it is thought, will be sufficient.

Rules and Regulations.—The Lond. "Elec.," Feb. 23, gives, in a parallel column form, the proposed Board of Trade regulations, with the suggested alterations and the source of such suggestions; the Lond. "Elec. Rev.," Feb. 23, gives a short abstract of a meeting at which they were discussed; the Lond. "Elec. Eng." discusses the subject editorially. We will reserve our abstract until further action is taken regarding their adoption.

Welding Rails.—According to "La Lum. Elec.," Feb. 17, 1 kilowatt is required per square centimetre during six minutes, and as the rails used in France do not exceed 60 square centimetres in cross-section, the cost of one welding is 82 cents, the price of the energy being taken at 10 cents per horse power hour.

Underground Sectional Railway.—"La Lum. Elec.," Feb. 10, mentions, but does not describe, a system of Mr. Chabault, which was recently tried in Marseilles, in which an underground conductor is connected by the car to insulated sections of a surface conductor as it passes over them.

Genoa.—"La Lum. Elec.," Feb. 10, reprints a description from the Italian of the electric railway installed by Siemens & Halske, some of the features of which differ materially from the practice in this country; the article includes eight illustrations.

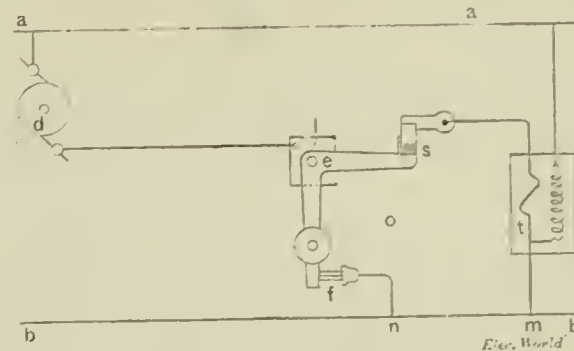
Remscheid Railway.—An illustrated description is begun in London "Electricity," Feb. 23.

Railways.—Mr. Richard's well illustrated serial, taken apparently from patent specifications, is continued in "La Lum. Elec.," Feb. 17, most of the descriptions being of American inventions.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Switches.—The Lond. "Elec.," Feb. 23, calls attention to a number of new switches and other appliances of the English Brush company, illustrating and describing a return current fuse, intended to render the parallel working of alternators perfectly safe; as the fuse melts only with the return current, but not with the current transmitted from the alternator, it will thus cut out the faulty alternator, when sev-

eral are in parallel, and not those which are not faulty, in which it differs from the simple fuses; the device is shown in the adjoining cut; *f* is the fuse, *e* a lever switch and *t* the



RETURN CURRENT FUSE.

accelerator, consisting of a small transformer; at *e* the current divides before going to the main *b*; the accelerator increases the voltage about half a volt, which is sufficient to induce the current to select that path in preference to that through the fuse, but if the current returns from the mains to the alternator, the accelerator acts as a retarder and forces the current through the fuse.

Switch for Explosive Surroundings.—The Medhurst switch is illustrated in "L'Elec.," Feb. 3; the contact is made by means of mercury or shot in the inside of a hermetically sealed vessel which can be turned on its axis.

Utilization of Small Waterfalls.—An article from the French by Mr. Chedeville is abstracted in the "Jour. Inst. Elec. Engs.," he shows the advantages of storing the water in a reservoir and gives an example in which the waterfall utilized directly would light 75 lamps of 16 c. p., while if stored in a reservoir 25 times the number can be run during six hours in winter and two hours in summer; if stored in electric accumulators only seven times the amount can be obtained.

Bournemouth Accident.—The Lond. "Elec. Rev.," Feb. 23, discusses this accident, in which the current which killed a horse must have come directly from the ground and gone into the ground again; attention is called to the fact that although the megohm resistance of a wire may be high, yet the thickness of insulation may leave no margin of safety; it has been recommended by the government inspector that the insulation of high tension leads should not be less than one-tenth inch in thickness and that the enclosing pipes should all be connected together and earthed; the result of the inquiry shows that for high voltages concentric mains are distinctly preferable to and safer than parallel cables.

Balancing a Three-Wire Station with Only One Machine.—In the Lond. "Elec. Rev.," Feb. 23, Mr. Gibson describes and illustrates a system in which a single armature containing two windings and two commutators is used together with accumulators; by means of the station lamps either of the batteries can be charged independently of the other and at any desired rate, while the voltage of the mains is balanced with the battery.

Rotating Field Apparatus.—Mr. Blondel's mathematical paper on the elementary theory of such apparatus is continued at considerable length in "La Lum. Elec.," Feb. 10, and concluded in the issue of Feb. 17. In this article he has discussed polyphase currents and rotating fields in general, and indicated what appears to be a new and complete method of calculation; in a table in the conclusion he gives some comparative figures regarding the weight of copper, loss of energy, etc., for a number of different conditions.

Multiphase Currents.—An article by Mr. de Chasseloup-Laubat is published in the Foreign Abstracts of the Institution of Civil Engineers; he shows, among other things, how the intensity of the field, the mechanical working done by the armature, the losses, self-induction, etc., may be calculated.

Pollak Rectifier.—The "Elek. Zeit.," Feb. 22, gives a short, well illustrated description of this apparatus, which has already been described in these columns; its efficiency is given by the inventor as 99 per cent.

Ferranti Rectifier.—The Lond. "Elec. Eng.," Feb. 23, mentions that the apparatus of Mr. Ferranti is now being made and tried with a view of introducing it in Cardiff for arc street lighting.

Fuses for High Tension Circuits.—The "L'Elec.," Feb. 3 gives an illustrated description of the Webber & Nisbett fuse, in which the wire is wound spirally around a non-conductor and enclosed in a tube, the whole being conveniently arranged for placing it in circuit.

Tram Lighting.—In the "Bul. de la Soc. Belge," for August-September-October, Messrs. Dery & Weissenbruch give, at considerable length, an illustrated description of existing installations, both in Europe and America; the question of costs is reserved for a subsequent article; this forms probably the best summary on this subject.

A long paper by Mr. Grawinkel and its discussion, on the electric lighting of the German mail cars, is reprinted in full in the "Elek. Zeit.," Feb. 22; he describes the installation and gives a diagrammatic drawing of the switchboard.

Installations.—The "Elek. Zeit.," Feb. 15, notices at some length a recent publication of the German Electric Company prepared for those who intend to instal plants; the first part is devoted to a discussion of the general principles and the second to a general guide for making approximate calculations of the cost, both parts including lighting and transmission of power plants.

Regulations for Installations.—The "Elek. Zeit.," Feb. 15, publishes a recent discussion of this subject in the Engineering Society in Hamburg.

Advantages and Disadvantages of Alternating Currents.—Mr. Snell discusses this subject in his serial on motive power in the Lond. "Elec.," Feb. 23.

Lighting from Primary Batteries.—In the "Elec. Tech.," Jan. 31, Mr. Wagner discusses the requirements, but gives nothing new.

Berlin.—The "Elek. Zeit.," Feb. 15, gives a brief summary of the electric lighting in that city for April 1, 1892, and April 1, 1893; the consumption of gas decreased about one million cubic metres, while the increase in the electric light was considerable; the number of private installations operated by steam engines diminished about 50 per cent., while those driven by gas motors increased almost 50 per cent., and in 1893 were more than double those driven by steam engines; the total number of arc lamps in the two years were 8,020 and 8,800, showing an increase of 780 lamps; incandescent lamps (presumably 16 c. p.), 140,276 and 172,067, an increase of about 32,000 lamps; the equivalent of all the electric lights in gas lamps is estimated at about 225,189.

A brief description of several of the Berlin stations is given in the "Bul. de la Soc. Belge" for August-September-October.

London.—Major General Webber's paper is continued in the English journals of Feb. 23; it includes a number of cuts illustrating various systems of underground conduits; the Lond. "Elec." contains a few more cuts than the other journals.

London Central Stations.—The Lond. "Elec. Rev." and "Elec. Eng.," Feb. 23, give the accounts of several stations in Great Britain; the Lond. "Elec. Eng." in its advertising pages, gives an analysis of the Board of Trade returns.

Paris.—A full page illustration of an interior view of the Halles station in Paris is given in the London "Electrical Plant" for February.

Electrical Industry in the United States.—Mr. Brunswick's serial in "La. Lum. Elec.," is continued in the issue of Feb. 17; it includes a full-page table of statistics for a number of the principal cities of the United States, giving the number of arc and incandescent lamps, the power, capital and the names of the systems; also another full-page table, giving the data for a number of different installations in reference to meters, their capacity and the method of payment, etc.

Multiphase Current Systems.—"Ind. and Iron," Feb. 16, in an editorial calls attention to a patent of Mr. Frank Wynne, September, 1886, which it believes was the first "multiple current system" (by which term is apparently meant what is here called multiphase system); the machine is described as being similar to a Brush dynamo with collector rings, thus delivering separate alternating currents of different phases; these were led to different points and transformed down to a low pressure, after which they were passed through a commutator driven by a synchronous motor, thus producing direct currents of low pressure; it believes that such a system is better in most cases than the employment of multiphase motors.

Electric Lighting Statistics.—The "Elek. Rund.," No. 10, contains an article by Mr. Paisler, in which he gives some statistics for cities in Germany and England.

Erding.—An abstract of the description of this three-phase station is given in the Foreign Abstracts of the Institution of Civil Engineers.

St. Pancras.—The Lond. "Elec. Rev.," Feb. 23, in an editorial discusses unfavorably the recently published description of this station.

Nottingham.—The Lond. "Elec. Eng.," Feb. 23, gives a brief description of this station with a number of large illustrations, limited entirely to the architectural features.

Bockenheim.—An abstract from the French of the description of this polyphase station is given in the "Jour. Inst. Elec. Engs." for February.

Darmstadt.—The "Elek. Zeit.," Feb. 22, abstracts at some length the accounts for this station.

Automatic Gas Engine Starter.—A description of the Niel starter, taken from "Genie Civil," is given in "La Lum. Elec.," Feb. 17, including an illustration.

Solidified Petroleum as a Fuel.—The Lond. "Elec.," Feb. 23, abstracts from a French journal a method of making fuel bricks of crude petroleum.

Combustion Without Smoke.—"L'Elec.," Feb. 10, gives an illustrated description of the Baumert & Wegner system.

Direct vs. Rope Drang.—The discussion in the Lond. "Elec. Rev." is continued in the issue of Feb. 23.

WIRES, WIRING AND CONDUITS.

Rules and Regulations for Ship Lighting.—In a second article of Mr. Kennedy in the Lond. "Elec. Rev.," Feb. 23, he discusses fittings, giving illustrations of a faulty form as often used, and two other forms, one for single and one for double wiring, which, though more expensive, are much safer, and have other advantages; he criticises the absurdity of the rules which require the mains to be kept a great distance apart, but permit the branch wires to be brought very close together, with little protection from each other in the fittings; rules ought to make it impossible to adopt a bad system and should insist on the use of properly constructed junction boxes, switches, fuses and fittings; joints should be reduced to a minimum and fittings should be made so that they can be taken down and put up without making any joints.

Wiring on Shipboard.—The Lond. "Elec. Rev.," Feb. 23, under the heading of "Jerry Wiring for Ships," gives a number of interesting illustrations of actual specimens of wiring found on board of some ships.

Regulations Regarding Electrical Conductors.—“L'Elec.,” Feb. 3, publishes the proposed laws regarding conductors; they are also given in “La Lum. Elec.,” Feb. 10.

Explosions in Manholes.—The Lond. “Elec.,” Feb. 23, suggests, in an editorial, an instrument to measure the percentage of hydrogen in a manhole without lifting the cover, and based on the high rate of diffusion of light gases through porous partitions.

Underground Conduits in London.—In the portion of Major General Webber's paper published in the English journals, Feb. 23, a number of cuts are given of the systems used in London.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telegraphy Between England and India.—The Lond. “Elec. Eng.,” Feb. 16, gives a brief abstract of Mr. Walker's paper, mentioned in the Digest last week.

Railroad Signals.—The “Elek.,” Feb. 8, reprints from the London “Engineer” of July 29 an illustrated description of the Sykes system, in which the signals are moved in both directions.

Review for 1893.—The “Jour. Telegraphique,” Jan. 25, gives a review of the telegraph and telephone for the past year, including a number of comparative tables.

Telegraph and Telephone Line Construction in Germany.—An abstract of the article of Mr. Kohlman is given in the Foreign Abstracts of the Institution of Civil Engineers.

Telegraphy Between England and India.—Mr. Walker's paper is abstracted in the Lond. “Elec. Rev.,” Feb. 23, and is discussed in a short note in the same issue, and in a long editorial in “Ind. and Iron,” Feb. 23; the Lond. “Elec.,” Feb. 23, publishes a report of the discussion.

Telegraphs of Queensland in 1892.—An article on this subject is given in the “Jour. Teleg.,” Jan. 25.

Long Distance Telephone.—The Brown Telephone is illustrated and described in “La Lum. Elec.,” Feb. 17.

Telegraphs and Telephones in Spain.—The “Jour. Teleg.,” Jan. 25, gives a summary of the years 1890 and 1891.

Electrical Wakening Apparatus for Hotels.—In the “Zeit. feur Elek.,” Feb. 1, Mr. Vianen describes, with a full-page illustration, an apparatus for hotels for sounding an alarm in any desired room at any desired time.

Bells for Damp Places.—“L'Elec.,” Feb. 3, illustrates the Hoffmann bell, in which both the magnet and the contact are in hermetically sealed cases, the latter having a flexible diaphragm, through which the vibrator is operated by the clapper.

Railway Signals.—The Daves signal is illustrated and described in “La Lum. Elec.,” Feb. 17.

Train Signals for Single Lines.—The Mene process is described and illustrated in “La Lum. Elec.,” Feb. 10.

ELECTRO-CHEMISTRY.

Purification of Sewage.—Mr. Hermite estimates that it would cost \$12,000,000 to change the present system in Paris to the one devised by himself.

Extraction of Zinc.—The Lond. “Elec. Eng.,” Feb. 23, mentions, but does not describe, a process tested in Sweden, giving satisfactory results and described in “Engineering”; the main feature is that it can be applied to ore of very poor quality, like sulphur ore, the metal being equal to the best zinc in the market.

Iron Ore Extracting Process.—“Ind. and Iron,” Feb. 23, mentions, but does not describe, the De Laval process, which is to be tried in Sweden, the current for which is to be supplied from a waterfall; the process is already spoken of as likely to effect a revolution in the Swedish iron industry.

Electrolysis of Chloride of Sodium.—The apparatus for the Cutten process is described and illustrated in “La Lum. Elec.,” Feb. 10.

Liveing Electrolyzer.—From an illustration in “La Lum. Elec.,” Feb. 17, the anodes are made of blocks of carbon placed in a closed vessel with a perforated bottom, contact being made with a carbon plate from their top surface held there by pressure.

Diaphragm.—Mr. Waite, in the “Zeit. feur Elek.,” Feb. 1, describes an improved diaphragm made of asbestos, the pores of which contain gelatine; it is intended to be used in the electrolysis of alkaline salts.

Electrical Inlayer in Metals.—The “Elec. Tech.,” Jan. 31, describes a process in which the metal is first etched and afterward filled in with another metal by electrolysis.

Galvanoplastic Apparatus.—The article in the “Elec. Tech.” is continued in the issue of Jan. 31.

Clubbe & Southey Accumulators.—According to “La Lum. Elec.,” Feb. 10, the positive plates are made of active material lying horizontally in perforated trays, and containing a conductor in the middle; negative plates rest on top of these, separated by insulators.

Raab & Bastian Accumulator.—According to “La Lum. Elec.,” Feb. 10, the electrodes consist of vertical rods of a star shaped cross-section enclosed in cylinders having numerous openings, thus preventing the active material from falling off from the electrodes.

Accumulators.—In an elementary article by Mr. Duerler in the “Elec. Tech.,” Jan. 31, he attributes the discovery of the secondary reaction of lead in sulphuric acid to Sinstedden in 1854.

Hellesen Dry Cells.—A good illustrated description, with some curves and tests, is given in “L'Elec.,” Feb. 10.

Dry Cells.—The “Elek. Zeit.,” Feb. 22, criticises unfavorably the recent tests of Mr. Zacharias, mentioned in the Digest some weeks ago.

Polarization of Thin Metal Partitions.—The first part of a paper by Mr. Daniell is given in the “Phil. Mag.” for February; several illustrations and tables of results are given.

Velocity of Ions.—The “Elek. Zeit.,” Feb. 15, abstracts at some length, a recent paper of Prof. Kohlrausch in the “Wied. Ann.,” volume L., page 385.

Sodium Silicate Solutions.—The “Elek. Zeit.,” Feb. 22, abstracts an article by Prof. F. Kohlrausch on this subject.

MISCELLANEOUS.

Electric Tempering.—According to the “Elec. Tech.,” Jan. 31, the Lagrange & Hoho system has been used with great success for tempering certain objects; the bearing part of a shaft, for instance, was tempered glass, hard to a depth of about 3-4 inch, while the interior was retained quite soft; with flat springs and files the trials were not a success, files, for instance, heated much more at the points than at the larger parts, and in thin springs the heating was unequal; in a gun factory at St. Etienne very good results were obtained, one man being able to temper 2,400 steel wire springs daily; unsuccessful results are reported from Kalk.

Ozone.—“La Lum. Elec.,” Feb. 17, states that Dr. D'Arsonval has obtained ozone without any special apparatus by the action of alternating currents on liquid oxygen; the quantity of energy required for transforming oxygen into ozone is considerable, and an influence machine is therefore quite insufficient for producing anything but small quantities; a short description is given of how he prepared liquid oxygen.

Manufacture of Mica Plates.—The description of a French process is abstracted in the “Jour. Inst. Elec. Engs.”; small pieces of mica are cemented together by shellac, the mass being compressed and heated.

Effect of Electricity on the Carburation of Iron.—An article of Mr. Garnier from the French is abstracted in the “Jour. Inst. Elec. Engs.”

Globular Lightning.—The *Zeit. fur Elek.*, Feb. 1, describes a recent case in an Austrian post office; the lightning appeared to have struck some distant telegraph lines, after which a very bright ball of light about three inches in diameter exploded with a very loud noise in the room, but without doing any damage; it was observed by a number of persons.

Effect of Lightning Upon Trees.—The *Lond. Elec. Eng.*, Feb. 23, abstracts briefly the recent paper by Mr. Dimitrie, abstracted in the Digest some time ago, in which the relative conductivity of different trees is given.

Fire Damp Measure.—The *Lond. Elec.*, Feb. 17, describes briefly the Coquillon apparatus, in which the gases are burnt by means of a heated platinum wire and afterward analyzed; 0.25 per cent. of fire damp was easily detected; it is said to be the only apparatus by means of which a sufficiently exact analysis can be obtained.

Electric Door Opener.—An illustrated description of a device is given in the *"Elec. Tech."*, Feb. 15.

Autoconduction.—An investigation regarding the priority of invention of the therapeutic application of currents induced in the body, showed that this method was first used by Boudet in 1877, but that Dr. D'Arsonval first used currents of very high frequency in this manner.

Emissive Power of the Skin.—A note in the January number of the *"Bul. de la Soc. Int. des Elecs."* mentions an experiment by Mr. Lecerele on the modifications of the emissive power of the skin under the influence of an electric brush discharge.

Central Station Currents in Therapeutics.—Mr. Gaitfe's paper is published in full in the January number of the *"Bul. de la Soc. Int. des Elecs."*

Electricity in Medicine.—A paper by Dr. Bloebaum is reprinted in the *"Elek. Rund."*, Nos. 9 and 10.

New Book.

DYNAMO AND MOTOR BUILDING FOR AMATEURS. With Working Drawings. By Lieutenant C. D. Parkhurst, U. S. Army. New York: The W. J. Johnston Company, Ltd. 162 pages, 71 illustrations. Price, \$1.00.

The author, in his preface, states that this book is an attempt to describe such forms and types of motors and dynamos as are simply and easily made, and yet such as will produce fairly efficient results as a return for the outlay of money, time and patience on the part of the builder, and prove profitable as actual working models, as well as through the instruction given in their construction. It is presumed, he adds, that the builder has a fair knowledge of the mechanical trade and the handling of the necessary tools; hence no attempt has been made to try and tell how these tools are to be used. Only such hints as the author has found to be of benefit to himself are given, the rest being left to the knowledge and skill of the amateur. It is not presumed or assumed that the amateur must follow implicitly the instructions or data given for the various machines; experiment and research will teach many things, and possibly and probably give as good results as a blind following of any data. So long as the grand underlying principles of dynamo construction are known and followed, the amateur cannot go far astray, and the types of machines given in the book are to be taken as a few samples of the many forms that have been successfully built by others, and that may be again built by any one.

The instructions in this book are clear and concise and accompanied by working drawings. While primarily intended for the amateur, the detailed information, particularly in the chapters on armature windings, connections and currents and on the design of a 50-light incandescent dynamo, will be of value to every electrician.

Full descriptions and working drawings are given for the following machines: A small bipolar shuttle armature motor of simple construction, capable of driving a small ventilating fan with current from a primary battery; a small motor for driving a sewing machine, for which no castings or patterns are needed; a sewing machine motor of more finished appearance and of greater efficiency than the above, being of a regular factory-made type, and a dynamo of modern type, capable of lighting 50 16-candle power incandescent lamps of 125 volts.

A chapter on armature windings, connections and currents gives minute instructions, illustrated by drawings, in regard to these subjects, and based upon the latest and best practice. The chapter on the 50-candle power dynamo will be found instructive aside from the construction of the dynamo, as all of the technical points involved in the design are fully treated, such as the proportioning of the armature and windings, calculation of the magnetic circuit, etc.

In an appendix data of some high-class dynamos and motors are given that will be of assistance as guides should the amateur wish to design any other types than those treated in the book.

Thomson Recording Wattmeter for Arc Circuits.

The success which the Thomson wattmeter for incandescent circuits has experienced has prompted the General Electric Company to design a recording wattmeter especially for the measurement of energy used in groups of arc lights in commercial lighting, such as in stores, factories, halls, and the like. This meter is the outcome of two and a half years of careful investigation and experiment. Indeed, probably no other meter or instrument manufactured by the General company has received more careful study than this meter. It is a true watt meter, modified in its principles only to meet the change of conditions of arc light service. It is similar in construction to the well-known Thomson record-



THOMSON WATTMETER

ing watt meter, and has the same damping device—a copper disc and two permanent magnets. It has been designed on the lines of an arc lamp, so far as its location, etc., are concerned, that is to say, to be suspended from the ceiling by two brass rods fastened to a simple ceiling board, and the same object is attained as in the suspension of arc lamps from the ceiling—the meter is inaccessible except to those who understand its manipulation. A special feature is the safety cut-out contained within the cover proper. The meter is designed to close immediately on possible trouble occurring within it, which might result in the burning out or breaking

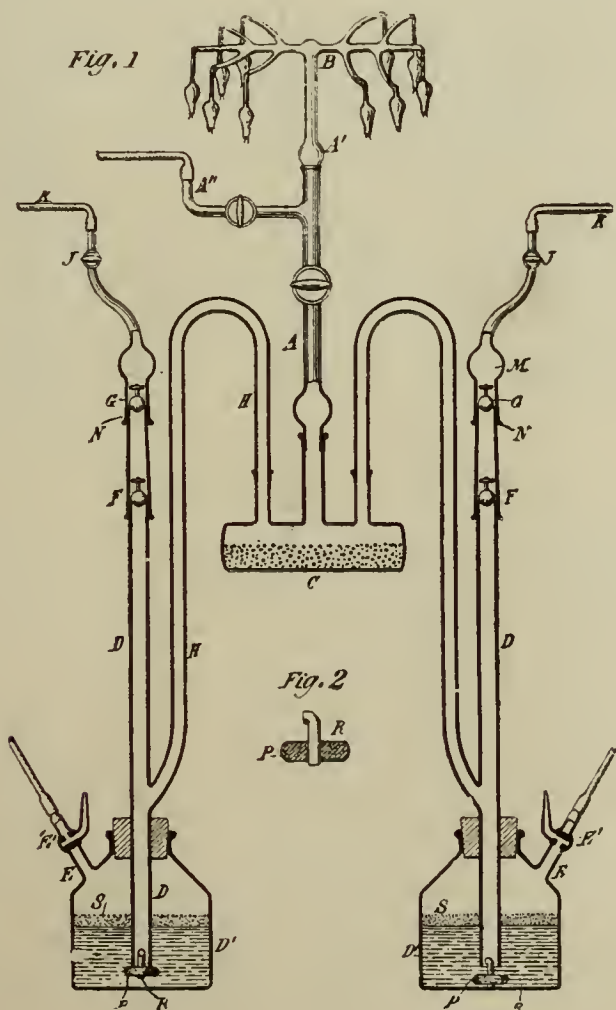
of the circuit. The cut-out serves to short circuit the meter and cut it out, rendering trouble in the meter impossible. At the same time it preserves the continuity of the circuit and permits the lights to burn without interruption, an advantage sufficiently obvious.

The connections of the meter are exceedingly simple. The connection blocks are at the top, the wires being brought first to the ceiling board, then dropping to the meter. The two terminals farthest from the front of the meter are connected to the line through an absolute cut-out, the two front terminals being connected to the lamps in the house. So far as the operation of the meter is concerned, it makes no difference which wire is positive and which negative, though, of course, to have the lamps to burn correctly, attention will have to be paid to this point. No trouble will be caused if the lineman should make a mistake and connect the wires which should go through the front terminals to the back and vice versa; there will be no short circuit or burning out. The meter will run backwards but register correctly, subtracting instead of adding to the sum on the dial.

The meter is shipped fully assembled and ready for installation. Careful tests show that the same accuracy can be expected on a minimum load as on a maximum, and this accuracy is of the highest.

Mercurial Vacuum Pump.

Among recent developments in the incandescent lamp field is a new and improved type of mercurial vacuum pump, recently patented, which, it is claimed by the makers, R. P. Ashwell and J. A. Vandergrift, 293 North Seventh street, Newark, N. J., will prove an important factor in determining the question of how to decrease the present price of lamps without sacrificing their quality. It will be noticed that while the well known Geissler principle is used, this pump differs from the usual Geissler forms quite essentially.



MERCURIAL VACUUM PUMP.

and can be briefly characterized as to its principle by the word "tubular."

It is the adherence to and development of this tubular principle that have enabled the inventors to obtain a great increase in pumping capacity and a consequent decrease in

the total expense of exhausting. One pump, as at present constructed, using 45 pounds of mercury, exhausts to the highest degree 10 lamps in 30 minutes from the time the lamps are first put on, as compared with three hours required to exhaust the same number of lamps by the usual Geissler form of pump.

A brief comparison between the new tubular pump and the usual Geissler form, based on capacities, as stated above, taken from actual practice, has been communicated to us by the makers and is given below; for purposes of comparison, 1,000 lamps are taken, to be exhausted to the same degree in 10 hours, from which calculations for other outputs can easily be made.

	New Tubular.	Usual Geissler.
Number of pumps.....	7	34
Horsepower of boiler and engine.....	7	34
Capacity of dynamos.....	70 lt.	350 lt.
Floor space, 12' X 5' 60 sq. ft., and 35' X 10' = 350 sq. ft.		

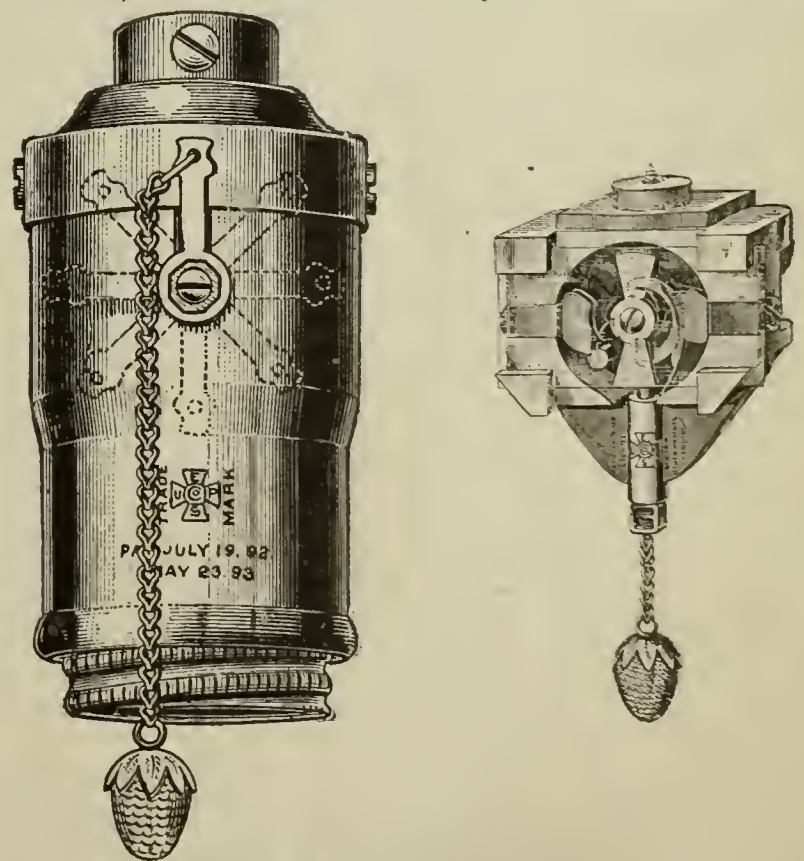
The above comparison shows that the ratio of the various items is about as 5 to 1 in favor of the tubular pump, and more detailed and exhaustive calculations, also taken from actual results, confirm this ratio, it is claimed. The important bearing which the above figures have upon not only the original outlay, but also in respect to interest on the power plant and building, will be readily perceived, as it is a well known fact that the pump department has hitherto occupied more space than any other department, and that at least 80 per cent. of the total power generated is absorbed by this department.

The makers claim that numerous and long continued tests upon lamps exhausted by this tubular pump have demonstrated that there is a decided gain in the quality of the lamps over those exhausted by the old form of pumps.

One single tube will operate about 14 times a minute. This is controlled by a three-way stop cock connected with a mechanical air pump, and also with the atmosphere, and operated by an electromagnet, which can be set to exhaust 14 times a minute.

Pull Switch and Pull Socket.

We illustrate an improved form of a pull switch and of a pull socket, both manufactured by the Universal Electric



PULL SWITCH AND SOCKET.

Pull Socket and Switch Company, 27 Beaver street, New York, and described originally in The Electrical World of Oct. 21 and 28, 1893. The improvements are in the direction of simplicity and add still further to the value of these useful appliances.

Financial Intelligence.

The Electrical Stock Market.

New York, March 17, 1894.

THE ELECTRICAL STOCK MARKET is evidencing, by improved quotations, the continued presence of bettered business conditions. Investors are beginning to recognize the fact that industrial securities of legitimate business corporations offer unusual inducements for the investment of capital, and some of the large amounts of money idle is quietly finding its way into the channels of investment represented by electrical corporations.

GENERAL ELECTRIC has been strong all the week; at times the price has fairly danced upward. Advice from all quarters on the company's prospects continue of the most bullish character, and the friends of the General Electric can now be counted among the most powerful interests in Wall street. Drexel, Morgan & Co. are the leaders in the talk that the company is in a fair way of improving its condition and business. The talk is "that it has been able to pay off all its indebtedness, and has on hand several contracts of a very advantageous nature. The removal of the plant to Schenectady is said to have made a saving of from 20 to 25 per cent. in expenses." Despite Mr. H. McK. Twombly's denial, Wall Street still believes that the Vanderbilt interests will be put in control next month. A good representation will be put into the directory and a Vanderbilt man may be elected president. Then it is now stated that present business is allowing the company such a margin of profit that the deferred dividend on the preferred is confidently expected to be paid in May. Whatever the facts of the situation may be, the strength of the stock has convinced a good many bear traders of the necessity or desirability of covering short contracts. But some of the operators on the bear tack are not yet dismayed, and insist that they are fully warranted in predicting lower prices. First of all, they argue that the competitors of the General Electric Company are getting all its business away from it; that what it does get is taken at prices that do not allow of a profit, that the strength the stock displays is not due to the buying for the bull side, but to covering of scared shorts. They continue to talk of a reduction in capital stock; a 50-per cent. reduction in the amount of common stock is said to be necessary to make up for the shrinkage in assets. Naturally, if the common stock holders make this concession, preferred shareholders must give way, some by foregoing a portion of their dividend rate and allowing the dividend to be non-cumulative. It is said that the directors would be personally liable if they declared a dividend when the capital was impaired and a profit and loss deficit in the annual report is foreshadowed; therefore the talk about cutting down the common stock. The most convincing argument on both sides, however, is the fact that somebody is buying and that that buying is putting up the stock. It closes for the week at 2½ points above last Saturday's quotation.

WESTINGHOUSE ELECTRIC stocks continue in good favor. The company has just declared the quarterly dividend of 1¼ per cent. on the preferred; it is payable April 2. It is reported that in the last eight months the company has reduced its debt by one-half, and will stand clear of debt by the end of 1894. Saving an issue of \$500,000 sub-company bonds guaranteed, there are no charges ahead of the preferred, which is preferred not only as to dividends with the cumulative provision, but also as to assets. Naturally, if the common stockholders make this concession the subject of much favorable comment. It is argued that the only reason for the preferred stock being under par, lies in the fact that the stock is so closely held by investors that the amount offering for sale is too limited to admit of spirited speculation with attending quickly rising quotations. There is, of course, no inherent weakness in the stock. The company has now gone into the fire light field, and is offering are lights at prices so far beneath the figures obtained by its rivals that its volume of trade will be extended more than ever. It is claimed now that the Westinghouse company does 70 per cent. of the entire business handled by it and the General Electric Company, and on a capitalization, par value, of \$9,000,000, as compared with the General Electric's capital of \$44,708,900. Relative to a rumor set afloat this week, an official says: "The Westinghouse Electric Company has not taken any securities during the past year or two in payment for apparatus. The company's sales have all been for cash or for short time paper. The latter has been taken only with bonds as collateral, and only in a few cases."

WESTERN UNION TELEGRAPH has been well supported all the week. Advantage has been taken, however, of the raised quotations to market some stock, insiders selling. It is intimated that, while the quarterly statement to be presented at next Tuesday's meeting of the executive committee may not be interpreted favorably, there will be a surplus after paying the regular dividend of 1¼ per cent., thus demonstrating the enormous earning capacity of the property even in periods of protracted depression.

EDISON ELECTRIC ILLUMINATING has been stronger on the favorable decision handed down this week by the Court of Ap-

pals in its suit against the State Comptroller, the appeal being from an order of the General Term affirming the decision of the Comptroller and imposing certain taxes upon the company for the years 1886, 1887 and 1888. The court holds that the company was not liable for the tax on capital stock during these years, and that it is entitled to a review of the proceedings levying the taxes.

THE COMMERCIAL CABLE COMPANY held its annual meeting this week. The annual report shows gross earnings for 1893 of \$1,842,346, and a balance, after paying expenses of \$784,600, of \$1,057,746. Net earnings, however, are \$41,840 behind the net earnings of 1892. Debenture bonds to the amount of \$600,000 were paid off during 1893, and provisions made to pay off during the year the rest of the entire outstanding indebtedness—a matter of about \$100,000. The dividends of 7 per cent. were regularly declared and paid. The old board of directors was re-elected. The annual report goes on to say that the whole system is in excellent condition and that the company has contracted with Messrs. Siemens, Brothers & Co., of London, England, for the manufacture and laying of a third cable, to be completed by the middle of July.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES trustees are again in the field for the purchase of preferred stock. They invite proposals for the sale to them of as many preferred shares issued on the trust deed of Aug. 18, 1893, as can be purchased with \$200,000.

THE ELECTRIC TRACTION COMPANY of Philadelphia has called for remaining installments on its capital stock, aggregating \$25 per share, by April 15, when the stock will be full paid. The stock has had quite a substantial rise of late.

BELL TELEPHONE STOCK has been prominent in Boston this week. Covering of shorts has caused most of the present advance, though at the highest price there has been free realizing, causing some recession in values. The counsel of the company says that, if the petition to increase the capital stock to \$10,000,000 is granted, the new capital will all be immediately spent on long distance lines in extension of the service. No objection is made by the Bell company to the organization of other telephone companies. They rely on their first presence in the field and their established business methods to keep on earning money. It is remarked that there are 5,227 Bell telephone stock holders; of these 3,721 hold less than 25 shares apiece, the average for the rest being about 70 shares apiece.

ELECTRICAL STOCKS.

	Par	Bid.	Asked
Brush Ill., New York	50	20	35
Detroit Electrical Works	10	7	8
Cleveland General Electric Co.	—	88	90
East River Electric Light	100	—	65
Electric Con. & Supply Co., pref.	15	15	16
Edison Electric Ill., New York	100	15	17½
Edison Electric Ill., 1st	—	93	95
Edison Electric Ill., Brooklyn	100	103¼	103½
Edison Electric Ill., Boston	100	100	101
Edison Electric Ill., Chicago	100	112	115
Edison Electric Ill., Philadelphia	100	145	150
Edison Electric Light of Europe	100	117	125
Edison Electric Light of Europe, Bonds	—	—	8
Edison Electric Light of Europe, Ore Milling	—	80	85
Fort Wayne Electric	—	10	11
General Electric Company	—	4½	6½
General Electric Company, deb. 5's	100	43	43½
Interior Conduit and Ins. Co.	—	81½	85
Mount Morris Electric	100	20	30
Westinghouse Consolidated	50	—	65
Westinghouse Consolidated, pref.	50	32	33
Western Union Telegraph	—	15	49
American Bell Telephone	—	80¾	86½
		174½	175

New Incorporations.

The Philadelphia Elevated Electric Railway Company, capital stock \$42,000, has been formed to construct and operate an elevated electric railway in Philadelphia. W. N. Boyer, D. R. Russell and D. C. McKee are interested.

THE ARINGDON ELECTRIC COMPANY, Abingdon, Ill., capital stock \$12,500, has been formed to maintain and operate a plant for the generation and sale of electricity. C. C. Travis, Annie J. Travis and C. D. Warner are the incorporators.

THE ATLANTIC TELEPHONE COMPANY, Jersey City, N. J., capital stock \$250,000, has been formed to manufacture and sell electrical machinery, apparatus and appliances. H. Scrymser, H. W. Gray and E. S. Wallace, of New York, are the promoters.

THE ELECTRIC POWER COMPANY, Portland, Me., capital stock \$500,000, has been formed to manufacture and deal in all kinds of electrical and mechanical appliances. E. A. Clark, C. T. Child, Boston and E. C. Ramsdell, Cambridge, Mass., are the promoters.

THE SPEARFISH ELECTRIC LIGHT AND POWER COMPANY, Chicago, Ill., capital stock \$50,000, has been formed to erect and operate an electric light and power plant and do a general manufacturing business. W. S. Corbin, J. M. Cameron and J. A. Griffin are the promoters.

THE COLUMBIAN ELECTRIC COMPANY, New York, capital stock \$5,000, has been formed to manufacture and sell electrical

apparatus. J. C. Smith, 251 West 127th street; R. G. Vassar, 28 West 25th street, and Alexander Carmichael, 232 West 48th street, New York, are the promoters.

THE CARONA MARBLE COMPANY OF VERMONT, Brandon, Vt., capital stock \$100,000, has been formed to supply electric lights, mine and quarry, etc. F. G. Swinington, Rutland; D. D. Hewitt, Brandon, Vt.; G. W. Quintad, D. C. Tate and John Yard, of New York, are the incorporators.

THE CHAGRIN FALLS ELECTRIC COMPANY, Chagrin Falls, Ohio, capital stock, \$10,000, has been formed to furnish electric light and power, deal in electrical appliances, etc. J. W. Hutchinson, Wm. E. Guyant, G. H. Gifford, William Hutchings and E. I. Bailey are the promoters.

THE MENOMINEE POLICE AND FIRE ALARM COMPANY, Menominee, Mich., capital stock, \$5,000, has been formed to manufacture and sell all kinds of mechanical and electrical devices for fire and police alarms, etc. H. Tideman, J. H. Kratz and Joseph Fleisham, of that town, are the interested parties.

THE LONG ISLAND ELECTRIC RAILWAY COMPANY, Freeport, N. Y., capital stock \$600,000, has been formed to operate an electric railway. A. R. Hunt, 196 Hancock street, Brooklyn; C. M. Cooper, 320 Pearl street, New York, and Clarence Wolf, 506 Minor street, Philadelphia, Pa., are the incorporators.

THE BELLEFONTAINE LIGHT AND POWER COMPANY, Bellefontaine, Ohio, capital stock \$25,000, has been formed to manufacture and furnish electricity for light, heat and power; to open street car lines, etc. Robert Colton, James Colton, C. H. Harner, F. J. McColloch, E. J. Hewenstine and W. C. Huston are the promoters.

THE WILLIAMS PUBLISHING AND ELECTRIC COMPANY, Cleveland, Ohio, capital stock \$50,000, has been formed to supply electricity for various purposes, also steam power, and to conduct a printing plant. C. V. Hard, D. J. Hard, L. P. Ohliger, Louis Mandelbaum and Wm. M. Raynolds are the promoters.

THE IDAHO ELECTRIC RAILWAY AND POWER COMPANY, Boise City, Idaho, capital stock \$2,000,000, has been formed to construct a standard gauge railway, to be run by electricity or steam, from Boise City to Lewiston, Idaho. The promoters are J. Bartlett Warren, F. C. Bond, G. M. Parsons and C. M. Day, Boise City, Idaho.

THE MOHNSVILLE AND ADAMSTOWN ELECTRIC RAILWAY COMPANY, Adamstown, Pa., capital stock \$50,000, has been formed to construct and operate an electric railway in Berks and Lancaster counties. L. T. Custer, E. E. Billingsfelt, S. W. Miller, Adamstown; I. S. Spatz, Mohnsville, and V. S. Setzer, Reading, Pa., are interested.

THE CORTLAND ELECTRIC FIRE ALARM COMPANY, Toledo, Ohio, capital stock \$100,000, has been formed to manufacture and deal in all kinds of electrical appliances, and to wire buildings and operate the Cortland fire alarm system, etc. H. Cortland, D. L. Boyce, J. G. Paine, C. W. Brokaw and E. B. Southard are the promoters.

PALMYRA, N. Y.—The Palmyra Electric Light Company has been organized with a paid up capital stock of \$10,000. The following gentlemen were elected directors for the ensuing year: B. H. Davis, C. C. Hunt, George Tinklepaugh, Samuel P. Nichols, of Palmyra, and W. J. Morrison, of Syracuse, N. Y. At a meeting of the directors the following officers were elected: B. H. Davis, president; W. J. Morrison, vice president; S. P. Nichols, secretary and treasurer.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
41 Park Row New York, March 10, 1894.

L. J. WING & CO. have taken a five years' lease of the building 109 Liberty street, to which they will remove their business May 1.

THE NATIONAL WATER TUBE BOILER COMPANY, of New Brunswick, N. J., moves its New York office from 18 Cortlandt street to 74 Cortlandt street the latter part of this month.

MR. L. C. LANPHEAR, 50 Oliver street, Boston, Mass., Eastern representative for M. T. Davidson's pumps and hydraulic machinery, was in New York last week and reports business in the East booming.

G. H. ALMON, 136 Liberty street, New York, selling agent of the Belknap Motor Company, has just sold to the Bishop Gutta Percha Company two 10-kw. Belknap dynamos, one 10-h. p. Belknap motor, and one 3-h. p. Belknap motor to the News Printing Company, Rutland, Vt.

CARPENTER, HEWARD & CO. have opened a store at 289 Fourth avenue, New York, for the sale of electric and gas fixtures,

fireplaces, mantels, etc., and architectural metal work. They will be the agents for the New Jersey Lamp and Bronze Company, of New Brunswick, and do a jobbing, supply and retail business.

MR. E. B. WILLCOX, proprietor of the Fulton Foundry and Machine Works, 21 Furman street, Brooklyn, N. Y., who, some months past was obliged, owing to illness, to close his works, has recovered his health and resumed operations in all departments.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., March 10, 1894.

MR. ELLIOTT O. JOHNSON has acquired the New England sole agency for the Boston Incandescent Lamp Company, in addition to representing Holmes, Booth & Haydens, with headquarters at 70 Pearl street, Boston.

LAWRENCE, MASS.—The City Council, through a committee, is investigating police signal systems preparatory to reporting on the advisability of placing one in the city. It is thought that it may cost \$7,000 to install a complete system.

THE J. M. CARPENTER TAP AND DIE COMPANY, of Pawtucket, R. I., is introducing its new set of adjustable dies, adapted to electrical work and also for bicycle work, and finds already quite a demand for them. It reports business as generally very good, which is not at all surprising, as its specialties are of the best manufacture.

THE BOSTON ELECTRIC LIGHT COMPANY has made a reduction to the city for street lights to 35 cents per light per night. This reduction was made with the understanding that the city use 2,000 lights. The city will be able thus to secure a greater number of lights for the cost than heretofore, which was 40 cents per light per night.

THE GAMEWELL WINS.—A year or more ago the Gamewell company was sued by the Municipal Fire and Police Telegraph Company for alleged infringement of patents issued to one Cole for devices on signal boxes. At the hearing Thursday Judge Aldrich granted the petition of the Gamewell company, dismissing both cases, and ordering the Municipal company to pay costs.

MESSRS. MCKENNEY & WATERBURY, 181 Franklin street, Boston, have been recently awarded the following contracts for gas and electric light fixtures: Insane Hospital, Augusta, Me.; new court house, Laconia, N. H.; Carter Building, Boston; First Unitarian Church, Medford, Mass.; Memorial School building, Greenwich, Conn.; the Webster Building, Gloucester, Mass., and also the magnificent Kennard Block, of Manchester, N. H., the

W. B. SOUTHGATE & CO. have just opened offices at 146 Franklin street, Boston, for the purpose of acting as manufacturers' agents and dealers in electrical supplies. Mr. Southgate was for a number of years connected with the Whitney Electrical Instrument Company, during which period he made hosts of friends, who wish him success in his new enterprise. He is a young man of business ability and integrity, and we understand his associates are of like character.

THE COMMITTEE ON MERCANTILE AFFAIRS of the Massachusetts Legislature gave its first hearing on March 7 on the petition of the Bell Telephone Company for an increase of capital stock from \$20,000,000 to \$50,000,000. Ex-Governor Long, counsel for the company, took up most of the time with an interesting account of the financial policy of the company, and showed conclusively why the new capital was needed, and why and where it was to be put if granted. The committee afterwards visited the company's buildings in Boston.

MR. LOUIS J. HIRT, who, as is well known, has been for a long period mechanical engineer of the West End Street Railway Company, of Boston, resigned his position March 1. Mr. Hirt identified himself with the West End Company very soon after it adopted electric traction, and did some excellent and valuable work. He is possessed of first-class abilities as a mechanical engineer, and has opened an office at 8 Oliver street for the purpose of pursuing his profession. Some of his recent inventions, in which the electrical fraternity will be interested, will be shortly placed upon the market.

largest and finest building in the State.

NOTWITHSTANDING THE REMOVAL of various departments of the General Electric Company business to Schenectady, the Hathaway and New England buildings, of Boston, are continually securing new tenants. There are already some 30 or 40 companies, large and small, engineering and wiring, of analogous interests to electric lighting and power, located in them. The rentals are far below other office buildings, and the buildings afford every comfort and convenience, superior light, good management; everything, in fact, to make a person or corporation comfortable, and secure him convenience, health and economy besides.

Pittsburgh Notes.

Pittsburgh, Pa., March 9, 1894.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, of this city, has declared a quarterly dividend of 1½ per cent., which is payable on April 2.

R. D. McGONIGLE, the treasurer of the Allegheny County Light Company, who has been indisposed for some time, returned to his office, in the Westinghouse Building, a few days ago.

THE CLAYTON ELECTRIC COMPANY, a small local concern engaged in the construction of electric fixtures, has made an assignment without preference. The liabilities are not large, and will be covered by collectable assets. Trouble in making collections is the cause given for the assignment.

AT A RECENT meeting of the board of directors of the Allegheny County Light Company it was decided to extend the operation of the company's circuit to Hazelwood, a small suburban town of Pittsburgh. Hazelwood has a population of about 10,000, and the company expects to add 1,500 lights to its capacity by next fall.

AT THE ANNUAL MEETING of the Allegheny Light Company the following board of directors was elected for the ensuing year: George Westinghouse, Jr., president; George H. Baxter, vice president and general manager; H. H. Westinghouse, C. L. Magee, John E. Ridally, Wm. Eberhard, James H. Willock, Robert Pinceln and William McConway.

THE PITTSBURGH AND MANSFIELD STREET RAILWAY COMPANY, a corporation organized about six months ago for the purpose of constructing an electric road from this city to Mansfield by building a bridge across the Monongahela and piercing a tunnel through the hills on the south side of the river, has at last succeeded in obtaining the endorsement of the Pittsburgh mayor of its plan, who withdrew his opposition a few days since and signed an ordinance granting the company the franchise to build their road.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD
417 Monachnock Building Chicago March 9, 1894.

Mr. W. C. McKINLOCK, secretary of the Metropolitan Electric Company, reports business as being on the increase, having just returned from an extensive business trip with some good sized orders for the specialties handled by his company.

THE ELECTRIC APPLIANCE COMPANY, without making very much hurrah about it, has been quietly building up a very nice trade on the Acme tape, a specialty which it first placed on the market something over two years ago, and which has stood the test of time and made many friends.

Canadian Notes.

Ottawa, March 3, 1894.

OTTAWA, ONT.—J. E. Chown, representing the Webster Electric Company, of London, who is in this city, purchased 75 tons of iron yesterday, the product of the mine at Perkins' Mills.

A SPECIAL GENERAL MEETING of the Ottawa Electric Light Company will be held March 19 to consider the proposed amalgamation of the company with other companies, etc.

AN ATTEMPT will be made at this session of the Dominion Parliament to give electric railways a status that they do not now enjoy under the General Railway act.

THE CITY CORPORATION is applying to the Legislature for power to manufacture and use and supply to others electricity for motive power and for any other purpose to which the same can be applied.

THE INCORPORATION of a company to construct and operate a bicycle electric railway from the city of Winnipeg, in Manitoba, to the port of Louisburg, in Cape Breton, is among the measures to come before the next session of the Dominion Parliament.

IT HAS BEEN definitely decided to establish government control over electric light meters, and a bill for this purpose will be put through Parliament this session. The electric light companies are in favor of government inspection, and the consumers will no doubt, be glad of some protection.

THE PLANS for the amalgamation of all the electric light companies in Ottawa have been fully matured, and it has been decided to carry the important changes into effect on June 1. After that date the Claudiere, Standard and Ottawa electric light companies will be under one management. No general manager has yet been appointed, but Mr. Berkeley Powell, at present manager of the Standard, is favorably spoken of for the position. It has been agreed between the promoters of the amalgamation not to increase the existing rates, but, if possible, to reduce them.

WINDSOR, ONT.—Application is being made to the Ontario Legislature to incorporate a railroad company with power to construct a railroad from the town of Amherstburg to the city of

Windsor, and to equip and operate the same by steam, electricity or other motive power.

LONDON, ONT.—Application is being made to the Ontario Legislature for an act to incorporate the London and Springbank Electric Railway Company, with power to construct and operate an electric railway from the city of London to a point on the River Thames, near Springbank, and to construct a bridge over said river at or near Springbank.

PETERBORO, ONT.—The Canadian General Electric Company has secured a contract from the Toronto Street Railway Company for 80 street car motors and about 3,000 h. p. of generators. Including this contract, the Canadian General Electric Company has sold during the past few weeks electrical apparatus to the value of about a quarter of a million of dollars.

BRITISH COLUMBIA.—The bill to incorporate the Great Western Telegraph Company has been printed. The line is to run from Nanaimo to Vancouver, from Vancouver to New Westminster, and from New Westminster across the Fraser River to Brownsville. The incorporators are R. A. Anderson, H. V. Burner, John A. Fleet, W. H. Goodwin and Michael King, and the capital stock is \$75,000, divided into \$5 shares.

MONTREAL.—The directors of the Merchants' Telephone Company, at a special general meeting of shareholders held this week, were authorized to dispose of the balance of the capital stock of the company, amounting to about \$20,000. The present shareholders, who were limited to \$100 stock, will have the first chance of subscribing for the stock. Mr. F. X. Moisan, the president of the company, stated to-day that there was no intention of selling out to the Bell company, even should that company be disposed to buy.

English Notes.

(From our own Correspondent.)

LONDON, Feb. 28, 1894.

THE FIVE-WIRE SYSTEM AT MANCHESTER.—The Manchester Electric Light Supply, which is on the five-wire system, is, I hear, by no means satisfactory, the pressure regulation leaving much to be desired, and the mains giving much trouble.

GAS ENGINES.—There is much discussion going on in the electrical papers in this country on the subject of the possibility of the parallel working of alternators driven by gas engines. One result of this discussion is to show that double acting gas engines are rapidly coming into favor. I understand that the well-known makers of steam engines, Messrs. Willans & Robinson, are shortly about to bring out a gas engine much on the same lines, I believe, as their splendid steam engine.

THE ELECTRICITY SUPPLY COMPANIES.—Judging by the dividends which have been announced within the last few days, the electricity business in this country is at last attaining a satisfactory stage. The Kensington and Knightsbridge company, which has some 64,000 lamps connected to its mains, has just paid a dividend of 5 per cent. for the year 1893, while the Westminster company, which has over 130,000 lamps connected, and the Chelsea company, which has about 45,000 lamps connected, have also both paid 5 per cent. dividends, while in Newcastle one of the electricity supply companies has scraped together sufficient profit to pay 5½ per cent. on its ordinary shares.

THE UTILIZATION OF TOWN REFUSE.—Owing to the high price of coal and other good fuels at the present time, the attention of electrical engineers has lately been directed to the utilization of dust bin refuse for raising steam for electric lighting. Among the municipalities which are paying some attention to this at the present time are St. Pancras, Shoreditch and Harrowgate, while a few days ago a party of representatives of the technical and general press visited Halifax, in Yorkshire, for the purpose of examining a new type of furnace and boiler, constructed under the patents of the late M. Livet. It is claimed that this furnace will evaporate from three to four pounds of water for every pound of refuse burned, without subjecting the refuse to previous desiccation, but so far as I could gather no official trials of this furnace either at full load or under actual working conditions have been made.

BOARD OF TRADE ELECTRIC TRACTION REGULATIONS.—An important conference between the Board of Trade and representatives of the interests involved in its electric traction regulations was held to-day, the sitting lasting from noon to 4 o'clock, the meeting being then adjourned until Friday. Everybody came armed cap-a-pie to fight the Board of Trade over Rule 14, which practically laid down that electric tramways were on no account to disturb telephone circuits. The impending fray was, however, ward off by the simple announcement on the part of the Board of Trade that they propose to make the rule read that electric traction people were to take "all reasonable precautions" to prevent the disturbance of telephone circuits. The procedure of the Board of Trade in connection with these electric traction regulations is much to be commended. The regulations were first of all published in draft, and criticism invited. Conferences were then held between the Board of Trade officials and each of the num-

erous interests concerned. Finally, the whole of the suggested alterations were considered to-day between the Board of Trade and representatives of the tramway, railway, gas, water and telephone companies.

News of the Week.

Telegraph and Telephone.

OCALA, FLA.—James Chambers and others have applied for a franchise for a telephone system.

EVART, MICH.—The village Council has granted C. E. Bell a franchise for ten years to build and maintain a telephone exchange.

HANOVER, PA.—The Hanover Telephone Company has been granted authority to erect poles and string wires in the streets of the borough of Hanover.

GAINESVILLE, GA.—The Gainesville Telephone Company, \$10,000 capital, has been incorporated. Hon. Allen Candler, H. B. Smith and H. L. Richardson are interested.

NEWBURGH, N. Y.—Through the efforts of Dr. W. B. Snow, of Milton, in Ulster County, the West Shore Telephone Company has been organized to connect Newburgh and Kingston.

BELL TELEPHONE PATENTS.—In the Senate, on March 1, Senator Gray offered a resolution directing the committee on patents to investigate all facts connected with the application for, and the issuance of, the Berliner patent, now held by the Bell Telephone Company. The same resolution was presented in the House by Mr. Bunn, of North Carolina.

LIABILITY OF TELEPHONE COMPANY FOR INJURY FROM CHARGED WIRE.—Where a telephone company permits a wire liable to become charged from an electric wire to hang down on to the sidewalk it is bound to exercise such care as will guard the public against injury from it. (Ahern v. Oregon Tel. and Tel. Co., Supreme Court of Oregon, 35 Pac. Rep., 549).

LIABILITY FOR CONVERSION OF PROPERTY USED IN VIOLATION OF LAW.—A telephone company which cuts and carries away wires of an electric power company is liable for the conversion, though the telephone company had lawful authority to carry on its business and the power company was not authorized to use its wires as it did, and though the telephone company cut the wires in attempting to comply with a notice from the Board of Electrical Control. Where the servants of the telephone company were ordered to cut the wires from its fixtures, also carry away the wires, it is liable for the conversion. (Electric Power Co. v. Met. Tele. and Tele. Co., Supreme Court, General Term, First Dept., 27 N. Y., Supp. 93).

Electric Light and Power.

OGDEN, IOWA.—Ogden is considering electric lights.

MONTGOMERY, MINN.—Citizens are working for electric lights.

BETHANY, MO.—Bethany has voted to issue \$30,000 in bonds for electric and water works.

MASILLON, OHIO.—The City Council is investigating the matter of an electric lighting plant.

WILLIAMSPORT, MD.—The matter of electric lights and a fire department are being agitated.

GREENVILLE, OHIO.—The Greenville Electric Light and Power Company is being organized.

JANESVILLE, WIS.—The Council is investigating the matter of a municipal electric lighting plant.

GRAND JUNCTION, IOWA.—The plan of putting in electric lights by private enterprise is being considered.

OCEAN GROVE, N. J.—About \$10,000 will be expended at Ocean Grove this year for better lighting of the streets.

AGRICULTURAL COLLEGE, MICH.—President Gorton is working for an electric lighting plant for the college.

KUTZTOWN, PA.—An agent is now canvassing citizens in the matter of locating an electric street lighting plant here.

WYTHEVILLE, VA.—The City Council of Wytheville has decided to purchase an additional dynamo. Wm. Terry is mayor.

CALEDONIA, N. Y.—The matter of an electric lighting plant for the village of Caledonia will be submitted to taxpayers March 20.

BUFFALO, N. Y.—A committee of the Buffalo Board of Aldermen has recommended that an electric light plant be built at a cost of \$100,000.

NIAGARA, N. Y.—The Schoelkopf Hydraulic Canal Company will put in an extensive plant to furnish electrical as well as hydraulic power.

SHELDON, ILL.—Residents of Sheldon will likely vote at the

spring election in the matter of issuing bonds for an electric light plant.

WOODSTOWN, N. J.—The taxpayers will vote at the spring election in the matter of an electric lighting plant for Woodstown.

MONTCLAIR, N. J.—Paul Wilcox, of Montclair, N. J., has applied for right to operate a public and private incandescent electric light plant.

DEMOPOLIS, ALA.—Proposals for a franchise to erect and operate an electric light and water works plant will be received by the Council.

APPLETON, MINN.—The citizens will vote at the coming election on the proposed issue of \$15,000 electric light and water-works bonds.

GRIFFIN, GA.—The Council has empowered the finance committee to contract for a power house, to be of brick, 30x45 feet, for the electric light plant.

TALLAHASSEE, FLA.—An electric light plant will be purchased by the Georgia and Florida Investment Company to light the hotel. H. P. Simmons, manager.

PLAINFIELD, N. J.—The North Plainfield Electric Light Company proposes to build a plant at Greenbrook, from which it will supply electric light to Bound Brook.

MILWAUKEE, WIS.—The Wisconsin Electric Dynamo Company will increase its plant at Layton Park as soon as the weather permits. Peter Egelhoff is president.

APPLETON, WIS.—O'Keefe & Orbison are making plans for a new power house for the Appleton Edison Electric Company, and they have contracted for construction.

SKIPPACK, PA.—The Directors of the Poor will hold a meeting on the 30th of March to decide finally in the matter of introducing the electric light into the institution.

HAMILTON, ONT., CANADA.—The matter of a municipal electric light plant will soon come up for settlement. Mayor Stewart is making a report to submit to the Council.

OWATONNA, MINN.—The city Council of Owatonna has voted to put in an electric lighting plant, which is to be owned and run by the city, and which shall not cost more than \$15,000.

JAMESTOWN, N. Y.—It is stated that George W. Sisson is endeavoring to establish a new electric lighting plant, and that capitalists from Dunkirk and Corry are back of the scheme.

ATHENS, GA.—The matter of a municipal electric light plant will soon be passed upon by Council. There is a division among taxpayers as to the advisability of erecting a municipal plant.

HAMILTON, OHIO.—Sealed proposals will be received to March 17 for the construction and equipment of an electric light plant, as per plans of Charles L. Cornell and J. J. McMackin, city clerk.

TIFFIN, OHIO.—Albert Brewer and W. H. Dore, of Tiffin, have formed an electric lighting company and put in the lowest bid for lighting the streets of the city, and will likely get the contract.

GLOUCESTER, MASS.—The committee on street lights are on a trip to near-by towns looking up the methods of electric lighting for comparison with the local plant, with the aim to improve the latter.

MARTIN'S FERRY, OHIO.—Complaint is made of the action of the water directors in purchasing an electric plant for the pumping works without advertising for bids. A town plant is desired.

BINGHAMTON, N. Y.—The old electric light plant on Noyes Island, which was bought from the General Electric Company by E. S. Hammond, Jr., has been burned. Loss \$7,000 and insurance \$5,000.

SPRINGFIELD, OHIO.—John Eisenmann, of 449 Arcade, Cleveland, Ohio, is making plans for wiring, heating, etc., the State Masonic Home. The building will be lighted by its own electric light plant.

CLEVELAND, OHIO.—L. H. Lindhorst will erect a four-story business building on Pearl street and Walton avenue, and the matter is being considered of placing an electric lighting plant in the basement.

DALLAS, TEX.—The city government asks for bids until April 2 for four 100-light arc dynamos, 300 double arc lamps, with the necessary line and station material to install the plant. Bryan T. Barry is mayor.

LOCKPORT, N. Y.—The Council has adopted a resolution of Alderman Lamson calling for a special election, at which taxpayers will vote in the matter of issuing \$40,000 4 per cent. bonds for a municipal electric lighting plant.

MALDEN, MASS.—This city has approved the all-night electric service contract, with the proviso that should a municipal plant be constructed the contract can be voided by a three months' notice to the company.

VINCENNES, IND.—At the annual meeting of the Vincennes Electric Light and Power Company the following officers were elected: C. Bierhaus, president; H. W. Frund, secretary and manager, and L. Reiter, treasurer.

WASECA, MINN.—Edmund Sykes, of Minneapolis, has been awarded the contract for putting in a waterworks system for Waseca at \$25,239, to include pump house, pumps and an engine for the electric lighting plant.

HAMBURG, N. Y.—The Hamburg Electric Light and Power Company threatens to withdraw and shut up its plant unless the price is advanced from \$60 to \$80 per lamp. The Council will be asked to take immediate action.

STAMFORD, CONN.—Gillespie Brothers, of Stamford, Conn., will build a four-story brick and iron building at Stamford, Conn., from plans of J. S. Bogardus, of Stamford, and they ask for estimates on an electric light plant.

NATIONAL HOME, WIS.—Sealed proposals will be received at the treasurer's office to H. A. M., March 26, for supplying the home with electrical supplies (Edison system) for the quarter ending June 30, 1894. J. E. Armitage is treasurer.

ALEXANDRIA, VA.—A bill has been introduced to incorporate the Alexandria Light and Power Company, with offices in Alexandria. The incorporators are R. H. Phillips and H. H. Wells, of Alexandria, and James H. Embrey, of Washington, D. C.

NEW BRIGHTON, STATEN ISLAND, N. Y.—The trustees of New Brighton have received a communication from A. E. Leon, representing Boston capitalists who wish to light the village streets by electricity, and the matter is being considered.

MONTCLAIR, N. J.—The petition of Paul Wilcox and others for leave to establish an electric lighting plant will be considered at a special meeting March 19, in the evening. They ask for a 25-year franchise, plant to be in operation within six months.

PALMYRA, N. J.—There is a project being pushed by which Palmyra will have electric lights. The scheme is to purchase the plant of Beverly, making Riverside the central station and then run wires from that place to Riverton, Palmyra and Beverly.

ATHENS, GA.—The Athens "Banner" calls attention to the fact that there are but four months of the present lighting contract to run, and that steps should be taken now or never in the matter of issuing bonds to pay for a municipal electric lighting plant.

HONESDALE, PA.—A project is being formed for the erection of an electric lighting plant on Wallenpaulack Creek, near Hawley. The company is to be known as the Delaware and Hudson Electric Motor Company, and it proposes to propel boats by electricity.

SOMERSWORTH, N. H.—The Consolidated Light and Power Company has been permitted to issue receiver's certificates to the amount of \$5,500, of which \$2,500 is for back pay and the balance for improvement to the plant, in order that better light may be furnished.

ERIE, PA.—The city clerk has been directed to call for proposals for lighting the streets of Erie with gas, electricity or other illuminator, proposals to be received to March 23. The Erie Telephone Company has been granted a franchise to operate a telephone system here.

MAMARONECK, N. Y.—The Larchmont Electric Lighting Company, which will establish a plant at Mamaroneck, will be ready for operation May 1. The alternating system will be used. A one-story brick building will be erected, with a dynamo room 50 by 50 feet, and a boiler room 30 by 45 feet.

WASHINGTON, D. C.—Sealed proposals will be received to 2 P. M. March 11, at the Treasury Department, for manufacturing and placing in position at the United States Building at Springfield, Mo., combination gas and electric light fixtures, as per specifications, on application to S. Wike, acting secretary.

HINGHAM, MASS.—The committee on a municipal electric light plant has recommended that a temporary contract be made for electric lighting, and that as soon as experience is gained the city establish and operate a plant. Fred. M. Hersey, Eben L. Ripley, C. Sumner Cushing and George W. Burr are the committee.

GORHAM, N. H.—The Gorham "Mountaineer" is authority for the statement that the Grand Trunk Railway of Canada, with head office at Montreal, Canada, will install an electric lighting plant at their works, that they have offered to put light in the streets of Gorham, and that the committee on light has the offer under consideration.

HIGGINSVILLE, MO.—Bids were received by the city on Feb. 27, 1894, for the construction of a complete electric light plant for the city. There were bids from all principal companies now doing business. The Council finally adopted the Westinghouse system, and awarded the construction to the Franklin Electric Company, of Kansas City, Mo.

KINGSTON, N. Y.—On motion of Alderman Lang, the Common Council decided to take into consideration the advisability of building its own electric light plant, and the mayor states that he will appoint a committee of three to investigate and report. Alderman Block has been informed that the desired plant can be built for about \$10,000.

READING, PA.—On April 12, at 2 P. M., the stockholders of the Reading Electric Light and Power Company will vote in the matter of leasing its property to the Metropolitan Electric Company, and, at the same time, the Metropolitan Electric Company

will vote in the matter of leasing the said lines of the Reading Electric Light and Power Company.

The Electric Railway.

NORFOLK, VA.—The Norfolk City Railroad has been granted permission to extend its tracks.

CLEVELAND, OHIO.—A project is being considered for the extension of the lines of the Cleveland and Berea street railway.

NEW BEDFORD, MASS.—It is reported that the Union Street Railway Company will soon equip the Purchase street line with electricity.

MINNEAPOLIS, MINN.—There is a prospect that the St. Louis Park electric line will be extended to Hokins this summer, a distance of two miles. T. B. Walker is owner.

RICHMOND, VA.—A bill has been introduced into the Legislature to incorporate the Southern Railway and Electric Company, to build an electric line from Richmond to the Potomac River.

BALTIMORE, MD.—The order has been signed granting a six months' extension for the work of beginning the construction of the Baltimore, Middle River and Sparrow's Point Railway Company.

HOMESTEAD, PA.—The Homestead Street Railway Company has accepted the franchise giving it right of way over Eleventh avenue, and will begin work at once, and hopes to finish in three months.

OLYPHANT, PA.—An ordinance has been passed granting additional right of way to the Olyphant Suburban Traction Company to lay tracks, erect poles and string wires in the streets of the borough of Olyphant.

MARION, IND.—The Marion Street Railway Company, which now operates a line between Marion, Jonesboro and Gas City, will extend its line to Fairmont, six miles south, as soon as the weather will permit work.

READING, PA.—It has been decided to begin at once the extension of the Reading and Southwestern electric road to Adamstown, ten miles southwest, and a call of 10 per cent. has been made on the capital stock.

HARRISBURG, PA.—The Philadelphia Electric Elevated Railway has been chartered. The directors are Walter N. Boyer, Radcliff B. Mills, John R. Rowman, Samuel R. Russell and David McKee, all of Philadelphia.

NORTHAMPTON, MASS.—The Northampton Street Railway directors have asked for permission to increase their capital stock from \$150,000 to \$300,000, that they may build an 8-mile extension from this city to Williamsburg.

JOHNSTOWN, N. Y.—Lawton Caton, of Gloversville, N. Y., so states the Johnstown "Republican," has announced that the proposed electric line between Akin, Johnstown and Gloversville will be built during the coming summer.

HAMILTON, ONT.—The Hamilton Radial Electric Street Railway Company asks for permission to increase its capital stock from \$1,000,000 to \$2,000,000, and to extend its lines to Niagara Falls, Brantford, Queenston and other points.

THE ALDERMANIC COMMITTEE on railroads will, on April 5, hear the application of the Third Avenue Railroad Company for permission to extend its lines up St. Nicholas avenue, New York. The committee is opposed to the trolley system.

DE PERE, WIS.—The Green Bay Electric Street Railway Company will petition for a franchise to enter the town of De Pere. Should the franchise be granted, tracks will be laid through the town of Allouez, between Green Bay and De Pere.

PHILADELPHIA, PA.—H. M. Hoyt, of Philadelphia, gives notice that on March 26 he will apply to Governor Pattison for a charter for the Berks and Dauphin Traction Company, one of the companies organized by the Penn Traction Company.

COLUMBIA, S. C.—It is stated that the Columbia Electric Street Railway Company and the Columbia Land and Investment Company propose to extend the electric line to a suburban town to be established just beyond the southeastern limits of the city.

BOSTON, MASS.—The committee on street railways will give a hearing March 5 at 10 A. M. at the State House on the petition of the Boston and Revere Electric Street Railway Company to lease its franchise and property to the Lynn and Boston Railroad.

PHOENIXVILLE, PA.—Colonel Du Pont, of the Delaware River and Chester Railroad, states that they will experiment with the trolley system for that portion of the line between Phoenixville and Falls of French Creek, and that in the spring they will build many extensions.

WATERBURY, CONN.—C. W. V. Blakeslee & Sons have contracted to build the tracks for the Waterbury electric road, and they will begin work as soon as the weather permits. There are six and a half miles of tracks, and the contract will amount to about \$25,000.

ALBION, N. Y.—At a meeting recently held, the following were appointed a committee to consider the proposition of Emmons, Dwyer & Co., of Syracuse, to build a road from Batavia to the

lake: Wm. Hallock, Henry Blood, George W. Potter, E. L. Wage and D. S. Beckwith.

WASHINGTON, D. C.—The House District committee has adjourned without taking action in the matter of the application for a franchise of the Washington and Georgetown Terminal Railway Company, of which Andrew B. Duvall, E. Kurtz Johnson and E. Southard Parker are directors.

HARTFORD, CONN.—At a meeting held in the office of M. S. Chapman, of the Government Envelope Agency, it was decided to open for subscriptions the books of the Hartford, Manchester and Rockville Tramway Company. It is the intention to extend as far as Manchester during the coming summer.

ANNAPOLIS, MD.—The hearing in the matter of the application of the City and Suburban Railway Company for a double track electric railway from Baltimore to Catonsville has been postponed. Nelson Perin is president of the company, Frank H. Sloan is engineer and G. D. Penniman is counsel.

WASHINGTON, D. C.—Mr. McKaig, of Maryland, has introduced a bill into the House to incorporate the Washington, Burnt Hills and Sandy Spring Railway Company to build a road to be operated either by electricity or cable between these points. Geo. W. Cissel, Ralph L. Galt, Charles G. Stone and George W. Harvey are interested.

SPRINGFIELD, MASS.—A public hearing will be given March 12 on petition of the United Electric Light Company for permission to place additional wires. A hearing will be given April 2 on petition of Henry S. Dickinson, George S. Taylor and George Nye, representing the Wymanlea Street Railway Company, for location for its tracks.

SPRINGFIELD, MASS.—Charles H. Hall, the well-known real estate operator, of Belmont avenue, is getting up a \$200,000 company to build an electric line to East Longmeadow and Hampden. The following residents of Springfield also are interested: Chauncey Morrill, D. M. Butterworth, Hitchcock & Co., Gowdy & Remington and E. M. Lombard.

PHILADELPHIA, PA.—The Brigantine Transit Company, of Brigantine, N. J., has contracted with Stern & Silverman, of Philadelphia, for the reconstruction of its entire road, built a year ago. The line is to be constructed on trestles, with a considerable amount of bulkheads and jetties projecting into the ocean. The road will be in operation June 1.

CINCINNATI, OHIO.—Plans are almost completed and bids will be asked in a few days for the proposed new power house for the Mount Adam and Eden Park Electric Railway Company, to be erected on Gilbert avenue, which is to have four boilers, two 800-h. p. engines and four 400-h. p. generators. Bert L. Baldwin, 227 Main street, engineer.

ST. AUGUSTINE, FLA.—The St. Louis Engineering Company has agreed to give \$100,000 to build an electric road from North Beach to Moultrie, provided \$25,000 is raised in St. Augustine. Captain Adolphus Pacetti has offered to give \$5,000 of the amount. It is understood that the promoters of the St. Augustine Electric Railway hold an option on the charter of the North Beach Railway.

CORNING, N. Y.—F. D. Kingsbury inserts an advertisement in the Corning "Democrat," stating that he has secured control of the charter and franchises of the Citizens' Railway Company, and that he will undertake the work of reorganizing the company, provided citizens will aid. He proposes, as soon as possible, to build a first-class street railway between here and Painted Post. He will personally subscribe one-tenth or more of the necessary funds.

LANCASTER, OHIO.—The stockholders of the Lancaster Street Railroad Company have elected the following officers: Wm. Duffy, president; Dr. G. Mussee, vice president; C. F. Nestor, secretary, and A. Bauman, treasurer and manager. It is the intention, as early as possible, to equip the road with electric cars, when an attempt will be made to extend the line to the Boys' Industrial Home, six miles distant, making a 10-mile road, as was originally intended.

GEORGETOWN, NEAR WASHINGTON, D. C.—The Washington "Star" is authority for the statement that the Metropolitan Railroad Company is considering the question of connecting its line with the various suburban electric lines about Georgetown, and that as soon as the existing question of introducing a new power on their road is settled application will be made at once for the necessary permission. The project of electric lines will also be considered in the application.

FAIRPORT, QUEENS COUNTY, N. Y.—The Long Island Electric Railway Company has been incorporated at Albany, with principal office at Fairport. It proposes to operate a 20-mile road between Hempstead and the intersection of Liberty and the city line of Brooklyn. The capital stock is \$600,000, and the directors are Alexander R. Hart, of Brooklyn; Charles H. Mullin, Mount Holly Springs, Pa.; Charles H. Cooper, William H. English, George W. Millar, of New York, and Clarence, Benjamin and Edward Wolf, of Philadelphia, Pa.

CENTREVILLE, MD.—Steps are being taken for an electric railway to connect Centreville, Churchville, Chestertown, Queens-town, and other cities in the peninsula. W. H. Bosley, of Baltimore, accompanied by a surveyor, has surveyed the proposed

route. The capital stock of the company will be \$500,000, and the incorporators are Congressman John B. Brown, W. W. Busteed and Wilmer Emory, of Centreville, and ex-Mayor Robert C. Davidson, Bartlett S. Johnson and William H. Bosley, of Baltimore. The principal office will be in Centreville.

Personal Notes.

MR. GEORGE F. PAGE, who has been the prime mover in de-



veloping the Concord Land and Water Power Company, and until Jan. 1 its president, was born at Pittsfield, N. H., in 1844. He was educated in the Franklin Academy and Eastman's Business College, Poughkeepsie, N. Y., in the meantime learning the tanner's trade. Immediately after completing his studies he went to Europe and served an apprenticeship to perfect himself in the business of leather making, and on his return to this country he mastered the trade of belt making. He then formed a partnership with his brother, C. T. Page, and under the name of Page Brothers they started in 1868, at Manchester, the business

now conducted under the name of the Page Belting Company, that enjoys almost world-wide reputation. Mr. Page has earned a reputation in the Legislature of New Hampshire, one of his great successes being the passage of a law establishing the Australian ballot system.

MR. E. F. CARPENTER, the general superintendent of the company, was born in Rowe, Mass. He early developed an interest in electrical matters. He was left an orphan at 13, and worked for two years in a saw mill, and then went to Fitchburg, Mass., where he learned the machinist's trade. He was made foreman of the shop while an apprentice, and gained a large experience in steam boilers and engines and in the construction of dynamos. He obtained instruction in mechanical engineering drafting at the Fitchburgh night schools. After completing his apprenticeship he worked at his trade through Pennsylvania and Ohio to Illinois. He then joined the Thomson-Houston Company at Lynn, Mass. He afterwards became assistant electrician of the Loomis Electrical Company, constructing a plant at Gardner, Mass. He held the position of superintendent and manager for nearly three years. He invented an ironclad armature, selling the patent to the Wenstrom Company of Baltimore. He then became electrical engineer for the town of Melrose, designing a large municipal plant there. Next he connected himself with the Edison General Electric Company. In January, 1892, he joined the Concord company, where he brought himself into notice by constructing an entire arc light plant of 100 lights capacity, including line, etc., within 30 days. He is now general superintendent of the company, which has obtained control of all its rivals in Concord.



MR. H. J. ODELL, the treasurer of the company, was born

at Franklin, N. H., and it was in that town that he first engaged in the retail clothing and dry-goods business. His commercial interests brought him in contact with the general agent and manager of the Franklin Woolen Company, who was impressed with his business capacity, and invited him to join the force of that concern. Mr. Odell was rapidly promoted, and soon gained a position of responsibility with that company. He is president of the Franklin Needle Company, and has established a reputation for integrity and energy which made his selection as treasurer of the Concord Land and Water Power Company a most natural one.



JONAS WENSTROM, inventor of the Wenstrom system of dynamos and motors, died at Westeras, Sweden, on Dec. 21, 1893.

Miscellaneous Notes.

WILLIAM MAVER, JR., delivered a lecture on "Telegraphy" on March 5 at Cooper Union, being one of the University extension course of lectures.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY has issued its annual report and catalogue, which show that the course in electrical engineering is more largely attended than any other of the thirteen courses taught; those in mechanical and civil engineering following in the order named. The number of students in electrical engineering for each year from 1881 to 1902 is given as follows: 30, 41, 52, 61, 74, 91, 105, 108, 112, 141.

A MUNICIPAL PLANT.—A committee of the Jamestown, N. Y., Council, in a report on the city municipal lighting plant, states that the superintendent, Mr. Maloney, paid the son of Alderman O'Connell for 22 hours of work a day, and when the latter was sick hired a substitute to whom he paid \$35 per month, but charged the city \$55. Other peculiarities of Mr. Maloney's administration are cited, all of which, however, were excused by Alderman O'Connell on the plea that the superintendent "had been careless in his figuring."

INGRATITUDE.—An injunction has been granted by Judge McConnell, of Chicago, requiring the Siemens-Halske Company to continue furnishing current to Larry McGann's Twenty-second street railway. The company claims that to accommodate Mr. McGann and enable him to hold his franchise it consented to furnish him from 60 to 90 h. p. of current from its factory temporarily for cost. At an extra expense they acceded to Mr. McGann's request to run at night and on Sundays, and were much crippled when it was found that instead of 90 h. p. 200 were required. When a bill was sent in payment was refused and the injunction procured compelling the company to continue furnishing power.

MR. W. J. HAMMER delivered a lecture before the Dryden Literary and Musical Society, of Newark, N. J., on March 17 on "Electricity." The lecture consisted of an elaborate series of experiments in electricity, magnetism and in the appliances of electricity to lighting, power, telegraphy, telephony, war purposes, ballooning, electric heating and cooking, storage of electricity, etc., etc. Some interesting experiments in radiant matter were also shown, and the large stage was filled with an extensive collection of interesting apparatus, which was used in the lecture. Large diagrams were hung on the walls to illustrate the apparatus referred to. Mr. Frank Lawton and Mr. E. J. Cabot assisted.

THE NEW YORK ELECTRICAL SOCIETY.—A lecture on "The Electric Lighting of the World's Fair" will be delivered by Mr. Thomas Commerford Martin at Columbia College on Thursday, March 15, at 8 P. M. The lecture will be profusely illustrated by lantern. In the collection of data and slides Mr. Martin has had the active assistance of Mr. Luther Stieringer, who was the consulting electrical engineer of the Fair. Special attention will be given to night views of the Fair, exhibiting a wonderful advance in the photography of scenery and scenic effects after dark, and exemplifying the beauty of the electric light for spectacular purposes. Among the many points of interest to be treated in this original manner will be: The Electricity Building, the Tower of Light, Scenic Theatre, the dome of the Horticultural Building, the lagoons, Manufactures Building, the big search light, the Fine Arts Building, Administration Building, the Grand Court of Honor, the Stieringer electric fountains, effects produced by electric illuminations, etc., etc. The scenes will be shown in contrast of daylight and night effect.

Trade and Industrial Notes

STERN & SILVERMAN, 707 Arch street, Philadelphia, have had adopted by the Electric Traction Company of Philadelphia, which controls over 100 miles of electric railway, their method of bonding, using the Stern & Silverman bonding chuck.

THE BRYANT ELECTRIC COMPANY, through its Western representatives, Thomas G. and Edward R. Grier, Monadnock Building, Chicago, has issued a circular in compact form calling attention to the standard Bryant electric light fittings.

MR. J. J. RYAN, for six years connected with the Thomson-Houston Company, and later agent of the General Electric Company, in Cincinnati, has taken charge of the office of the Fort Wayne Electric Company, at 288 Noyes Building, Cincinnati.

THE MASON REGULATOR COMPANY, 10 Central street, Boston, will send a box of the Columbian dominoes, which were in such great demand at the National Electric Light Convention, upon receipt of 12 cents, to prepay the cost of postage and packing.

THE SWITCH EXHIBIT of the W. S. Hill Electric Company that was admired by all at the convention recently held in Washington is now at the office of their representative, the Allen & Brewster Engineering Company, 141 Liberty street, New York, where it is attracting a great deal of attention. The new lightning arrester is causing much favorable comment.

THE AMERICAN FUEL ECONOMIZER AND ENGINEERING COMPANY, 136 Liberty street, New York, has issued a handsome and well illustrated catalogue thoroughly describing the American fuel economizer. The pamphlet contains considerable engineering data of importance, and many hints may be gotten from the plans of arrangements of boilers and economizers shown.

THE GRAPHITE LUBRICATING COMPANY, Bound Brook, N. J., has issued a neat 36-page catalogue relating to its graphite and bronze bushings. It will repay any one to send for a copy of this pamphlet and read the testimonials of some of the leading manufacturers of the country, who have become converted to what was even recently considered a mechanical heresy—the use of dry bearings.

THE INDIA RUBBER COMB COMPANY, 9 and 11 Mercer street, New York, sole agents for the sale of Chicago electric wire, is in receipt of a letter from Mr. W. L. Pomeroy, president of the Brush Electric Illuminating Company, of New York, in which he says: "We have been using, since 1889, rubber insulated cable manufactured by the Chicago Electric Wire Company, and it has given us entire satisfaction in every respect."

MR. NATHAN DURFEE AND MR. T. W. SPRAGUE, who, for three or four years past, have been connected with the Thomson-Houston Motor Company, and later with the power and mining departments of the General Electric Company, moving with the latter to New York and Schenectady, have returned to Boston to accept positions with the engineering firm of Westinghouse, Church, Kerr & Co., with headquarters at 620 Atlantic avenue.

THE CENTRAL ELECTRIC COMPANY, Chicago, reports a larger demand for the new iron armored interior conduit, which has been brought out to meet the requirements of a higher grade of construction. Their first order was given by Mr. C. W. Furbeck, 1161 Monadnock Building, who will use it for the wiring of the new west side tunnel. The presence of a large amount of moisture renders the use of a high insulating medium imperative, and this new type of conduit meets all of the exacting requirements.

CHARLES A. SCHIEREN & CO., 45 Ferry street, New York, have recently received an order for a 72-inch three-ply electric belt from the Kearney Cotton Mill, Kearney, Neb. They find that the idea of the perforations is meeting with more favor day by day as people find practical results emanating from them and the satisfaction that the perforated belts give. They pride themselves on keeping up the quality of their electric belting, and intend it shall be the very best belting that can possibly be made under any circumstances for electrical machinery.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., has just received an order from the New Jersey Zinc and Iron Company, at Newark, N. J., for the iron roofs on its buildings. The furnace room will be 50 feet wide and 400 feet long, made entirely of brick and iron. The engine room, fan room and boiler room will be 60 feet wide and 187 feet long, the engine room covered with slate and the fan room and boiler room covered with corrugated iron. Also an order from the Philadelphia Gas Improvement Company for an iron roof for its new coal sheds.

THE BALL ENGINE COMPANY, Erie, Pa., has recently received orders for the following engines for public buildings in different parts of the country: Two 100-h. p. engines to the Criminal Court Building, Chicago; one 100-h. p. engine to the House of Correction, Chicago; one 60-h. p. engine to the Illinois State Reformatory, Pontiac, Ill.; one 100-h. p. engine to the Industrial Home for the Blind, Chicago; two 100-h. p. engines to the State Asylum for Chronic Insane, Wernersville, Pa.; one 135-h. p. engine to the Willard State Hospital, Willard, N. Y.

THE OHIO BRASS COMPANY, Mansfield, Ohio, has issued a handsome catalogue (No. 2) of its manufactures of electric street railway supplies, consisting of construction material, line devices and car appliances. Attention is called to the fact that all of the devices are thoroughly tested for electrical and mechanical defects and approved by the engineering department before being sent out. Although the Ohio Brass Company has not until recently dealt directly with the electrical trade in general, it had been manufacturing construction material for several years for one of the largest supply houses in the West, and its products are now in use on many of the largest roads in the country. The catalogue contains 84 pages, is handsomely illustrated, and should be in the hands of all dealers and users of street railway material.

THE HINE & ROBERTSON COMPANY, 57 Cortlandt street, New York, is having much success with its Union semi-metallic packing, made from a fine quality of imported asbestos cord, braided together in layers, and well lubricated during the process of braiding. Each asbestos braiding is closely covered with a braiding of fine metallic wire, producing an article which is claimed to be a most important improvement in piston rod packings. It is designed for all purposes where packing is employed, but is more especially valuable where a high pressure of steam is used, as the most intense heat has no effect on it. For some months past it has

been tested by experts in one of the most prominent departments of the United States government, as well as in many other places, where pressures varying from 125 to 160 pounds are used, with most gratifying results.

THE WHITNEY ELECTRICAL INSTRUMENT COMPANY has given up its Boston office, and its business will hereafter be conducted at its factory at Penacook, N. H. A reorganization of the company has been effected as follows: Hon. D. B. Varney, president; F. T. Dunlap, vice president; D. H. Young, treasurer; O. B. Green, secretary; E. R. Whitney, financial manager, all of whom are well known New Hampshire capitalists; Dr. A. H. Hoyt, electrician, and Henry F. Kellogg, general selling agent. Mr. James F. Preston, its former treasurer and general manager, still retains an interest in the company, but will take no active part in its business conduct, which will be a source of regret to all who have had business dealings with him, as he is the embodiment of courtesy and kindness. The present successful condition of the company is largely due to his energy and well directed efforts. The company is to be congratulated that it retains the services of genial Henry F. Kellogg as general selling agent, who is popular with the trade generally and possessed of exceptional abilities.

M. T. DAVIDSON, 77 Liberty street, New York, is much pleased with the praise received for the working exhibit of Davidson pumps at the World's Fair, which aggregated a pumping capacity of 5,000 h. p., and received an award. M. J. Dodds, operating engineer of the N. W. T. B. Co., in a recent letter says: "For many years I was led to believe that single acting pumps were not as reliable as boiler feed pumps. I am satisfied now that I was wrong. In the World's Fair Machinery Hall boiler house I had two of your make to feed our boilers (National water tube boilers of 1,500 h. p.) from March, 1893, to January, 1894, and I must say I was surprised with the regularity of feed, the water often registering 210 degrees Fahrenheit. I did not have the least trouble, something I cannot say for the injectors, which I never used except when compelled to do so. For your pumps in the future I shall always have a good word, because having seen all the different types of pumps in operation before, during and after the Exposition, I prefer yours to all of them."

THE PHILLIPS INSULATED WIRE COMPANY, of Pawtucket, R. I., is now located in its factory at Darlington, just on the outskirts of Pawtucket, and actively engaged again in the manufacture of its well known wire specialties. Its new factory is imposing and handsome, is built of brick with granite trimmings, and is 186 feet by 50 feet, with three stories and a basement. It is solidly built throughout, with a view of enabling the floors to bear the weight of the heaviest machinery, and its large amount of window space affords abundance of light and cheerfulness. It occupies, all told, 36,000 square feet of floor space. Its power plant consists of a 100-h. p. horizontal tubular

boiler, from the Bigelow Works, New Haven, and a 60-h. p. Green engine, built by the Providence Steam Engine Company. Ample space is left in the power house for the addition of another 100-h. p. boiler, should occasion arise for additional power. It possesses also an electric plant capable of generating power for 200 incandescent lights. Particular attention has been given to the steam heating of the building, also to the system of sprinkling, the building being thoroughly equipped with the Newton automatic fire extinguisher. Its plumbing, it is said, cannot be surpassed in any building erected for manufacturing purposes. The offices are in the northeast corner of the building, and tastefully fitted up, and in thorough keeping with the brightness of the countenances of Treasurer H. O. Phillips and Secretary F. L. Smith over their new homes and their happy anticipations for a successful future. Considerable land is held in reserve for the growth of its business. The location of the factory is on the East Providence branch of the New Haven road, near the Darlington station, and the best of freight facilities is afforded.

MR. W. L. FAIRCHILD, 521 Kirk Building, Syracuse, N. Y., has recently received the appointment of electrical engineer for the city of Jamestown, N. Y., which is going to expend over \$30,000 in betterments on its electrical plant, and has also been appointed engineer for D. McCarthy & Co., of Syracuse, who are going to build a block and will install a very large electric light plant. Mr. Fairchild has had experience in the electrical business for a number of years, and has recently started out in this branch on his own account, with flattering prospects of success.

THE ELECTRICAL APPLIANCE COMPANY, of Chicago, is one of the firms that bear evidence of the rapid development of electrical interests in the West. Their headquarters at 242 Madison street are most complete in arrangements for handling large quantities of supplies with great facility, and their line of specialties has always been considered standard. Visitors to the World's Fair will remember the exhibit of this house as one of the most attractive in the Electricity Building, where their display of "O. K." and "Paranite" wires and cables was handsomely set off by an artistic illuminated sign of "Packard" lamps flashing in various colors. During the Fair, and since, they have been very busy with orders, notwithstanding the general business depression, and they are now regarded as one of the first supply houses of the West.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED FEB. 27, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

515,321. INSULATING THIMBLE; I. A. Brown, Toledo, Ohio. Application filed April 5, 1893. An insulating thimble having its closed end increased in thickness, reduced in size near its open end and increased in thickness at or near its open end.

515,333. METHOD OF PEROXIDIZING LEAD; W. W. Griscom, Haverford, Pa. Application filed July 17, 1893. An electrolyte comprising water, sulphuric acid and nitric acid, in which the ratio of sulphuric to nitric is more than three to one.

515,342. ELECTRIC ARC LAMP; G. Kirkegaard, Brooklyn, N. Y. Application filed June 19, 1893. This comprises a frame pivoted at or near its upper end, and carrying a clockwork located below the pivotal point, in combination with an electromagnet acting upon the frame to swing on its pivot. (See illustration.)

515,366. ELECTRICAL RAILWAY SIGNAL; H. V. Riley and C. Selden, Baltimore, Md. Application filed Oct. 5, 1893. A differentially wound polarized relay, so wound that when the circuit is closed through both windings during the same interval of time the operation of the magnet will cause its local points to assume a certain position.

515,374. ELECTRICAL CONTROLLER; E. A. Sperry, Cleveland, Ohio. Application filed Aug. 23, 1893. In a controller, a cover provided with a slot for the operating handle, an apron overhanging the slot, and a handle protruding upward within the slot.

515,386. DYNAMO ELECTRIC MACHINE. J. Wenstrom, Orebro, Sweden. Application filed March 6, 1893. In a dynamo electric machine, the combination of the two poles with a field magnet, of an armature attached to one of the poles and having a continuous uninterrupted surface adjacent to the air gap, and a keeper of solid magnetic material, revolving in the air gap between the armature and the other pole.

515,397. ELECTRIC GAS LIGHTER; J. O. Dahlgren, Boston,

Mass. Application filed Dec. 30, 1893. The combination of a gas cock having attached to it an electrode and a spring pressed lever attached to a projection on the plug and carrying in one end an insulated electrode and in the other a pivoted pawl.

515,401. ELECTRIC HEATER; A. S. Hatch, Windsor, Canada. Application filed March 27, 1893. This comprises a face plate having an open base and an apertured upper portion, a series of open, rectangular insulated frames arranged one above the other and out of contact, and a heat developing conductor wound spirally around the frames.

515,420. WIRE COUPLING; D. A. Byers, Denver, Col. Application filed March 13, 1893. A coupling composed of an integral open ended tube enlarged interiorly and a detachable plate covering an opening leading to the central chamber.

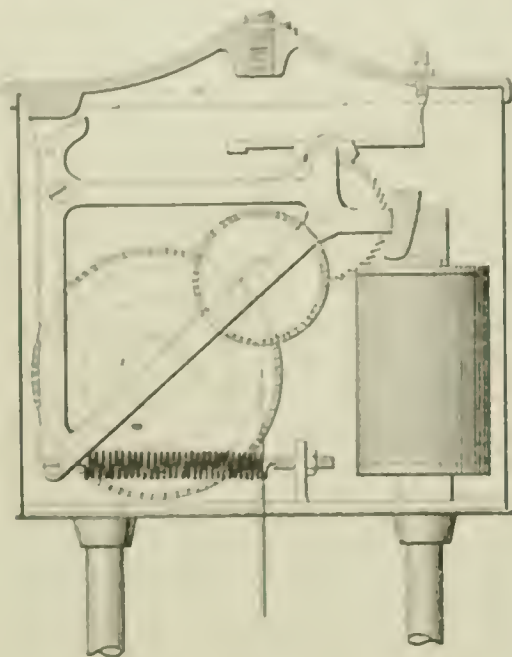
515,432. PRIMARY BATTERY, C. J. Hubbell, Boston, Mass. Application filed May 31, 1893. This comprises a zinc element having a stud of metal projecting centrally from it and adapted to extend downward into a mercury cup; with the mercury cup connected electrically to one of the binding posts of the cell.

515,448. FIXING ELECTRIC CONDUCTING WIRES TO INSULATORS SUPPORTING THE SAME; R. Shomburg, Berlin, Germany. Application filed March 29, 1893. An insulator carrying a clamping device and means for operating the clamp, consisting of a bolt passing through the insulator and having eccentric discs at its ends.

515,465. ELECTRICAL GLOW LAMP; H. Cottrell, Newark, N. J. Application filed March 30, 1893. An exhausted bulb having a single conductor only, and a single conductive coating in electrical connection with such conductor through the source of current.

515,467. ARMATURE FOR ELECTRIC MACHINES; W. Fritzsche, Berlin, Germany. Application filed July 11, 1893. This comprises a hub, a core built up of a series of interspaced elements arranged radially on the hub, and conductors contained in the spaces between the elements and arranged parallel with the longitudinal axis of the core. (See illustration.)

- 515,473. REGULATOR FOR CONTINUOUS CURRENT ARC LIGHT CIRCUITS; D. Higgin Boston, Mass. Application filed May 11, 1892. This comprises an electromagnetically device corresponding to wave variations of current, and acting to stable the main or generated current, combined with a second device responding slowly to variations of mean intensity of current and acting to regulate the main or generated current.
- 515,475. BOND FOR ELECTRIC RAILWAYS; J. Meyer, New York, N. Y. Application filed Oct. 21, 1893. The combination with the end rails of metallic plates located below the rails and provided with downwardly extending lugs and bonds connecting the lugs.
- 515,484. SOCKET FOR INCANDESCENT LAMPS; L. Stirn, New York, N. Y. Application filed June 22, 1892. A socket containing a shaft with a ratchet wheel and carrying a spring actuated pawl lever, to which a cord is connected, and a check pawl engaging the ratchet wheel.
- 515,485. LAMP SOCKET; L. Stirn, New York, N. Y. Applica-

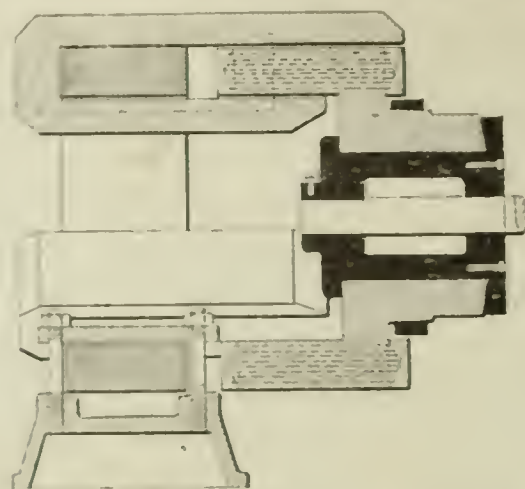


NO. 515,312.—ARC LAMP.

tion filed Nov. 18, 1892. The combination with a disc of two screws on the upper surface of the same, a cylindrical socket provided with a bottom flange and two opposite notches and two opposite hooks on the flange, the hooks being adapted to pass under the heads of the screws.

- 515,489. ELECTRIC MOTOR; C. Doriot, Philadelphia, Pa. Application filed March 11, 1893. The combination with the motor frame having a base portion projecting at one side of belt guide pulleys mounted on the projecting portion.
- 515,502. SECONDARY BATTERY; L. B. Rowley, Ashland, Wis. Application filed Feb. 7, 1893. A secondary battery electrode, consisting of the combination of a series of tubes, horizontally disposed, and two uprights, by which the tubes are supported, a space being left between the adjacent tubes for the circulation of the electrolyte.
- 515,503. AUXILIARY FIRE ALARM TELEGRAPH SYSTEM; J. Sachs, New York, N. Y. Application filed Feb. 15, 1893. This comprises a box having signal sending devices, a signal box having similar devices, and main and auxiliary circuits, both of which enter both of the boxes. (See illustration.)
- 515,531. SWITCH AND CIRCUIT FOR TELEPHONE EXCHANGES; J. J. O'Connell, Chicago, Ill. Application filed April 17, 1893. The combination with a plug cord of a switch or key having a part extending into position to be shifted by the cord as the latter is moved.
- 515,572. CONDUIT ELECTRIC RAILWAY; J. A. Cassidy and W. A. Butler, New York, N. Y. Application filed Aug. 24, 1892. In combination with a car, an electric contact bar, pendulum contact levers arranged within a conduit and mounted in protective boxes, and toggle mechanism connecting the bar to the car and for elevating and lowering the bar.
- 515,589. SIGNALING APPARATUS; O. D. and M. A. Kleinstaubler, Milwaukee, Wis. Application filed April 8, 1893. A steam whistle having controlling valve adapted to be operated by a lever arranged to act when released by an electric current.
- 515,606. INCANDESCENT LAMP SOCKET; R. C. Nourse, South Framingham, Mass. Application filed May 31, 1893. The combination of a head and base of insulating material, a metallic shank connecting the same, a contact plate affixed to the base, a contact spring affixed at one end to the head, and a rotary key rod in the head and provided at one end with a cam formed to depress the spring into contact with the contact plate when in one position and to permit the spring to separate from the plate when in another position.
- 515,613. CURRENT COLLECTOR FOR DYNAMOS; C. R. Roberts, Addison, Pa. Application filed Aug. 21, 1892. The combination with the commutator cylinder of a dynamo, of two endless belts of conducting material, and adjustable sheaves for supporting the same.

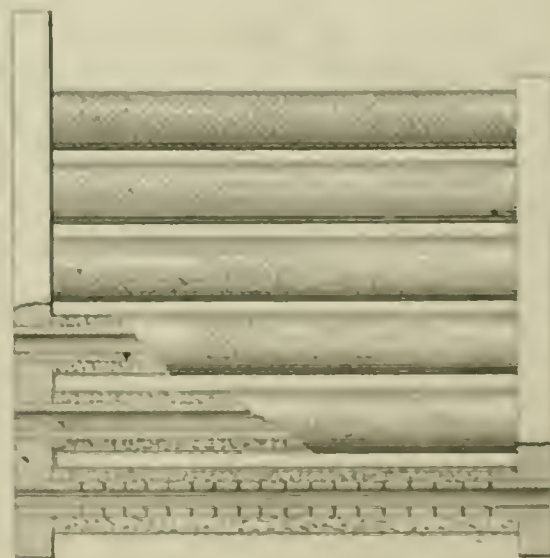
- 515,628. ELECTRIC ALARM SYSTEM FOR RAILWAY CROSSINGS; A. J. Wilson, Port Chester, N. Y. Application filed April 25, 1893. The combination of three independent track sections in line, a magnet for each section, the middle section magnet being incapable of operating when both end section magnets are



NO. 515,467.—ARMATURE FOR ELECTRIC MACHINES.

operated, a signal circuit in the operative condition when the middle section magnet is not operated and an end section magnet is operated.

- 515,648. AUTOMATIC ELECTRIC RAILWAY SYSTEM; C. F. Breese, New York, N. Y. Application filed March 22, 1893. The combination of two track sections, two independent magnets and a relay magnet for each independent magnet in a compound circuit, one branch of which is controlled by the relay magnet itself and an independent magnet jointly, another branch of which is controlled by the other relay magnet, and a third branch of which is controlled by the two independent magnets jointly.
- 515,652. APPARATUS FOR ELECTRICALLY HEATING OR WORKING METALS; C. L. Coffin, Detroit, Mich. Application filed Feb. 9, 1893. This comprises electrodes for the passage of current and an arc distributor with mechanism for changing its relation to the electrode during work.
- 515,654. ELECTRIC RAILWAY; B. F. Comstock, Decatur, Ill. Application filed April 13, 1893. The combination of a trolley arm provided with a yielding rod, of a plate having pointed ends and provided with rollers having wheels or flanges at their ends.
- 515,655. SIGNALING APPARATUS; J. W. English, New York, N. Y. Application filed Oct. 26, 1893. This comprises a plurality of targets arranged in series, each target comprising a common staff and oppositely projecting signal flags at opposite ends of the staff, a motor for each target geared to swing the same, and a containing case for the mechanism, the case having a single slight aperture before which the targets appear.
- 515,693. ELECTRIC HEATER; S. E. Nutting, Chicago, Ill. Application filed April 27, 1893. This comprises electric wires provided with terminals embedded in a non-conducting cement and



NO. 515,502.—SECONDARY BATTERY.

between two layers of a flexible non-conducting material.

- 515,709. TELEGRAPHIC INSTRUCTOR; T. J. Houck and H. M. Browning, Baltimore, Md. Application filed Sept. 21, 1893. The combination of a pivoted operating lever, signal wheel, contact finger to make and break contact when the signal wheel is turned, a spring adapted when wound to turn the signal wheel, a lever connecting with a rock shaft, and means for regulating the speed of the signal wheel.
- 515,716. INSULATED PIPE COUPLING; G. Peeples, Philadelphia, Pa. Application filed June 5, 1893. This comprises an upper section with a threaded neck, a ring adapted thereto, and insulating material between the meeting faces of the rings.

The Electrical World.

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No. 12.

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1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 289 " "
1884 " 82 " "	1891 " 325 " "
1885 " 100 " "	1892 " 316 " "
1886 " 138 " "	1893 " 317 " "

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CHANGES IN OUR DIGEST.

The number of articles which a complete record of current foreign electrical literature must notice has become so great that some of the abstracts in the Digest often become quite short in consequence; much interesting and useful information in these abstracts is thereby crowded out, making the record more like a mere index, which would be of much less value than a true digest. In order to be able to devote more space to these abstracts, certain references will hereafter be omitted, as explained in a note in this issue, and we trust that the readers of the Digest will agree with us that the usefulness of this department will be increased by making these unimportant omissions.

LICENSEES OF PATENTS.

The recent memorandum handed down by Judge Lacombe defines the right of users in licensed territory in regard to a patented article bought from other than the licensee of such territory. In the present instance the Imperial Hotel, which had been enjoined from using other than Edison lamps, purchased such lamps from dealers outside of New York, and the Judge decided that in view of the defendant's claim of ignorance of the restrictions under which the sellers were not to dispose of lamps in licensed territory, the motion for punishment for contempt of court was denied. The memorandum quotes the proposition that once lawfully made and sold, there is no restriction on the use of a patented article in favor of the patentee or his licensees, and points out that a patentee who wishes to divide his rights territorially is dependent upon the good faith of those to whom he sells. He may protect himself either by selling his lamps only to persons on whose honesty and responsibility he can rely, or require from them sufficient security for damages through failure to keep faith, and cannot charge the purchaser with knowledge of agreements made with those from whom he buys lamps. The effect of this decision would seem to be likely to curtail still more the dearly bought privileges of the Edison licensees.

JUDGE RICKS' OPINION.

The opinion of Judge Ricks in the case of the Universal Electric Company contains two points of great interest. In the first place, it narrows the opinion in the Buckeye case to the point that the Buckeye company had obtained vested rights by investments made when it was generally thought, and with good reason, that the Edison patent was invalid; that its grounds were further strengthened by knowledge of the endorsement of the Edison attorneys on the Edison lamp patent, limiting its life to November, 1893, and by acquiescence in its sale and manufacture of lamps even after Judge Wallace's decision. All of this placed it in the light of a company that had made investments in good faith and consequently one that could not be made to suffer by the subsequent revocation of an act upon which it with reason had relied. The other point is in the concluding portion of the opinion, where the judge refers to two contentions of the plaintiff which, he apparently goes out of his way to remark, "might be of very great importance in connection with the case if presented in a different phase." These are, that the endorsement of December, 1883, was entirely void for want of jurisdiction of the Patent Commissioner, and the record, not one of which the public were obliged to take notice; and that it was not binding on the complainant, for

the reason that its license antedated the endorsement, and therefore could not be affected by proceedings in the Patent Office of which the licensees had no notice.

THE PRACTICAL PROPERTIES OF POLYPHASED APPARATUS.

In this issue we give the concluding portion of Dr. Bell's Institute paper on polyphased apparatus, which is undoubtedly the most important contribution on the practical side of the subject that has yet been made. In the present section the questions of frequency are discussed from various standpoints, and while it will be seen that special considerations largely enter in the choice of the number of frequencies, yet there seems to be little reason for going above 60, and to go below 30 is pronounced a wanton disregard for the most characteristic advantages of the alternating system. The remarks on static capacity are timely, as this subject and the effects of resonance do not seem to have received the attention their practical importance warrants. As to the saving of copper with different alternating systems, that depends upon the basis of comparison. If the effective E. M. F. is taken, then the results of the author are approximately correct, the saving in the interlinked two and three phased systems over the simple alternating system being 27.1 and 25 per cent. respectively. If, however, we consider the stress on the insulation, which would appear to be the only true criterion, then, while the saving of the interlinked, three-phased system would remain 25 per cent., the two-phased system, with three equal wires, would require 50 per cent. more copper than the simple alternating system, or 45.7 per cent. more with the same density of current in all three of the wires, one being 1.4 times larger than either of the others. The author calls attention to the absurdity of comparing the copper efficiency of direct and alternating currents not only because they are not competitors in practice, but also on account of the unknown but probably considerable weight of the electrolysis factor in the former case.

AN IMPORTANT PATENT CASE.

The celebrated Bate refrigerator case has at last been argued before a court of final jurisdiction and the decision will be awaited with much interest in electrical circles. Should the court conclude to reverse former decisions and decide that the language of the Revised Statutes shall be interpreted not according to their meaning, but according to the supposed intent of the framers of the original law, a new field of litigation will be opened up that seems to be boundless in extent. As to the case at issue, among the important effects of a reversal will be to prolong the life of the Edison lamp patent to 1897, extend the life of the Edison carbon telephone patent, and similarly affect important patents in every branch of the electrical industries. Among other questions dealt with in the arguments is the intent of our patent policy as regards the public and inventors. Mr. Peckham in his argument held that patent legislation is not class legislation, not primarily for the benefit of the inventor, but for the benefit of the public, and the Constitution and Supreme Court are quoted as authorities. A patent, it is stated, is given, not to reward merit or as a bounty, but as a compensation to secure a public benefit upon just terms, which shall recognize and protect the inventor's property in his invention by giving him a monopoly therein in return for its disclosure, but shall also protect the public against exorbitant demands by limiting that monopoly to a fixed and uniform term, that is deemed adequate to furnish a proper compensation. It is argued that there is no injustice to a patentee in restricting the life of his American monopoly, which is the only one that can be reached, when he is at the same time enjoying further compensation from other countries. It is also held that if the construction asked for is granted three objects which the law now subserves will be defeated: First, to cause an invention patented here

and abroad to be free to the public here as soon as it is free abroad; second, to promote the earlier introduction of the patented invention in this country; third, to secure some allowance to the American public on account of the further monopoly enjoyed in foreign countries. It is also claimed that the change would delay the issue of the American patent until after all of the foreign patents were secured, and thus plainly nullify the spirit of our patent laws. On the other hand, the counsel for the appellants claim that the construction they ask for is in conformity with reason and justice. That an applicant for an American patent who has satisfied every requirement of diligence and promptitude in making his application, and thus entitled himself to a patent for his invention for the full term of seventeen years, should, be subjected, in consequence of something thereafter happening over which he has no control, to the penalty of having his patent abridged for a period, it may be, of many years, and even, as possible, of losing it altogether, is they maintain, repugnant to every sentiment of justice. This view is elaborated throughout the argument and seems to have been met with difficulty by the other side, who apparently rely more upon the previous decisions sustaining their point and upon their contention against going behind a statute to change the plain meaning of its words.

GERMAN SERIOUSNESS.

Under the heading "Another Startling Discovery" in our issue of Feb. 3 we published a little amusing filler from a German paper not thinking for a moment that any one would believe we meant seriously that it was what the title claimed, or that there was a shadow of truth in the statement. We thought that the language we used would suffice to show our opinion of the absurd claims, and we are therefore greatly surprised, and a little discouraged, to find that a leading German contemporary—we have too much respect for it to mention its name here—credits us with really believing this absurdity. For the benefit of its editor and other Germans who may have had the same unfortunate impression, we state here in plain terms—and we mean it seriously this time—that our knowledge of electricity leads us to believe that that inventor is mistaken—to put it mildly. It appears that this clipping has, like most of its kind, gone the rounds of the press, and as it was published also in this German journal, its editor asks us to kindly state the name of the "German journal whose title leads one to believe that it is a scientific paper"—evidently believing that we meant his journal. We regret not being able to give the source, but are pleased to assure him that it was not his journal, which we esteem very highly, even though its editor failed to grasp our attempt at ridiculing. It reminds us of a saying that "Germans must club together to understand a joke." Acknowledging our humiliation, we promise to try to do better, and hereafter when we are not serious we will adopt the English plan and explain in parentheses exactly where the point of the joke lies, what the joke really is, and what it would have been if there had been no intention of being sarcastic, etc.—at least when it is intended for our German friends. We admit that this is a safe rule even though Americans would rather not try and say anything amusing if they have to do it in that extremely thorough way.

Honesty the Best Policy.

It is the policy of some English journals to give little or no credit to America for what it has done, even though the editors must sometimes think the contrary—if they are reasonable and if they read anything outside of their own paper. It is therefore very refreshing to find the following in such a high-class journal as "Industries and Iron." In referring to the Niagara Falls plant it says: "America is the raising ground for able, fearless and persevering practical men suitable for dealing with such problems as these."

A. E. Kennelly.

Among the electricians of the younger generation there are very few to whom it has been granted to have given to the world so much that is of permanent value as has Mr. Kennelly. His investigations have included many branches of electricity, and in each one his work now forms an integral and important part of the structure of the science. The Kennelly law of copper exposure resistance has rendered the localization of faults on cables, in most cases, a comparatively simple matter. The Kennelly law connecting ferric reluctivity with intensity of magnetizing force is destined to be of the greatest importance when it becomes necessary, as it soon will, to take into account more precisely the secondary effects of iron in alternating current circuits. His results on the heating of conductors in air, in conduits, underground and submerged in water, have become classical, and form the basis of nearly all the tables now in use. The introduction, due to him, of complex quantities into alternate current equations is a mathematical advance of the first order, of what importance may be seen from Mr. Steinmetz's paper on the subject, and from Mr. Kennelly's further application of it, in conjunction with hyperbolic functions, to the solution of the very complicated phenomena of flow in circuits having leakage, capacity and self-induction, in addition to resistance. By a recent application of the latter methods he has raised telephony from an empirical to an exact science.

Mr. Kennelly was born in Bombay, Dec. 17, 1861. It is from his father, at that time commander of a frigate in the East India Navy, that Mr. Kennelly has inherited in large part his well-known mathematical ability. He left India at an early age for the purpose of receiving an education in Europe, and finally entered the University College School, London.

While at this institution, in 1875, his attention was turned to electricity by a lecture of Mr. Latimer Clark on telegraphy, and on leaving University College School, in 1876, he became assistant secretary at the office and Ronalds Library of the Institute of Electrical Engineers (then the Society of Telegraph Engineers).

As a result of his studies at the Ronalds Library, he was enabled to enter the service of the Eastern Telegraph Company in 1877, and from thence onward promotion was rapid. In 1880 he became assistant electrician on board the steamship John Pender, and in 1881 became chief electrician on board the same vessel. Later he served in the same capacity on several other vessels in the company's service, and was employed in work over all parts of the Eastern Telegraph Company's submarine cable system.

It was during this period that he discovered the law of fault resistance known by his name, and which is now so much employed in cable testing, and in 1887 he published a paper on the subject which received the "Society's premium" for that year.

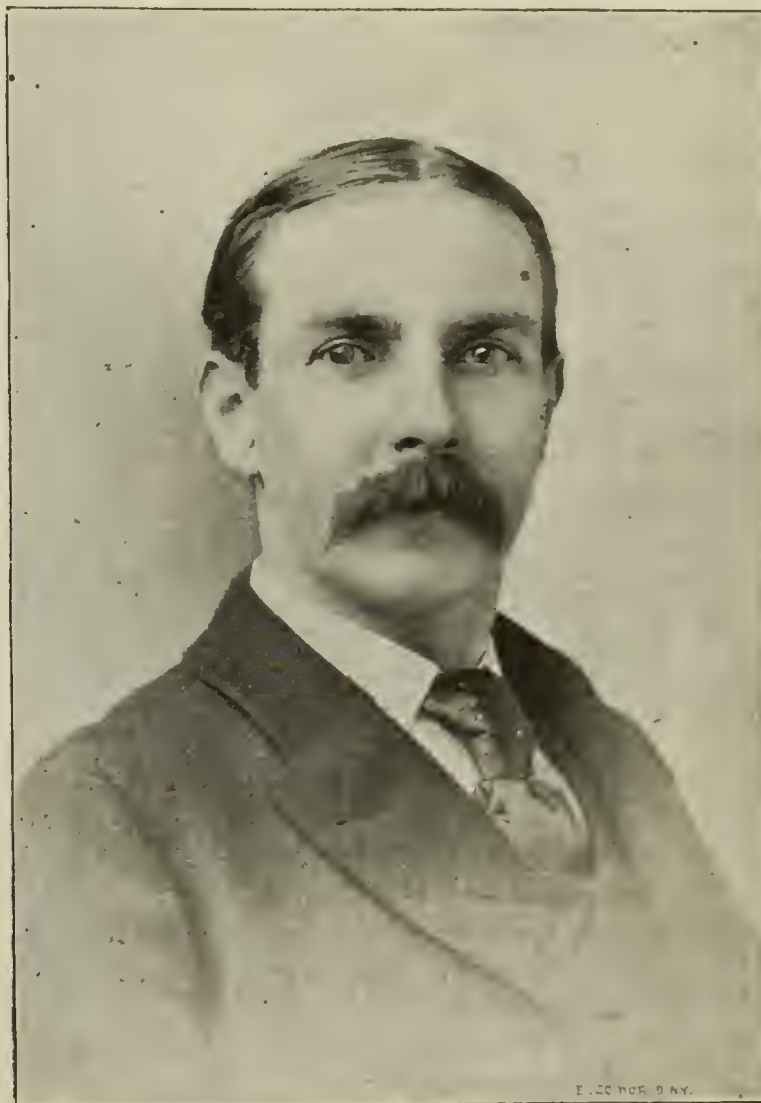
Other methods originated by Mr. Kennelly about the same time were the method of fault localization (a combination of Clark's method with the Wheatstone bridge), given in Jamieson's pocket book, pages 167-168, and, in conjunction with Mr. James Anderson, of what is known as the "earth-overlap" test.

In 1888, while senior electrician afloat of the Eastern Telegraph Company, he resigned his position to accept that of electrician to Mr. Edison, then just commencing work in his new laboratory at Orange, and was shortly afterward appointed consulting electrician to the Edison General Electric Company and later to the General Electric Company. He has recently left Mr. Edison's laboratory to enter upon electrical engineering work in Philadelphia with Prof. Houston, under the firm name of Houston & Kennelly.

Mr. Kennelly is a vice president of the American Institute

of Electrical Engineers, and chairman of the committee on units and standards of the same body. He is also a member of the New York Mathematical Society, of the Astronomical Society of the Pacific, an associate member of the Institute of Electrical Engineers of London, and a fellow of the Royal Astronomical Society.

Mr. Kennelly's work, as the readers of the technical journals are aware, has covered a wide field. Owing to his connection with the Edison company, necessarily but a small portion of his work in electrical engineering has been published. Through the courtesy of that company, however, his experiments on the heating of electrical conductors have been given to us. The first of the papers on this subject was read before the Association of the Edison Illuminating Companies in 1889, and upon the results contained in it, as mentioned above, almost all the tables at present in use have been based. The treatment of the subject was completed last year by a second one¹ on the carrying capacity



A. E. KENNELLY.

of cables underground and submerged in water, and this latter paper bids fair to be as valuable as the former.

Mr. Kennelly's discovery of the law of resistance of an exposure of a conductor to salt water and his other work on the localization of faults have already been referred to. They are generally considered to be among the most important contributions to that subject.

For the reason given most of his published work has been in a purely scientific line. A considerable number of laboratory methods are due to him, among others a method of measuring mutual induction, which appeared in *The Electrical World*, Oct. 5, 1889; a magnetic bridge, described in the same paper,² and which is probably the most convenient and accurate way at present known of rapidly making permeability tests; a method of measuring the temperature coefficient of copper,³ which formed the subject of a paper read (in conjunction with Prof. Reginald A. Fessenden) at the Electrical Congress at Chicago, and a number of other

¹The *Electrical World*, Sept. 2, 1893.²The *Electrical World*, Sept. 9, 1893.³The *Electrical World*, Oct. 7, 1893.

methods which have from time to time been published in the electrical papers.

Among the more important instruments designed by him may be mentioned the differential dynamometer wattmeter, an instrument by which, the primary of a transformer being suitably connected to one set of coils, and the secondary to the other set, the losses in the transformer at any load may be read directly from the instrument; a static voltmeter* now in use in street railway stations, and which overcomes the difficulties met with in other forms of the instrument; and the ammeter bearing his name, which are made by the Edison Manufacturing Company.

Among the papers dealing with theoretical subjects is that on "Reluctance," read before the American Institute of Electrical Engineers (October, 1891), in which the law connecting ferric reluctivity with intensity of magnetizing force was first stated. In passing, it may be pointed out that the statement made by some authorities (e. g., Prof. S. P. Thompson, "Dynamo Machinery," page 169) that this law may be derived from the hyperbolic formulæ of Stoletow and other experimenters, is incorrect. There is no connection between them, as they do not deal with the same physical quantities. The formulæ referred to give relations between the reciprocal of the total permeability and $\mathcal{H}$, and are approximately accurate for low magnetizations only. The formula given in the paper on "Reluctance" is concerned with a relation between the reciprocal of the ferric permeability and $\mathcal{H}$, and experimental evidence shows that it holds up to the highest point to which saturation has been carried. The introduction of the ideas of ferric permeability, ferric reluctivity, etc., form an important advance in the theory of magnetism.

Other papers read before the Institute are those on "Inductance and Its Proposed Unit, the Henry" (December, 1899), and on "Impedance" (April, 1893). It was in this latter paper that the use of complex quantities in alternating equations was first proposed, a suggestion which has given to us a method of dealing with such equations much more powerful and simple than we possessed before.

Other recent papers give for the first time the methods of calculating the drop on long lines carrying high potentials* and an application of the same method to the problems of telephony, which enables us to calculate very approximately what the efficiency and behavior of any given line will be.

One of the most striking features of Mr. Kennelly's papers is their admirable clearness. If true art, as a well-known painter has said, is shown in the absence of the appearance of effort, then his papers may lay claim to being truly artistic productions. In the latter papers mentioned, for instance, so simply and lucidly is the subject dealt with, that not every one would suspect that the formulæ employed were really a transformation of some of Oliver Heaviside's most unmanageable equations into a form in which they can be used by every electrical engineer to work out the most complicated problem of alternate current circuits.

Mr. Kennelly is the author of two books. One, "Practical Notes for Electrical Students," written in conjunction with Mr. Wilkinson, and a later one, "The Theoretical Elements of Electro-Dynamic Machinery," in which the subject is dealt with, in a great many cases, from an entirely new standpoint, so that one turns the last page with the realization of the fact that his views have been greatly broadened, and that what one had supposed to be a more or less complete conception of the subject, was in reality but an incomplete and one-sided view.

Mr. Kennelly's work as the chairman of the committee of units and standards is well known, as also his work as

a member, in conjunction with Mr. Carl Hering and Prof. Anthony, on the Institute programme for the Chicago Congress. One result of his labors in the latter connection was the extension to him and to Mr. Carl Hering of a special invitation to attend the meetings of the official delegates to the congress, and although all the plans of the committee were not carried through by that body, there is little doubt but that in the end most of them will be accomplished.

The appreciation in which the work of Mr. Kennelly is held by those exceptionally competent to judge was illustrated recently at the last meeting of the National Electric Light Association. Prof. Forbes, in the course of some remarks on the calculation of alternating current effects, paid the following tribute:

"Any paper presented to the convention on this subject which does not mention Mr. Kennelly's name would be defective. Of all the beautiful expositions of profound mathematical work in the simplest language which can be understood by any student in our technical colleges, there is nothing in the literature of the day to come up to the writings of Mr. Kennelly for the last year or so." Mr. C. F. Scott, electrician of the Westinghouse company, said: "I heartily agree with Prof. Forbes in his remarks concerning Mr. Kennelly. The article* he brought out a month or two ago treating the problem of the alternating current circuit in its relation to self-induction, capacity and insulation resistance, is a very comprehensive and elegant solution of the general problem."

Electricity on the Canals.

Superintendent of Canals Edward Hannan has granted a fifty-year permit to the Cataract General Electric Company authorizing it to enter upon all canal lands of the state for the purpose of constructing either on or over or under either canal bank a system for propelling canalboats by electricity, without interference with the present method of operation. Central power houses may be erected. The rates for towage shall be subject to modification and review by the State Superintendent of Public Works, but such rate shall not exceed \$20 per electrical horse power for any season of navigation. An important provision is that the company may, so long as the wants of the canal are supplied, employ its electric plant along the line of the canal in furnishing electric light, heat, and power for distribution to any point or points beyond the line of the canal. The company is to furnish the state, free of charge, sufficient power to operate motors to open all gateways leading to and from locks, and also electric lights sufficient to properly illuminate such locks at night.

The company must have its plant for operating boats by electricity in operation on the Erie Canal between Buffalo and Albany within three years from date, or else the privilege accorded by the permit shall be forfeited.

The company will obtain its electrical power at Niagara Falls, from the Niagara Power Company, and transmit it to Albany along the line of the Erie Canal. There is another company, having the same directors as the Cataract company, called the Erie Electric Towing and Power Company, with principal office in New York City. This company will construct and put in operation as soon as possible, a half-dozen tugboats, operated by electricity, either on the storage or trolley system, with a view of showing the adaptability of electricity to canal navigation. These tugboats will also tow for a moderate consideration any horse boats, the captains of which desire to avail themselves of such method.

Mr. Hawley states that \$20 is the maximum charge that can be made, but that the rate will undoubtedly be much lower. Even at \$20 a horse-power, he says that an owner would be saved 50 per cent. a season on the operation of his boat, in comparison with the present cost of propulsion.

*The Electrical World, Oct. 27, 1893.

*The Electrical World, April 22, 1893.

*The Electrical World, Jan. 6, 1894.

*The Electrical World, Feb. 17, 1894.

*The Electrical World, Jan. 6, 1894.

Polyphase Transmission.—II.*

BY CHAS. F. SCOTT.

POLYPHASE CIRCUITS.



THE subjects which have so far been considered apply to single phase as well as to polyphase circuits. The effects of self-induction will be brought to the attention of the electrical engineer much more prominently in connection with polyphase work, however, because larger alternating current enterprises will be carried out with the polyphase system, and power work involving variable power factors will be a large element in this system. There are, in addition, several problems which relate distinctively to polyphase working. One of these is the most suitable number of phases to be used. The two-phase system and the three-phase system are both in operation, and while it is admitted by the adherents of each system that there is no fundamental difference between them, yet each has specific characteristics giving particular advantages.

ADVANTAGES OF THREE PHASES.

It has been recently emphasized by a good many people that the single-phase system and the two-phase system require the same weight of copper, and that the three-phase, three-wire system requires 25 per cent. less for transmitting power under similar conditions with the same maximum E. M. F. This places an advantage on the side of the three-phase system, which in many cases is of very considerable importance. The aggregate advantage, however, is greater than 25 per cent. A two-phase system laid out for the greatest economy requires that the interest on the cost of conductors shall equal the cost of the power lost. If the three-phase system be substituted, the loss may remain the same, and the copper will cost 25 per cent. less. This does not give the best relation between cost of copper and loss of power, so that a more economic adjustment is possible.

It has also been shown that the self-induction of a three-phase, three-wire circuit for transmitting under similar con-

is the effect of loading one branch of the system more heavily than the others, as is common in incandescent lighting. One of the statements which remain uncontroverted in Prof. Forbes' recent comprehensive and remarkable paper upon the "Electrical Transmission of Power at Niagara Falls" is in reference to the difference of regulation in dynamos for two-phase and for three-phase alternating currents. He gives the result of tests showing that the circuits of a three-phase generator differ greatly in pressure if they are not equally loaded, and states that having considered these points the directors of the company determined to reject the three-phase system. These results agree fairly well with tests which I have made. The relative regulation of the two types of machine depends very largely, of course, upon the character of the construction. Although it is not just to condemn one system because a certain construction is bad, yet the theoretical and practical tendencies toward the evil are largely removed by discarding the three-phase type.

If independent regulation of circuits is necessary, one circuit can be given the proper pressure directly from the dynamo and the other circuits may be raised or lowered, as may be required. This involves apparatus for regulating two circuits if the station be operated by the three-phase system, and only one circuit if the two-phase system is in use.

In a system where incandescent lighting is to be a prominent feature, or where load of any kind may be required upon one circuit and not on the other, the two-phase system has, therefore, a decided advantage in station regulation over the three-phase system. Another advantage of a two-phase circuit is that the load is separated into two divisions instead of three divisions, which is in general much simpler. A further advantage of the two-phase is in the reduction of potential for motors. Two transformers are sufficient in the two-phase system, whereas three transformers are commonly used in the three-phase system. The two transformers which would be required for small motors will cost con-

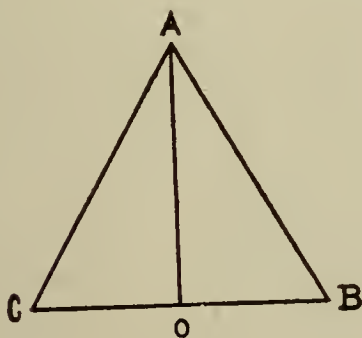


FIG. 14.

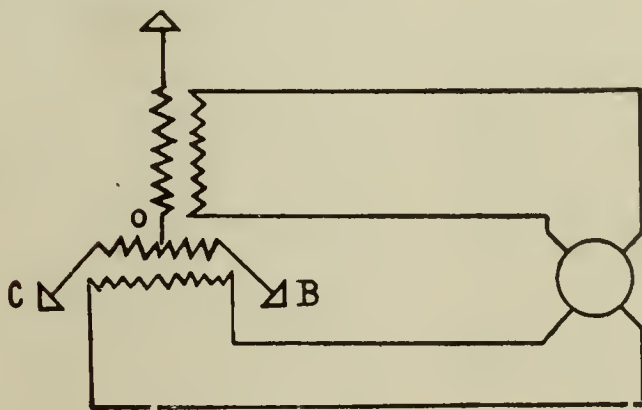


FIG. 15.

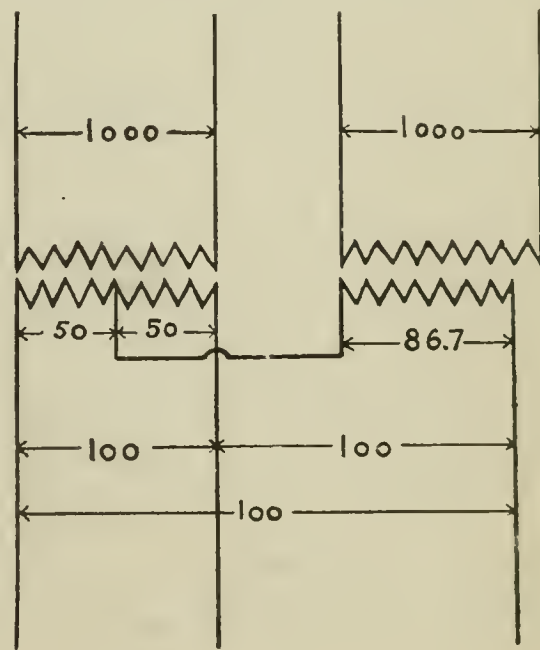


FIG. 16.

ditions of E. M. F. is only 57 per cent. of that which is incident to the two-phase, four-wire circuit. When the power factor is high, the effect of self-induction of line upon regulation varies approximately as the square of the counter E. M. F. The drop due to the self-induction of a three-phase circuit is therefore only about one-third of a two-phase circuit. This is a second advantage for the three-phase system which is of great value. A further advantage of three instead of four wires is the reduced cost of insulators and pole construction, the reduced losses due to leakage, etc.

ADVANTAGES OF TWO PHASES.

An important point of difference between the two systems

siderably less than the three transformers which would be required on the three-phase system, and the loss in transformation will be much less, as there is not much difference in the cost of small transformers of slightly different sizes, and the large sizes are more efficient. The ease and simplicity of installation is also a gain for the two-phase arrangement.

A NEW SYSTEM.

In considering the marked advantages of the two-phase system for distribution and of the three-phase system for transmission, it occurred to me that a combination of the two systems might secure the advantages of both in a combined system, and I have worked out a simple and effective

*A paper read before the National Electric Light Association, Washington, D.C.

method of accomplishing this result. It is well known that if two E. M. Fs. differing in phase be connected in series that the resulting E. M. F. will, in general, differ in value and in phase from either of its components. If two E. M. Fs. differing in phase 90 degrees be connected in series, the resultant E. M. F. is represented in direction and magnitude by the hypotenuse of a right angle triangle, of which the

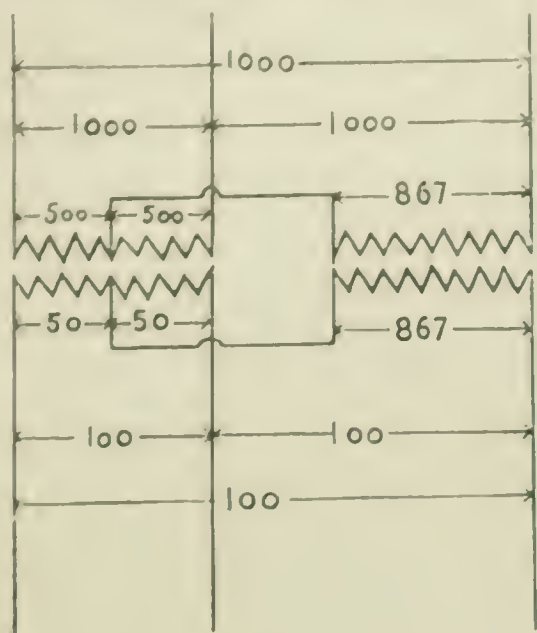


FIG. 17.

two sides are the two component E. M. Fs. Thus, in Fig. 14, if AO and OB are two E. M. Fs. at right angles, and these E. M. Fs. be connected in series, the resultant is the line AB , of different phase from either of the components. It is a simple matter to so proportion the components that OB is equal to one-half of AB , as shown in the diagram. In a similar manner it is readily seen that the same E. M. F. OA may be combined with OC , which differs from it by 90° (but is equal and opposite to OB) in such a way as to give AC equal to AB but differing in direction. BO and OC added together give BC . The E. M. F. BC may therefore be combined with the E. M. F. AO at right angles to it in such a way as to give additional E. M. Fs. AB and CA , which, in connection with BC , give three equal E. M. Fs. 120 degrees apart. This is the relation of E. M. Fs. in the three-phase system.

The application of this arrangement to transformers is illustrated in the accompanying Figs. 15 and 16. The primaries of two transformers are connected to a generator giving two-phase current. The secondary E. M. Fs., therefore, differ 90 degrees. One secondary is made equal to 100 turns and a loop is brought out at its middle point, giving

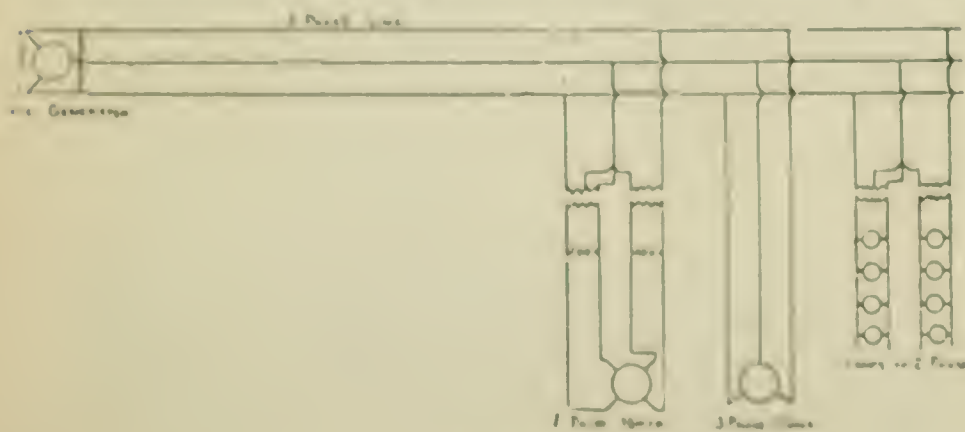


FIG. 18.

50 turns at each side. The second secondary has 87 turns, which is approximately equal to 50 multiplied by the square root of 3. One end of the secondary circuit is connected with the middle point of the secondary of the first transformer, as shown, and the three free terminals will then deliver E. M. Fs. differing in phase 120 degrees. If the E. M.

F. on each primary be 1,000 volts and on one secondary 100 volts and on the other 87 volts, then the E. M. F. measured between any two secondary terminals will be 100 volts. This three-phase circuit is adapted for operating three-phase motors. In a system of transmission two-phase currents at the generator may be converted into three-phase currents, as shown in Fig. 18, and the windings may be such that the E. M. F. is raised for transmission. The currents are then transmitted by three phases, effecting economy in copper. At the other end of the line a similar arrangement of transformers may be used for converting from the three-phase to the two-phase system. The two-phase currents may then be used for the operation of two-phase motors or the circuits

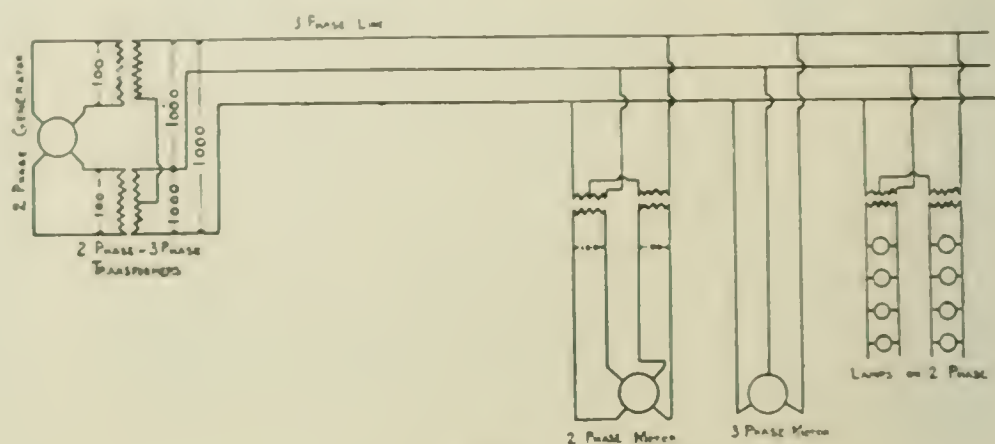


FIG. 18.

may be independently loaded with lamps, or otherwise. If lamps be placed on the transformer which supplies directly from its two terminals, the transmission is directly from the generator without affecting in any way the other circuit, as the generator terminals are connected directly to the first primaries, and the secondaries of the raising transformer are connected directly to the primaries of the lowering transformer, and the current from this is taken directly to the load. On the other hand, if the other circuit be loaded, the action here will also be on its own generator circuit without affecting the first. The current from the raising transformer in this circuit passes to the middle of the secondary of the other transformer, where it divides and flows in parallel through the two parts of the coil and two of the lines. As one-half of the current flows through each part of the secondary coil in opposite directions, the self-induction is completely neutralized and the transformers in this circuit are independent of the operation of the other circuit. It is to be noted that under this condition the line E. M. F. delivered by this transformer is only 87 per cent. of that delivered by the first transformer. The lower E. M. F., however, is compensated for by the fact that the current on one side is passed through two of the lines in parallel, thus reducing the resistance of the circuit and compensating for the slightly lower E. M. F.

The effect upon the regulation of the generator when two-phase circuits at the end of a three-phase transmission line are independently loaded is found, both by theory and test, to be the same that prevails when the load is placed directly upon the corresponding circuit of the generator. A modification of this system is found in the arrangement where the three-phase current is produced in the generator and transmitted over three wires to the reducing transformers. These transformers may be arranged as described for producing two phases. (Fig. 19.) Loads may be placed upon either of the two-phase circuits, and practically the same regulation in the generator will result that would have resulted if the generator itself had been wound for two phases and one of these circuits loaded. In this way it is possible to place lighting load upon a three-phase generator in two instead of three units and to avoid the bad regulation in the generator due to unequal loading.

A similar arrangement of two transformers may be used for converting three phases of one potential into three phases

of another potential. This arrangement is shown in the accompanying Fig. 17.

The efficiency of two transformers arranged for converting from two-phase to three-phase is reduced below that when working independently on ordinary loads by an insignificant amount. If the efficiency in ordinary working is, say, 97.5 per cent., it would be reduced to 97.4 per cent. in converting from one number of phases to the other.

The Tesla polyphase system, in which the largest electrical enterprises are seeking a realization, adapts itself with marvelous facility not only to all branches of electrical industry, but also by the transformation of its phases to the utilization of three phases for gaining the highest economy in transmission, and of two phases for securing the maximum advantages in distribution.

DISCUSSION.

Prof. Forbes.—It gives me great pleasure to speak on the exceedingly interesting paper which has been read to us by Mr. Scott. The paper has really several totally distinct points of interest. Let us begin with the last part first; that is to say, I would like to say a few words simply to express the admiration I am sure every one has felt for the great ingenuity which Mr. Scott has displayed in working out this beautiful arrangement of a combination of the two-phase and three-phase systems together. We must all admit that it is an extremely beautiful idea and appears on the face of it to be a feasible method. With regard to the practicability of it, I think Mr. Scott will agree with me that it must be left to the test of experience before we can say whether it is a satisfactory method of working, as satisfactory as the two-phase or three-phase systems separately. On the face of it it looks as if it were so.

I confess I do not appreciate so much as he seems to do the superior advantages of the three-phase system for transmission over long distances. It seems to me that the two systems, so far as we can find out in practice, as to their economy, etc., have little advantage one over the other. That is the conclusion I have come to, but Mr. Scott and others hold different opinions. If the opinion be right that the three-phase system has a distinct advantage over the two-phase, then such a scheme as Mr. Scott's ought to prove of great value.

I am sure that if there are any members of the convention present who are devoted to the direct current system and determined never to hold any other opinion whatever may happen, they will be extremely pleased to learn all the apparently intricate calculation and investigations that have to be made by the ordinary electrical engineer in dealing with the alternating current; but as a matter of fact many of these problems and apparent difficulties of calculation to which Mr. Scott has alluded do not become very important in the ordinary electric lighting or power station work with alternating currents of moderate dimensions. But these matters of the self-induction of the line, and the influence of different circuits upon each other, become of the very utmost importance when we are dealing with the transmission of power over great distances and on a large scale, and carrying a large amount of current through our mains. I need hardly say that in the course of the last year or two in connection with the transmission of power at Niagara it has been my duty to go into these points that Mr. Scott has touched upon very fully indeed; and in a large problem like that the importance of these incidental matters to the alternating current, the dropping volts, the self-induction of the loop circuit of the line, etc., are so important that one cannot spend too much time in investigating them prior to the establishing of the plant. I have in the course of this work prepared for my own use a variety of tables and curves illustrating the effects and enabling one to get the results in a particular

case at a moment's glance, and it has been my purpose to publish these tables and curves for the use of others; but Mr. Scott has gone a long way to make this unnecessary.

I would particularly thank Mr. Scott for this diagram which shows the inductive electromotive force in volts per ampere per thousand alternations per thousand feet of circuit at different distances between the centres. The compactness of that diagram is extremely beautiful, and I am sure that it will be of greatest value to engineers who are planning large power distribution plants in the future.

Mr. Scott has mentioned the name of Mr. Kennelly as having worked in this line. Any paper presented to the convention on the subject which did not mention Mr. Kennelly's name would be defective. Of all the beautiful expositions of profound mathematical work in the simplest language which can be understood by any student in our technical colleges there is nothing in the literature of the day to come up to the writings of Mr. Kennelly for the last year or so. I think if we take this paper of Mr. Scott's in conjunction with those which have been written by Mr. Kennelly on the same subject, any engineer has got before him all that is required for calculating the effects of self-induction and capacity upon the circuit; that is to say upon the efficiency of the circuit and upon the dropping volts on the circuit. A little more has to be done, however, and that is the effect of resonance. The question of self-induction in the circuit is too full. We first have to deal, as Mr. Scott pointed out, with the whole circuit as forming one loop within which lines of force are formed, which cut both conductors, and therefore produce E. M. F., and then you have to consider the back E. M. F. which is induced in the conductors themselves. Now, if we have a conductor, an inch in diameter we will say, if that were built up of a number of wires a current suddenly started in these would induce a back E. M. F. in each of the others, and, therefore, every one of these wires would be acted on by the others, but it is obvious that the central wire of the bundle would be acted upon more by the others than any other; and, therefore, the back E. M. F. would be the greatest in the centre of the bundle. Instead of a bundle of wires we have a solid conductor, but the effects remain the same and the back E. M. F. in the centre of the conductor prevents the current from passing through the conductor, and as it has to pass over the outside of the conductor there is a resistance to the passage of the current, and that is the skin resistance. These two elements have to be taken care of, and also the question of capacity. Capacity may tend to diminish the drop in the line. Now in regard to the lines of force that are formed in the loop of the circuit, as a matter of fact, even though E. M. F. produced by this line of force, being enclosed in the circuit, even though that E. M. F. may be considerable, it does not necessarily imply that the whole of that E. M. F. is taken off from the applied E. M. F. That is to say, suppose we found in a long circuit going from Niagara to Buffalo that there were 1,000 volts in the circuit due to this self-induction, that does not necessarily imply that there is a drop of 1,000 volts, because from the sketches which Mr. Scott showed you, the E. M. F. is not in phase with the current. In fact, the chances are that it is nearly 90 degrees away, and therefore the actual drop is much less than that. But here is a case which we have to consider and which is of the utmost importance. Mr. Scott has spoken of the interference of separate circuits upon each other. If he had considered the question of these circuits—two different circuits, being the circuits of a two-phase circuit of a distribution, one being a quarter of a period behind the other—then we have a very serious interference. Suppose this current is changed from positive to negative. At the moment when it is zero there is a maximum electromotive force cutting the field and that maximum electromotive force cuts the other conductors which carry the current a quarter of a phase be-

hind, at the very moment when that current is at its maximum. Therefore, the E. M. F. induced by one circuit upon the other is in phase with one current in the other conductor, and the pole of the electromotive force thus generated is a drop in the E. M. F. of the other circuit. For this reason you will see that it is of the utmost importance in a large station where the polyphase system is employed to consider most carefully the arrangement of the conductors in your subways or on your poles; so that the interference of one circuit upon the other shall be a minimum. This interference between the two circuits is of very great importance, far more important than the self-induction of one of the circuits upon itself; and it is largely owing to the trouble that may arise from this and largely owing to the trouble which may arise from capacity that I have to look more carefully into the subject and have found the lower the frequency the less do these things trouble us. It is largely, I say, owing to these reasons that we determined at Niagara to reduce in our dynamos the frequency to as low a point as was consistent with the construction of good, sound generators; and that is largely the reason why we have reduced our frequency to so low as twenty-five periods a second.

I take this opportunity to say a few words not directly on the subject in hand. Many persons have been surprised that the Cataract Construction Company and myself have taken no notice of numerous fault findings and misstatements that have at different times appeared with regard to our work at Niagara. We have not the slightest intention of paying any attention to these whatever. All that we want to do is to have our work done properly, and it is of no moment to us what opinions others may hold. We have not adopted any particular system; we believe that by the construction of dynamos of two phases we shall be able to meet all the requirements that will come to us. We are, however, ready to utilize every invention of merit. We have ordered the construction of a certain number of dynamos by the Westinghouse company; they are devoting their energies unsparingly to producing splendid machines and we are confident of the final result. I think it advisable to make these remarks, because it is not often that one happens to meet one's friends in this way; and I am glad to explain why we do not consider it necessary to take any notice of such criticisms as have occurred.

Prof. Rowland.—It is with great pleasure that I rise to say a few words with regard to this invention of Mr. Scott's. As far as I can see, it is one of the finest things that have come out in recent years in this country. Very few of us expected that we would be so soon able to transform a two-phase system into a three-phase, or any number of phases. It gives us possibilities in the working of motors, etc., which we had not before, and I think this paper marks an era in the science of the polyphase system. It is curious that I happened to be writing a paper at the present time upon something on this very subject—the subject of transforming one number of phases into another number; that is, two-phase into three-phase, etc. I think I have also solved the problem of transforming any polyphase system into any other polyphase; also with any different period of the current. That is a little broader than this is; at the same time, my method is not in any way so practical as this, and is not so simple, and in no way bears comparison with it. It has, however, a little broader aspect, as I can change the period of the current at the same time that the number of phases is changed. It is not, however, practical, like this beautiful method of Mr. Scott.

In regard to the period of the current, this is an important question in long distance transmission, in the use of motors of the Tesla type, or the alternating current motors of all sorts. Although I quite agree with Prof. Forbes that a low period is very excellent in many respects, I was not able to agree with him as to the exact figures—when you get

down very low, things happen that would not happen with a reasonable frequency. I have been studying the subject especially of the Tesla motor, and I see no reason in that motor for lowering the frequency; as good motors can be made for a reasonably high frequency as for a low one. When it comes to the subject of transformers, of course, the larger the period the better the transformers become, and the smaller the period of oscillations of the current, the larger the transformers, etc.; so that there is some limit to this question of frequency. I have only to say once more that this invention of Mr. Scott seems to me to mark an era in the science of this current.

Mr. Scott.—I was a little afraid, in presenting some of the subject taken up in the paper, that there would be somewhat of a scare with regard to the use of alternating currents, and that it would be apprehended that they would give rise to some trouble; but usually if a subject of this kind is taken up in the right way, the difficulties may be overcome by the right kind of engineering, and the observance of a few of the precautions mentioned, the running of two wires in the circuit close together, and some other practical points of that kind, which will readily suggest themselves—may be handled successfully; if one studies the diagrams and makes use of them, and takes his own problems and works out the exact electromotive force and the exact effects of the conditions he has, they will give him an accurate notion of the extent of these effects.

I heartily agree with Mr. Forbes in his remarks concerning Mr. Kennelly. The article which he brought out a month or two ago treating the problem of the alternating current circuit in its relation both to self-induction and capacity and insulation resistance is a very comprehensive and elegant solution of the general problem. In ordinary working, however, capacity will have very little effect upon the practical conditions with which the ordinary central station man will come in contact. It is only when we get up to very high voltages or very long lines that the effect of capacity will enter in a marked degree into the operation of the circuits. The so-called skin resistance, or increase of resistance of the conductor, due to the uniform distribution of electric currents referred to by Prof. Forbes, in ordinary working may be very largely neglected. This effect decreases as the number of alternations increases, so that with sixteen thousand alternations the increase in resistance in a conductor half an inch in diameter is only three per cent., or thereabouts, so that ordinarily this is an insignificant amount. In order that the resistance shall not exceed this, with low alternations, three or four thousand, the diameter of the wire must be something like an inch or an inch and a half.

Prof. Forbes pointed out that the action of one circuit on the other is such that the electromotive force induced is in phase with the electromotive force on the first circuit, and the latter causes a greater drop than would be caused if the two circuits were at the same phase. This is true, and the reflex action is an interesting one; the action of one circuit on the other is to decrease the electromotive force, and the reverse action of the second circuit on the first is to increase its electromotive force, so that circuits become unbalanced—the electromotive force of one circuit increasing and that of the other decreasing.

In reply to an inquiry from Mr. Spenser in regard to the application of the load factor when the load is distributed along the line, Mr. Scott stated that when the load on the circuit is distributed the case becomes more complicated. It would be necessary then to take each part of the circuit and calculate the amount of electromotive force in it, and so on for each part of the circuit, and the problem in general would be very similar to the calculation of the drop in different parts of a continuous current circuit, which is much broken up, and the load distributed and the wires interconnected. It becomes quite a difficult problem to apply the

simple Ohm's law in a case of that kind. In practice, however, the counter electromotive force in primary circuits of one or two thousand volts extends over a small area—a mile or so—and with ordinary currents up to one hundred amperes is not such as to cause effects of very great practical importance. That is shown from the fact that in the circuits ordinarily operated these effects have not been very prominent. They have not interfered with the working of central stations of pretty large capacity. For instance, at the World's Fair, the circuits there were the largest incandescent lighting plant which has been installed, and one of the lessons of the World's Fair is that a large alternating incandescent central station can be operated, and that these effects of self-induction and capacity, which under certain conditions may give rise to difficulties, in the operation of this large central station gave no disadvantageous effects. In general, the inductive drop in circuits for incandescent lighting is only a small percentage of the ohmic drop, and it is an extreme case when the drop due to induction equals the drop due to the resistance of the conductor.

Mr. Stillwell.—I have been pleased to note the interest which those members of the Association who are managers of central stations have taken in Mr. Scott's paper. One of the things which manufacturing companies have to contend with and one of the obstacles which is in the way of a more rapid development of new apparatus—the turning out of practical alternating current motors—is the fact that the time of a considerable part of the electrical staff of the large electrical companies is taken up in answering questions—largely in the line of the points covered by Mr. Scott's paper. The operators of central stations employing alternating currents have run across these phenomena from time to time, they have not understood them—none of us have understood them thoroughly until recently—and they naturally call upon the engineers of the manufacturing companies to help explain them. Every member of the Association should make it his business to study this paper, and there is nothing in it which any central station manager need fail to understand. I think it is not out of place to congratulate the Association upon the fact that at this meeting—and I think for the first time—an invention of great scientific interest, as well as great practical importance, has been first laid before this body. A year or two ago it would, undoubtedly, have first been presented to the American Institute of Electrical Engineers. I think it is a compliment to the Association, and an evidence of the fact that the efforts of the Association to study these problems are understood and appreciated.

The paper is specially important in view of the fact that we are just now approaching the time in this country when there will be a necessity to supply arc service and motor service from our incandescent circuits. Many of you have already felt the pressure which is being exerted to drive you underground with your circuits. When that time comes the importance of being able to supply all kinds of service from one system of conductors will be great.

In regard to criticism made by Prof. Forbes: There has been some controversy over certain points, which are familiar to the electrical fraternity. We claim that the plans at Niagara Falls are substantially those laid out by Mr. Tesla several years ago. The statement we issued, as nearly as I can recall, was this: The plans which have been adopted by the Cataract Construction Company for their work at Niagara Falls are simply the Tesla polyphase system, as developed by the technical staff of the Westinghouse Electric and Manufacturing Company. Prof. Forbes says that statement is not correct. From a lawyer's standpoint it is incorrect in this respect, my attention having since been called to it. The Niagara Falls company have ordered three two-phase generators: they have not ordered any motors. These latter will be one or two phase. If they are two-phase, the statement stands without amendment; if they are one-phase it

also stands without amendment—because the language is this—the Tesla polyphase system as developed by the Westinghouse company. We made no small exhibit at the World's Fair, in the power transmission department. We had a 500-h. p. generator, driving a 500-h. p. motor, and a smaller one. It was the alternating current system. It was of the constant potential type, and the motors there shown were of the two-phase variety. The frequency was thirty periods per second, or thirty-six hundred alternations per minute. The potential was four or five hundred volts. We showed motors of the non-synchronous and synchronous type. We did not show single-phase motors in operation, but they could have been run by these generators. In the case of Niagara Falls, we have the frequency reduced to twenty-five periods; but this difference is hardly sufficient to differentiate between the two systems. I do not suppose that in the strict sense any difference in frequency could be taken as a line of demarcation between the two systems. The potential at Chicago was 400 volts and at Niagara it will be 2,000 volts, for certain reasons. The difference of potential does not differentiate between two systems; it is selected with reference to the distance over which we are to transmit the power. Electrically speaking, these are the only differences between the plant at Chicago and the one at Niagara.

Prof. Rowland.—As I know all about this Niagara Falls affair, and know exactly what was recommended and what was not recommended, I may say that Mr. Stillwell's statement is correct. The things advocated are not the things which are now there.

A Switch Patent Suit.

Judge Coxe last week rendered a decision in the case of the Schuyler Electric Company against the Electrical Engineering and Supply Company, of Syracuse, N. Y., for infringement of the Perkins snap switch, the decision being in favor of the latter.

In his opinion Judge Coxe says, after examining into the prior state of the art, that it is perfectly clear that the Perkins patent does not cover all snap action circuit breakers and that it is confined both by the prior art and its own language to the device described. At least it is clear that it cannot be expanded to cover devices differing in size, shape, material, situation, mode of operation and object to be attained; devices whose only points of resemblance are features open alike to defendant and complainant.

The Crowell switches, he says, are snap switches, it is true, and they cannot be turned backwards, but in other respects they are much nearer several structures found in the prior art than to the Perkins switch. They are mounted on a large stationary china base, 3 inches in diameter and are intended to be screwed on a wall or other support. They cannot be used in a lamp socket, neither has a ratchet wheel, and No. 2 has no insulating teeth or any equivalent therefor. Neither has a pawl or detent, unless a very broad construction is given to these words. Both belong to a different type of switch from the patented switch.

The court cannot avoid the conclusion that it would be doing injustice to the defendant and others to give the Perkins patent a construction so broad as to suppress improvements like those embodied in the Crowell switches.

Mr. Kapp Explains

In a recent issue we published some information which was sent to us regarding Mr. Gisbert Kapp, who was reported to have accepted an appointment in Germany. In a letter published in the London "Electrician" Mr. Kapp states that his leaving England is in contemplation, but by no means certain; he has been offered the appointment, but the matter is still pending and will not be settled for about a month.

Private Electric Light Plants.

BY FRANK C. PERKINS.



URING the past year a great many plants have been installed for lighting city and country residences throughout the United States. Many of these lighting installations have no storage battery plants connected with them, although for residence lighting it is a great advantage to be able to shut down the engine at night and yet have current at your disposal at any time.

It is becoming common to install small plants, ranging from 25 to 100 lights, in stores and residences, and it may be interesting to note some of the methods of English practice in these lines. The English firms, Patterson & Cooper, Drake & Gorham, and others, have installed many small plants complete in such country mansions as Balnagown Castle, Ross shire, residence of Sir Charles Ross; Craig-y-nos Castle, near Swansea, residence of Madame Patti.

Undoubtedly the gas engine has received greater attention in England with reference to its adaptability for driving electric light machines than it has in this country. Figs. 1 and 2 show the plan and elevation of a gas engine plant installed by one of the above firms for running 50 lights of 16 c. p. each. The engine room is 18 feet long by 9 feet wide, and the storage battery room is 9 feet long by 6 feet wide. The



FIG. 1.—PLAN OF GAS ENGINE PLANT.

engine develops 4 h. p. and drives a 5-unit dynamo. The dynamo is wound for a potential of 135 volts, and is used to charge a storage battery of 53 cells. Fig. 2 shows the arrangement of a steam plant commonly used by the same firm in private isolated plants; the engine room in this case being 24 feet long and 8 feet wide, and the storage battery room 9 feet long and 6 feet wide.

A semi-portable steam engine and boiler of 3-h. p. capacity is belted to a shunt dynamo, which is wound for 135 volts and is capable of supplying current for 50 lamps of 16 c. p. each. The engine is mounted on a cast iron ash pan, with feed water cistern under the smoke box, and is fitted with an efficient water pump.

The accumulator installation consists of a storage battery capable of operating 25 16-c. p. lamps for a period of nine hours. The D. P. storage cells are used. It is claimed that these batteries combine the durability of the Plante cell with the capacity of the pasted form. The special construction of the plates affords an enormous working area, enabling the cells to be charged and discharged at very high rates without producing disintegration or buckling. The battery consists of 53 cells, having a capacity of 140 ampere hours, the normal rate of charge and discharge being 12 amperes. The cells complete weigh about 65 pounds, including the acid. The outside dimensions of the cells are 12 inches long, 6 inches wide and 13 1-2 inches high. When fully charged the battery will operate 40 16-c. p. lamps of 60 watts each for four hours.

The "Neville" automatic accumulator switch is used in charging in order to prevent the current from the battery of accumulators discharging itself through the

dynamo, when for any reason, such as a belt breaking or the gas supply of the gas engine being accidentally cut off, the E. M. F. of the dynamo falls below that of the battery. The objection to this class of apparatus usually is that it is actuated by springs or is so wound that during the whole time of working a small current is flowing from the battery through the instrument, causing waste and heating; further, that it has generally been found necessary to adjust them for one E. M. F., which has, therefore, been the highest one at which the battery was likely to be. Hence, when they are first started with the battery low they do not close the

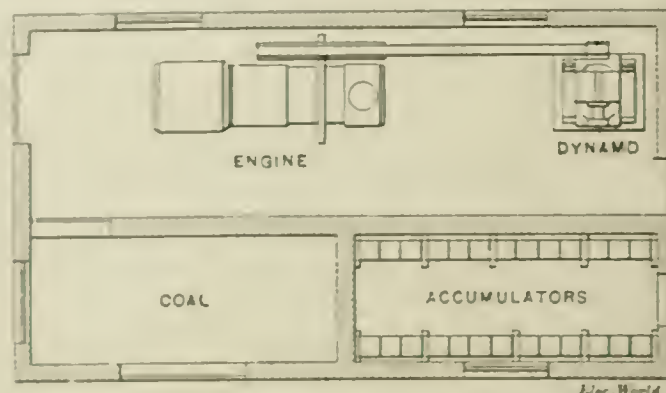


FIG. 2.—STEAM ISOLATED PLANT.

circuit until the dynamo is considerably above the battery in E. M. F., causing a jump in the lights, a shock to the dynamo and sometimes melting the main fuses by the large current generated.

This switch is constructed somewhat on the principle of a polarized relay, and is so wound that as long as the E. M. F. of the battery is greater than that of the dynamo, the circuit is held open, but as soon as the E. M. F. of the dynamo exceeds that of the battery, the tendency of the switch is to move. A difference of one or two per cent. is sufficient to close the circuit, and this is accomplished by a copper fork dipping into two mercury cups. The opening or closing of the circuit is effected when the E. M. F. on the two sides is practically the same, and therefore the current then passing is so small that even with a switch constructed to carry 200 amperes the spark is scarcely perceptible. If the battery is nearly run out, say at 98 volts, or if the battery is fully charged, say at 110 volts, the switch will, without adjustment, open and close within one or two per cent. of the E. M. F. which the battery is then giving. After the circuit has been closed the only loss of power in the instrument is that caused by the resistance of the large wire through which the current flows, and this is not worth considering.

The arrangement of switchboard is very convenient, and includes regulator switches for both charging and dis-

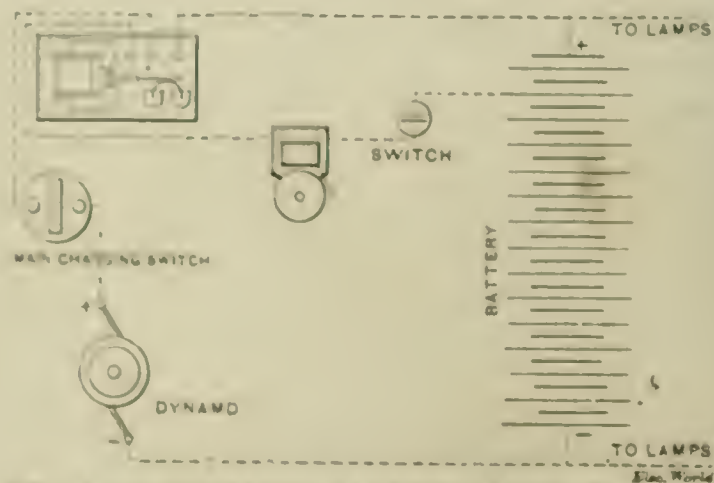


FIG. 3.—AUTOMATIC ACCUMULATOR SWITCH.

charging the accumulators, also switches for lamps and dynamo circuits, provision having been made for mounting voltmeter and ammeter for measuring either the charging or discharging currents.

The automatic accumulator switch may be connected in either branch of the dynamo circuit (Fig. 3) so that the cur-

rent (assuming that an electric current always flows from a positive toward a negative pole) shall flow in the pole marked + and out the other, noting that it is approximately level. Each cup is filled with mercury up to the level of the small knife edges projecting into the cup. The balance weight is so adjusted that when not under the influence of any current the fork, when pressed down and gently released, will at once rise clear out of the mercury to its normal position.

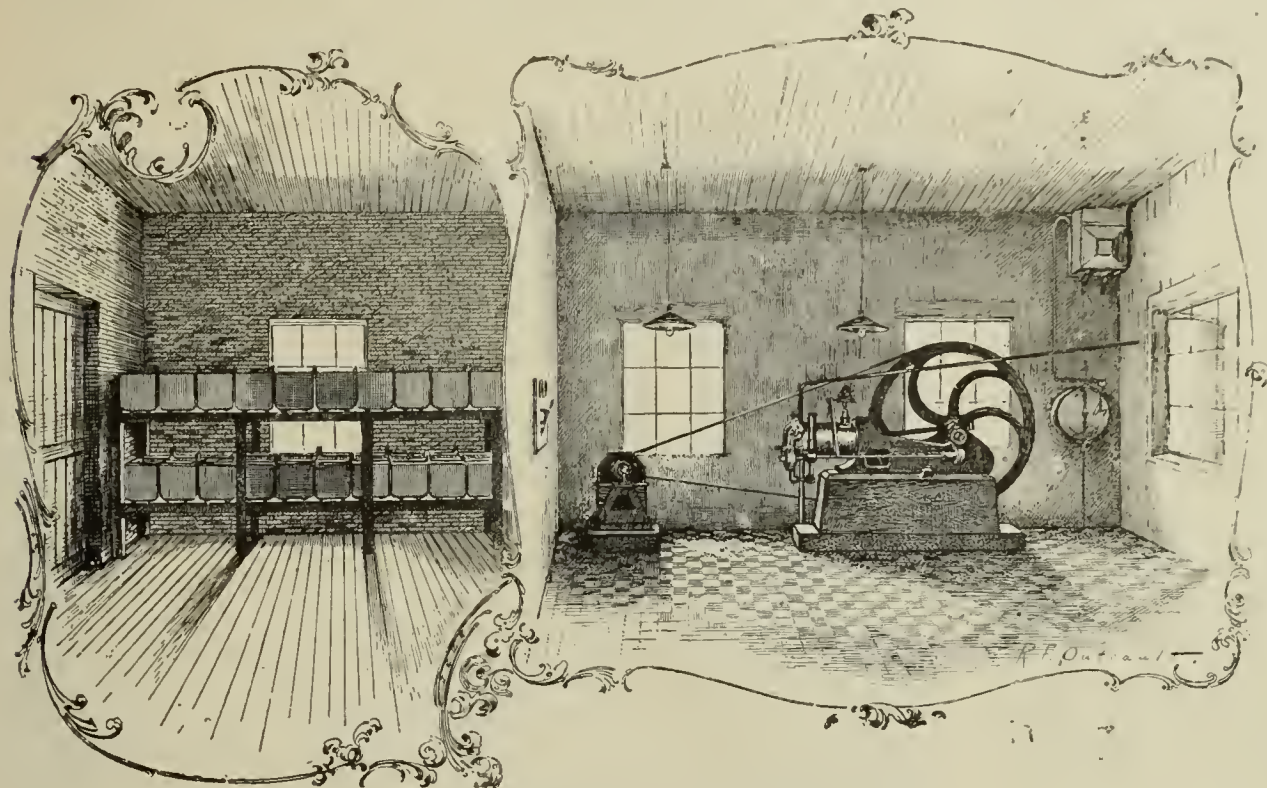


FIG. 4.—GAS ENGINE PLANT.

The main switch on the dynamo circuit may then be closed and the dynamo started. If properly connected when the voltage of the dynamo is about two or three volts higher than that of the battery, the automatic switch will work, and when it is once started there is no need of further attention. In some cases it is desirable to call attention, by means of a bell, to the fact that the switch has opened and that the dynamo is no longer charging the cells. In such cases an electric bell can be inserted in the circuit (Fig. 3) of the instrument in such a way that, as soon as the switch has opened and the E. M. F. of the dynamo has fallen much below that of the battery, the bell will ring, and thus call the attention of the man in charge.

The condition of each cell forming a battery may be ascertained during the discharge of the battery by means of a voltmeter and a hydrometer. Much can be determined by a careful examination of the cells when fully charged, at which time all the cells should give off gases equally, but without the aid of such instruments as a voltmeter and a hydrometer a decrease in capacity cannot be detected. The voltmeter readings should be taken toward the end of the evening's work while the cells are still discharging on the lamps, when the lower capacity of any faulty cells may be apparent. The specific gravity readings are useful in that they show approximately at any time, the charge remaining in a cell; and the discharge E. M. F. test is necessary to indicate whether any cell drops in capacity before the remainder. A rod is supplied with each instrument for insuring proper contact on the battery and enabling one person to make the test.

While a storage battery plant is a very convenient ac-

cessory to a residence electric lighting plant, it is very costly and requires a great deal of attention and continued watchfulness on the part of the attendant in order that the best results may be obtained. The 3-h. p. engine and dynamo will charge the battery during the day, and at night the engine, dynamo and battery can all work together and give a total output of 50 16-c. p. lamps, the battery supplying 25 lamps for nine hours.

There seems to have been no attempt made abroad to construct the steam plant so that the fuel and water may be supplied to the engines automatically. Some of the more recent plants installed in this country are so arranged that kerosene oil or natural gas can be used for fuel, and the water is automatically kept at the proper height in the boiler by means of a float attached to the feed pipe. If the steam pressure arises above 80 or 90 pounds, the fuel supply is automatically cut off, and when the pressure falls below 80 pounds the fuel is again supplied. In this way a plant can now be installed which will require little or no attention beyond that of starting and stopping. The engine and dynamo can be started at 3 P. M., and operated until 10 or 11 P. M., practically without

attention. The dynamos used have automatic oil ring bearings, and the main engine bearings are lubricated from the crank case.

Magnetised Side-Arms.

It is reported that bayonets belonging to marines on board Her Majesty's ships have in certain cases become highly

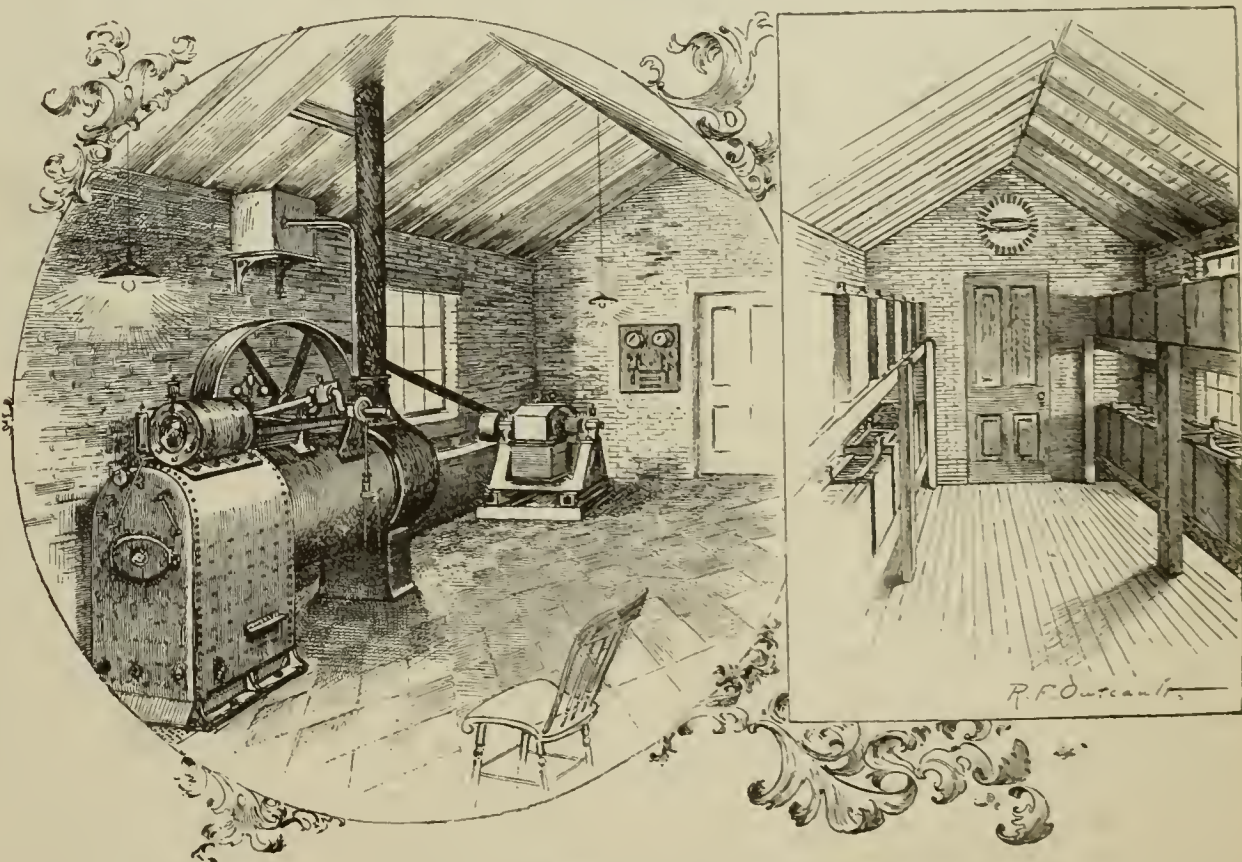
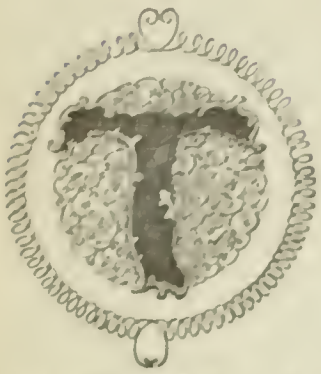


FIG. 5.—STEAM ISOLATED PLANT.

magnetized through contact with, or close proximity to, dynamos, or from other causes, the result being that compasses have become affected by sentries passing near them when wearing these sidearms. In future sentries are not to wear sidearms when on duty in the dynamo flats, and this is expected to overcome the difficulty.

Practical Properties of Polyphase Apparatus.—III.*

BY LOUIS BELL.



HE place where it is most desirable to retain as high a value as possible for the power factor is where the motors are to be used on long circuits, in which case it is important to keep the general inductance of the system low. In this connection, however, nearly all the long distance propositions which I have investigated—and their number is very

great—require the use of mixed apparatus—induction motors, synchronous motors and lighting, in which case the general energy factor can be kept fairly high, particularly as the synchronous motors can even be made to compensate in large measure for the presence of the induction motors.

A word now with reference to efficiency. Fig. 7 gives a pair of efficiency curves, one of them, *A*, taken from a 5-h. p. motor, the other, *B*, from a 25-h. p. machine. The 5-h. p. motor had four poles, the 25-h. p., six, and both were intended to run at 50 cycles. A glance at the curves will show that their full load efficiencies were respectively a trifle over 82 and 88 per cent., the larger motor in particular retaining a very uniform efficiency from half load up. These figures can be raised by paying the same attention to the iron as in the case of transformers which do not have a movable secondary.

The two in question had stampings of ordinarily good armature iron without extraordinary precautions in annealing. From a special 5-h. p. motor I have obtained a full load efficiency of very nearly 90 per cent. I can hardly refrain from comparing these efficiency tests with those of motors of similar size and of the synchronous alternating type, as made by Ganz & Co., and described in the report of

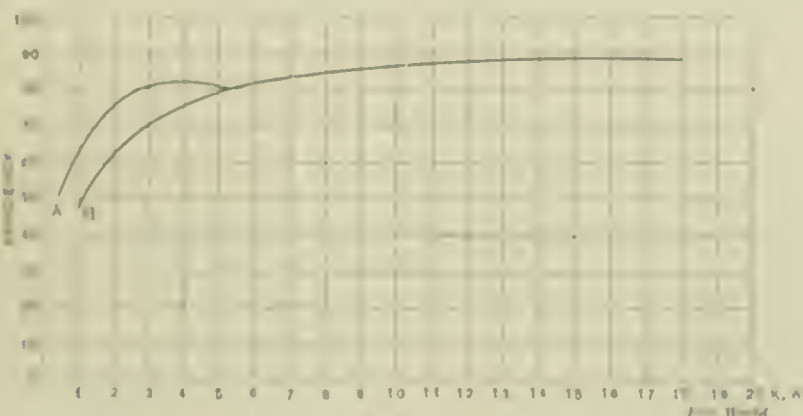


FIG. 7.

the Frankfort Commission, the periodicity being 42. In this case the maximum efficiency of a 25-h. p. motor was 88 per cent., the half load efficiency about 80, while the maximum efficiency of a 5-h. p. motor was but 80 per cent. All these are, of course, commercial efficiencies. Motors of other sizes will bear about the same relation to the figures given as in the case of ordinary continuous current machines, the two shown being thoroughly typical.

To conclude the matter of efficiency I annex the weight efficiencies of five sizes of induction motors:

H. P.	Weight per H. P.
5	103
10	66
15	68
20	73, 6 pole
100	66, 5 pole

These weights compare extremely well with those of any standard direct current machines, and were light weight a special object, could readily be considerably improved.

Much has been said regarding the effect of frequency on the properties of induction motors, and I am sorry to say

most generally from a purely theoretical standpoint. Judging from numerous experiments between 30 and 70 cycles, I am strongly of the opinion that within this range not much is gained or lost by varying the frequency, provided the motors are designed with reference to the particular frequency at which they are to be used, although, as in static transformers, increased frequency tends to increased output. As reasons quite independent of the character of the motors which can be obtained limit the frequency advisable in power transmission work to something like the working range just mentioned, I do not think the gain is one of sufficient importance to cause a choice to be made of one moderate frequency rather than another. For example, low cycles compel the use of uncomfortably large 2-pole induction motors, while at high cycles even very small motors must have 6 or 8 poles. At 10 cycles the highest possible motor speed is 600, at 100 8 poles are necessary to get any decently low speed.

I will now briefly pay my respects to what are really unsymmetrical polyphase motors; that is, the so-called non-synchronous single phase motors, which start by means of some phase differentiating device, whereby a derived phase is employed to produce a sort of rotary pole. The result is what may be characterized as an elliptical rotary magnetization as distinguished from a circular one, and consequent loss of efficiency. In general they start and run like bad polyphase machines, have a less output for the same size, and a lower efficiency. These statements are amply borne out by figures which have been published on the Oerlikon three phase and single phase motors, showing that the latter have for the same output greater weight and less efficiency. The power factors of such motors are decidedly below those of polyphase motors. I believe that it would be possible, however, to design a motor of this class which should have nearly as good properties as the polyphase motors I have described, but it would be costly, and would perform much better if regularly wound for two or three phases. In other words, the same structure that would give a good single phase motor would give a phenomenal polyphase one. With single phase induction motors, the use of condensers would be decidedly advantageous, and they thus might be made fairly operative even at rather high cycles.

The static transformers used for polyphase work being, in all essential particulars, like those with which the public is already familiar, little need really be said on this score except that in most cases the average efficiency of transformers in polyphase plants will be found decidedly better than in the lighting plants now in operation, principally for the reason that larger units are, and will be, generally used.

The question of frequency is of more importance, however, and the general facts in the case are that the low frequency transformers, other things being equal, are the more bulky and expensive, though not in a very great degree. Within the working range for power transmission work the difference is, as in the case of motors, not so considerable as entirely to overshadow other considerations which arise in specific cases, such as those of permissible inductance, size of units, permissible heating, loss of energy generally under the particular circumstances considered, and the like.

The convenient and efficient use of rotary converters is a very characteristic advantage of polyphase systems. These machines have already been considerably discussed, and it is perhaps sufficient to say, as regards their general character, that they are in all essential particulars, closely similar to standard direct current machines. They are self-starting, can readily be compounded for constant potential and behave in all respects like direct current generators. It is possible to make a single phase machine of somewhat smaller output for the same size, and non-self-starting. In actual operation they are highly satisfactory and appear to give

*Abstract of a paper read at the eighty-third meeting of the American Institute of Electrical Engineers, Jan. 17, 1904.

considerably better results than any methods which have yet been brought forward for converting alternating into direct current by any species of commutation.

As a good many of our friends who are not deeply versed in the electrical industry say, electricity is in its infancy, and from all I can learn, the art of directly commuting an alternating current and getting a decent direct current is very decidedly in its infancy.

In the use of rotary transformers, the frequency is a consideration of much more importance than in the case of transformers or of induction motors. It is a matter of some difficulty to build a large unit for high frequency, the difficulty being encountered, as might be expected, in the commutator. It is probably as easy or easier to build a 500-kw. unit for 30 cycles as it is to build a 100-kw. unit for 60, so that where, for any cause, it becomes necessary to use a large number of rotary transformers, this necessity may quite control one's choice of the precise frequency to be employed.

In all practical cases of transmission of power, rotary converters require the use of transformers for reducing the line potential, inasmuch as if they are not used the voltage on the main line will necessarily be so low that it would be quite as well or better to transmit the continuous current directly.

In planning a polyphase system one of the first questions that naturally arises is that of frequency in its relation to the machinery, the line and the service. So far as the first count is concerned, one can say that while in general the higher the frequency the less the bulk of the apparatus, each size of unit has a certain frequency which gives the greatest economy in material and labor. The larger the unit the less this frequency. The rate of change, however, is rather slow, and as an actual result of designing with economy in view, the largest units as yet proposed, 5,000 to 10,000 h. p., will show very little difference in economy between say 25 and 40 cycles. In discussing frequency, theorists have often fallen into the grievous error of considering only the generating units. The load of transformers and motors is of equal, in fact of greater importance, since the actual aggregate cost is far greater, and in nearly every practical case will call for a frequency considerably higher than in the case of the generating units. One might, for instance, by ignoring this fact, save \$10,000 in the generators and lose \$50,000 in the transformers and motors.

So far as the line alone is concerned, the lower frequencies are the better, since they reduce inductance and static effects. Nevertheless, too much importance should not be attached to this, since the vast majority of cases can be handled with perfect success at a frequency of 50 or 60 $\sim$. For example, one can transmit 1,000 kw. at 10,000 volts a distance of twenty miles or so on a single circuit (three phase) and still have the total impedance less than double the ohmic resistance. In practice, such a system would generally, too, carry a considerable output in synchronous motors, which can be, and should be, made to serve as gigantic capacities reducing, or even annulling, the inductive drop. Finally we come to the service. There is a frequency below which incandescent lamps cannot be operated without perceptible flickering. This frequency certainly varies with different observers and perhaps also with the same observer at different times. Prof. Mangarini and others have placed the limit as high as 40 or 50 $\sim$. The average eye, I think, is less sensitive than this. Personally, the limit seems to be about 30 $\sim$, certainly over 25 $\sim$ and under 35 $\sim$, and a number of other observers unite on about these same figures. It would be almost impossible not to notice variations at 25 $\sim$, and they are most annoying, not to say intolerable; 30 $\sim$ certainly leaves a small enough factor of safety.

Alternating arc lights are even more sensitive. The very

best carbons begin to give considerable trouble at 40 $\sim$, and with most carbons flickering is perceptible at 50 or even at 60.

Inasmuch as most large systems find the arc lighting desirable, and practically all must use many incandescent lamps, the frequency should certainly be kept above 30 $\sim$ and preferably above 40. To go below 30 $\sim$ is wantonly to throw away the most characteristic advantages of the alternating system, and in the vast majority of cases is not worthy of serious consideration.

To my mind the most serious consideration in long overhead lines and all underground lines is static capacity. Particularly is this the case when the current waves are non-sinusoidal, for in such case we can get phenomena of resonance not only from the fundamental frequency, which is generally low enough to keep out of the way, but from the higher harmonics as well. These are liable to produce discharges that will rupture almost any finite insulation. For this reason the sine wave is highly desirable, far more than from any consideration of efficiency. I am sure, however, that a sufficiently close approximation to it can generally be obtained from a properly designed dynamo, and the inductance that generally exists helps to muffle the higher harmonics. Resonance is generally in evidence on long lines, however, and makes itself felt by a tendency to spark and sputter beyond the capabilities of the nominal voltage. It may prove advisable in some cases, when dealing with non-sinusoidal waves, to give the line artificially a capacity that will not readily respond to the most prominent harmonics. I remember once experimenting with a tuning fork with a sixth harmonic that quite drowned the fundamental, and it is quite possible to conceive of a dynamo with undesirable characteristics of a similar sort.

The upper limit of practicable voltage is most uncertain; 5,000 and 10,000 volts have been experimentally shown to be available, and 15 to 25,000 possible. If the conditions to be met render these voltages necessary, I think they can be handled well enough. The question really resolves itself into the commercial one of paying for the necessary precautions in insulation. A voltage will be reached, however, at which these precautions will cost more than the extra copper required for a lower voltage, and here commercial necessity will call a halt. This point, however, has yet to be experimentally found.

Whether these high voltages should be derived direct from the machine, or obtained from step-up transformers, is a question which has been often discussed. The high voltage dynamo in very large sizes has the advantage in first cost over a low voltage one plus transformers, but runs a far greater risk of serious injuries. Besides, what is of practical importance is that with a high voltage dynamo, if anything happens, the dynamo is gone. Take a 10,000-volt dynamo, let a rupture once get started, and it is a case of ruined machine practically every time. When you have transformers and a burn-out, you may have lost one or more transformers to be sure, but probably you are running banked. Indeed it is very foolish to put all one's eggs in one basket in such a matter. So instead of losing a 5,000 or 10,000-h. p. dynamo, you may lose only a transformer of 100 kw. or something of that kind. Although we would all like to use high voltage dynamos, on account of economy in first cost, until they have been practically proved to be sufficiently free from breakdowns, I should say it would be very poor practice to use them extensively, although they are now being tried somewhat, and I hope we shall find the result to be good.

I am now compelled to disturb a very much mooted question; that is, the amount of copper required for polyphase lines. It goes almost without saying that all polyphase systems using a complete circuit per phase will require the

same amount of copper as an ordinary alternating system. Some statements have been going around recently as to the relative amount of copper required for the alternating system and for the direct current, which, I think, are very largely founded on a misconception. They seem to proceed on the principle that in all cases where alternating currents can be employed we may consider direct current as a straightforward competitor. This is certainly not so. In a vast number of cases where we have to deal with voltages somewhere near the limit of insulation, the direct current is out of it from the start, and is not to be considered at all. In the second place, it is a grave question whether the electrolytic strains of the direct current are not under some circumstances, perhaps many circumstances, fully as bad as the electrostatic stresses caused by the somewhat higher alternating voltage. That is a subject that will have to be studied very thoroughly before we shall know quite where we stand. Now, as regards the copper required for polyphase circuits which are interlinked, I went to the trouble, for the sake of informing a few recalcitrant persons who do not want to believe a mathematical demonstration, of having an experiment actually made, setting up a triphase generator with a bank of lamps in the laboratory, and trying the relative conditions as between a single phase system and a triphase system with interconnected circuits. The experiment was performed in an exceedingly simple manner. Four non-inductive artificial lines were prepared, and using two of these in parallel, a certain amount of energy was transmitted to lamps banked at the other end. A single phase current was used and the losses carefully measured. Then one of the lines, this experiment having been made, was removed, and the remaining three wires worked on the triphase system transmitted the same energy at the same initial voltage, with the same loss, showing conclusively, as might be expected, that theory in the matter is quite correct and that the actual saving of copper in the interconnected triphase system is 25 per cent. The experiment came out within one per cent. of the calculated amount, and this must be true whatever assumption is made regarding the conditions under which we are to transmit power. Take a plain alternating system at any voltage you please, and compute the copper on any series of hypotheses that may suit your fancy, yet the interconnected three phase will do the same work and do it just as well with three-fourths the outlay for copper. It is precisely equivalent in its net result on the economy of the system to raising the voltage about 15 per cent., without, however, any added strain on the insulation, and I think the man would indeed stultify himself who would deny that raising the voltage affects the economy of the system. Aside from all other questions concerning it, an additional advantage of this particular type of circuit is the greatly reduced inductance for the same energy transmitted under similar conditions, amounting only to about 57 per cent. of that found on a single phase circuit. This reduced inductance, which, after all, is in part attributable to the less cross-section of copper required, or is rather interlinked with it, is perhaps the greatest advantage that this particular system has, and makes it of extreme value on all very long lines. There are not very many points which differentiate triphase from other polyphase systems, and so far as my knowledge goes, the two that I have mentioned are by far the most important, more especially that which relates to inductance and incidentally to capacity—getting around as it does the "bugs" which are most dreaded on very long distances.

Unfortunate.

Mr. Charles Henry, a French physicist of some standing, says that the intense electric illumination in our railway stations and large stores caused indigestion!

An Important Patent Suit.

The case of the Bate Refrigerating Company was argued before the United States Circuit Court of Appeals last week, C. E. Mitchell and J. C. Carter appearing for the appellant and W. H. Peckham and Edmund Wetmore for the appellees.

The point at issue is in regard to the meaning of the part of the paragraph of section 4,887 of the Revised Statutes, reading as follows: "But every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent," the appellant contending that it should be construed to read "an invention which has been patented previous to the application for a patent therefor in the United States shall be limited," etc., while the appellees contend that the meaning is plain as it is.

The main argument of the appellant is that in the revision of the law on the subject the language had been so changed as to thwart the plain intent of the original framers of the law, and that the statute is therefore open to interpretation, and should be construed as above in harmony with the original law, and thus prevent great injustice to patentees. The appellees dispute the right to enter upon an inquiry as to the supposed intention of Congress, show that the courts have invariably maintained their view and argue that if the construction claimed is allowed it will result in gross injustice to the public.

The Electrolytic Production of Caustic Soda and Bleach.

The Electrolytic Caustic Soda and Chlorine Trust, of Snodland, Kent, England, is about to convert itself into a limited liability company, under the title of the Electro-Chemical Company, with a capital of £200,000 in 40,000 shares of £5 each, divided into 26,000 10 per cent. preference shares and 14,000 ordinary shares. Subscriptions are being now invited for the 26,000 preference shares. The syndicate is to be given the 14,000 ordinary shares, plus £30,000, either in hard cash or preference shares. This is no doubt a large sum to give for a process protected only by patent law, although it is not, as things go now, by any means extravagant, and the validity of the patents for the production of caustic soda and bleach by electrolysis has been thoroughly well ascertained. There is, of course, nothing particularly novel in the electrolysis of a saturated solution of common salt and the obtaining thence of caustic soda and chlorine, the latter being subsequently passed into chambers containing lime and converted into bleach powder. But the Snodland process has been experimented with on a commercial scale for some years, and it is not too much to say that the syndicate has succeeded in overcoming the most important difficulties which have hitherto barred the way to commercial success. The anodes first employed were made of comparatively costly electric light carbons, and were rapidly eaten away. At present, instead of trying to discover some unattackable form of anode, the syndicate is using the cheapest possible form of carbon, consisting of the ordinary gas retort carbon set in a frame of stout strip lead, so arranged that the lead is not in contact with the electrolyte. The cost of replacing these anodes only amounts to a few shillings per ton of caustic soda. Another specialty of the process is the absence of any form of porous partition and the employment of kathodes of copper, covered with a superficial film of copper oxide, which prevents the back electromotive force due to nascent hydrogen. Owing to these two improvements, the volts per electrolytic vat have been reduced from 6 to 4, the minimum theoretical voltage required being 2.02 volts. A consulting chemist of high standing gives as his opinion that caustic soda and bleach can be produced on a large scale by this electrolytic process at about half the present market price.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE
PRINCIPAL FOREIGN
ELECTRICAL JOURNALS.
BY CARL HERING.

NOTE.—Owing to the crowded condition of this department the following changes will be made, the object being to enable more space and attention to be given to abstracts of articles and papers of a more important nature. Almost every issue of each of the foreign journals contains descriptions and data, often with illustrations and tables, of local central stations and isolated plants; unless they appear to be of special interest they will not be noticed hereafter. References to descriptions of steam and gas engines, boilers, fuels, etc., and all other subjects not belonging under the heading of electricity and magnetism, will in general be omitted. The Swiss monthly "Journal Telegraphique" (in the French language) contains probably the best telegraph and telephone statistics of the world, and as this journal is doubtless accessible to those specially interested in this subject, references to such statistics and descriptions in that journal will hereafter be omitted. Serials in the nature of a treatise on a subject will be noticed only once; this will apply also to papers which are continued in several issues and which are merely referred to in these columns as distinguished from being abstracted. When the same paper or article is reprinted or abstracted in several journals, only the first appearance will be noticed, except if the original is in a foreign language and the reprint is an English translation, in which case the references to the translation will also be given, as usual. Very good abstracts, generally longer than can be given here, are published in the monthly journal of the Institution of Electrical Engineers (London), and in the Proceedings of the Institution of Civil Engineers (London), which abstracts will be noticed only in case the original article has not been mentioned in these columns.—C. H.

ELECTRO-PHYSICS.

Cosmical Electricity.—In a communication to the Lond. "Elec. Rev.," March 2, Prof. Elihu Thomson replies to a recent criticism of his remarks (see Digest Feb. 17), and states that the criticism was due in part to the want of the full text of his remarks, in which he was particular to point out the difference between science and speculation, and laid stress on the fact that his remarks come under the head of speculation, in which case the unfavorable criticism was not justified.

Apparatus for Studying Hertzian Oscillations.—In a paper from the Italian by Mr. Righi, abstracted briefly in the Lond. "Elec.," March 2, he describes a modification of the apparatus for lecture purposes, for which he claims decided advantages and with which extraordinarily short waves have been investigated, the shortest being 7 centimetres long.

Differential Equation of Electric Flow.—The Lond. "Elec. Rev.," March 2, discusses editorially Mr. Blakesley's Physical Society paper, in which he shows that the admission of certain properties of matter not usually recognized is the only way of obviating satisfactorily the imperfections of existing views.

Electro-Dynamic Screening and Electric Shadows.—The Lond. "Elec. Eng.," March 2, abstracts from the "Wied. Ann." a paper by Messrs. Ebert and Wiedermann.

Propagation of Electromagnetic Waves.—"L'Elec.," Feb. 24, and "L'Ind. Elec.," Feb. 25, reprint in abstract an Academy paper of a mathematical nature by Prof. Mascart.

A New Electrical Theorem.—In a Physical Society paper abstracted briefly in the Lond. "Elec." and Lond. "Elec. Eng.," March 2, Mr. Blakesley gives a theorem regarding two or more dispositions of electromotive forces in any network of conductors.

Radiation.—The "Elek. Zeit.," March 1, abstracts a paper by Mr. Lenard from "Wied. Ann.," page 225, in which he describes researches with his tubes containing a "window" of thin aluminium foil.

Piezo Electric Phenomena.—An article by Mr. Somigliana is abstracted in part in "La Lum. Elec.," Feb. 24.

Conductivity of Discontinuous Conductors.—An Academy paper of Mr. Branly is abstracted in "L'Ind. Elec.," Feb. 25; he describes experiments made with pulverized materials.

Influence Machines.—"La Lum. Elec.," Feb. 24, contains a note regarding some improvements.

MAGNETISM.

Reflection of Magnetism.—In the discussion of Mr. Kapp's paper, abstracted elsewhere, Prof. Silvanus Thompson stated that a large sheet of iron not less than 10 millimetres thick acted toward all the things that might be placed in front of it as a magnetic mirror giving negative, but not positive images; an illustration is given in the Lond. "Elec.," March 2; if this sheet of iron is placed in front of the end of a coil the effect is the same as if there were no sheet, but as if the coil were double the length; that is, as if the coil and its image (on the other side of the screen) were both at work, doubling the action of this coil; if two such sheets were placed at the two ends the effect is analogous to a candle between two mirrors, thus producing an endless row of coils, or practically an endless straight coil.

Magnetism and the Makers of Iron.—Mr. Evershed in the Lond. "Elec.," March 2, discusses this subject without, however, giving anything new; he states that the hope that by further purification of the iron hysteresis might be eliminated entirely, is almost certain to prove illusory, as hysteresis is a property inherent in a group of magnetic molecules; a far more important matter for iron makers is to supply a uniform quality rather than iron of absolute purity; to builders of dynamos and transformers his recommendation is to make frequent tests.

Sun Spots and Magnetic Disturbances.—A paper by Dr. Palazzo from the Italian, published in "Nature," volume 22, page 189, is abstracted briefly in the Lond. "Elec.," March 2; he discusses the relation between the two phenomena, and concludes that the connection between them is by no means a simple one.

Magnetic Induction.—The "Elek. Anz.," Feb. 25, contains another article by Mr. Schwartze, in which he criticises unfavorably the usual formulas for magnetic induction.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Testing the Magnetic Qualities of Iron.—Mr. Kapp's paper, mentioned in the Digest last week, is reprinted in the Lond. "Elec. Rev." and Lond. "Elec.," March 2, the latter journal containing also an illustrated report of the discussion; the illustrations of the paper are given best in the Lond. "Elec. Eng.," March 2, which are reproduced here. His aim was not absolute accuracy, but more a method which can be used by any one in the laboratory; it has been in use for some years and has given results which have always been sufficiently accurate for practical purposes. For testing iron bars he uses a modified form of the Thompson permeameter, in which the induction through a sample bar is measured by the force required to pull it away from another piece of iron; as the induction is proportional to the square root of this force, any small error in the measurements results in a still smaller one in the induction; his object was to make the corrections both small and definite; as will be seen from Fig. 1,

it consists of a heavy rectangular frame of Lowmoor iron well annealed, within which is a fixed solenoid with a subdivided winding, so that a variable but known number of turns can be placed in circuit, the object being to keep the current within limits between which it can be measured accurately; the sample consists of a bar accurately turned and faced at the lower end, it is larger at the upper end, where it makes a tight fit, and is centred at the lower end by a gun metal ferule; a movable plunger at the bottom contains a scale pan for the weights; the correction due to the air space, which is the most important one, can be easily calculated and the others are quite trifling; for inductions above

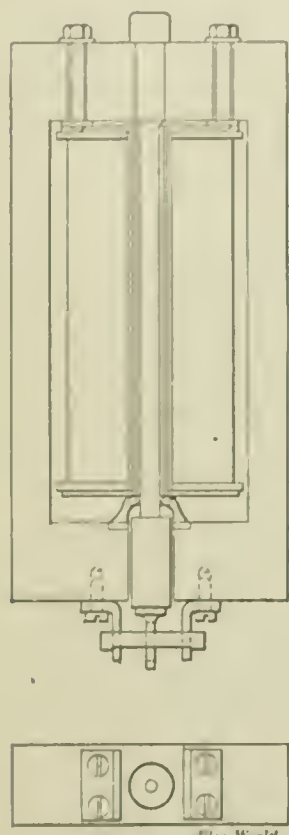


FIG. 1—TESTING MACHINE FOR IRON BARS.



FIG. 2—TESTING MACHINE FOR TRANSFORMER PLATES.

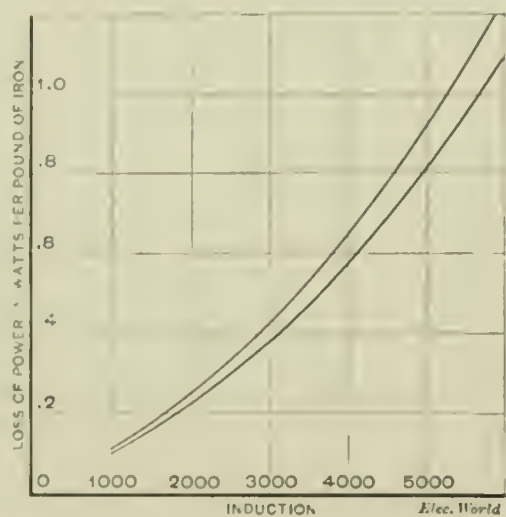


FIG. 3.—DIAGRAM SHOWING AVERAGE RESULTS OBTAINED IN TESTING SAMPLES OF PLATES.

10,000, even the former becomes relatively small, and above 15,000 quite negligible; it is necessary to use a storage battery, as a dynamo current is too variable; the greatest weight supported by a half-inch sample bar of good iron is about 45 pounds; the time occupied for a test through a complete cycle is about one hour with two men. For testing transformer plates the apparatus in Fig. 2 is used, consisting essentially of a closed magnetic circuit, as shown, the sample plates being the straight upper pieces, which are laid together to make up a certain weight and inserted through the top coil, being fixed by wooden wedges, the coils being connected to a sine current through a wattmeter; the instrument is calibrated once for all by making the sample and the permanent part of the same quality of plates and then apportioning the losses according to their weights; with other samples from the loss measured by the wattmeter this constant portion is deducted, the remainder being the loss in the sample, a correction being made for the loss due to ohmic resistance, which, however, is exceedingly small; as before, the coils are subdivided; the resistance of the joints is immaterial, as it influences only the current, but not the power. Two curves are given in Fig. 3 for the mean and the minimum induction and the loss of power in watts per pound; within thicknesses between 10 and 13 mils, the thickness has only a very small influence on the loss, which confirms Ewing's investigation, from which he concluded that there is no advantage in going below 13 mils. He discusses also the method of making up a complete transformer with sample plates, but concludes that besides being expensive it is very uncertain, as the test includes that of the complete transformer and is not that of the iron alone.

In the discussion Prof. Hughes and others brought up the

objection to the contact between the two pieces of iron. Prof. Thompson believed that his (Thompson's) later form was even better than Kapp's; he tries to avoid sources of correction, and makes the cross-section of the yoke pieces 200 times as great as that of the test rod, the latter being made longer and thinner than in Kapp's instrument to diminish the error of contact, the rupture taking place between the sample piece and the yoke; he suggested a method for testing iron in large blocks by means of two small coils embedded in a strip of ebonite, acting as a sort of transformer; this is laid on a block of iron and a magnetizing coil is applied; it was a mere suggestion. Mr. Steele called attention to the importance of selecting a proper sample from which the skin had all been turned away; to get rid of contact resistance he suggests using a small cap. Dr. Fleming suggested that unless the iron was tested in the form in which it was to be used, the test would not be conclusive; he showed that eddy currents in a transformer plate might circulate in the plane of the plate; also that the loss in the iron seemed to depend on the E. M. F. of the curve; it would be of great importance to ascertain whether it was not possible to get rid of hysteresis altogether. Mr. Sparks thought that the results for a sample bar would not be the same as that of the iron in the machine. Prof. Perry did not approve of Thompson's proposed methods, as there was no saturation and no permeability; he called attention to the fact that the lifting power is greatly increased by reducing the area of contact. Mr. Mordey stated to have had great trouble in obtaining an even quality of iron; in his specification he adopts the standard of 2,500 lines per square centimetre and a loss at 100 periods of 0.38 watts per pound, a standard easily worked to; 0.25 and 0.28 have been obtained; the variation was 60 per cent. above the standard, even in the same case of iron; chemical analysis was absolutely no guide; the power factor varied all the way from 0.6 to 0.9 with the same hysteresis; he had found great difficulty with the contacts. Mr. Ravenshaw called attention to the importance of testing armature iron, stating that the hysteresis loss had been found to be twice as great in bulk as in samples. Mr. Siemens described the method used in Woolwich, which, he claimed, was much simpler and safer; it was based on that of Prof. Ewing, the apparatus consisting of a brass tube 3 feet long and 3-4 inch internal diameter, over which a coil was wound and connected to a rheostat and double key with a 10-volt battery, an exploring coil connected to a galvanometer encircled the middle portion; by this method the hysteresis curves were plotted, the iron, which must be shorter than the tube, being placed in the inside; the area of this curve gave the quality of the iron; if the piece of iron was smaller, the curve would be inclined, but its area remained the same; there was no fitting whatever; it takes one man a quarter of an hour to make a test. Mr. Kapp, in replying, agreed that the difficulty was in the contact, but stated that for high inductions this did not make much difference. "Ind. and Iron," in an editorial, states that the methods are quite old and that the real drawback was in the pull being too large, and that if the induction is not perfectly uniform over the contact surface, it could not be determined from the pull. In an editorial discussion, the Lond. "Electrician" does not think that Mr. Kapp has solved the problem satisfactorily, the objections being due to the joints; attention is called to the neglect of testing of armature iron, and it does not believe his methods admit directly of the determination of the permeability of the armature, on which it is claimed the characteristic of a machine depends to a large extent; it believes that none of the methods discussed appear to be quite perfect. Some further extracts from the discussion will be found under "Transformers" and "Magnetism."

Photometers.—A well-illustrated description of Mascart's photometer is given in "La Nature," Feb. 24; also a novel form of photometer devised by Mr. Henry, intended spe-

cially for very dim illuminations; a tube resembling a small telescope contains two semi-circular screens, one of ground glass permitting the light which is measured to pass through; the other is covered with phosphorescent sulphide of zinc; a short piece of magnesium wire of fixed dimensions is placed in front of this screen; the burning of this illuminates the phosphorescent screen; with a stop watch the time is then measured after the light is extinguished and until the two screens have the same illumination; from a curve the illumination is found which corresponds to this time.

Attachment of Quartz Fibres.—In a Physical Society paper, abstracted in the Lond. "Elec." and Lond. "Elec. Eng.," March 2, Prof. Boys describes in detail a method of soldering the ends of such fibres; the ends are silvered and electro-coppered, after which they are soldered to a piece of metal; if they are required to conduct electricity, as in electrometers, they are afterward silvered.

Ampere- and Voltmeter.—According to an illustrated description in the "Elek. Zeit.," March 1, the Wilkins' apparatus consists of a thermometer tube with a large bulb at each end containing a gas, the tube itself containing a short column of mercury; a shunt or series coil in the interior or around the outside of the lower bulb heats the air, driving the mercury indicator to various positions, which are said to represent a measurement of the current or the voltage.

Temperature Coefficient of Copper.—The Lond. "Elec. Rev.," March 2, in an editorial abstracts the Congress paper of Messrs. Kennelly and Fessenden, criticising it and suggesting that the fact that different samples of copper may behave differently might account in part for the apparent ambiguity between the results of different experimenters.

Electrodes for Measuring the Resistance of Electrolytes.—The "Elek. Zeit.," March 1, abstracts a paper from "Wied. Ann.," page 346, by F. Kohlrausch, in which he describes some forms of electrodes for this purpose.

Testing Circuits.—In Mr. Guy's serial in the Lond. "Elec. Eng.," March 2, he discusses this subject.

DYNAMOS AND MOTORS.

Alternators in Parallel.—In the Lond. "Elec. Eng.," March 2, Mr. Proctor, of the Bristol station, describes with the aid of a diagram the method which he uses and with which he has never had any difficulty, and which, he claims, renders an accident impossible. It consists essentially in connecting the alternator to the synchronizing apparatus and when synchronism is obtained connections are made with the mains through a synchronizing fuse, which will blow if the synchronism is not successful; if it does not blow, the permanent connection may be established; the switchboard arrangements are such that the same fuse is used for any of several alternators. He states that they should be connected when the synchronizer is on the increase, never when it is decreasing, and preferably not when it is stationary; the only inconvenience experienced was due to the loaded machine being too much overloaded to keep a constant speed.

Armature and Field of Rotary Field Motors.—In a brief discussion in "L'Ind. Elec.," Feb. 25, regarding the question of how these terms should be used, it suggests that all confusion could be avoided by using the French terms "inducteur" for the part which produces the inducing field, constant or not, and "induit" for the part in which induction takes place; it also mentions the words "stator" for the fixed part and "rotor" for the movable part.

Unipolar and Non-Polar Induction.—The discussion in the "Elek. Zeit.," March 1, is continued by an article by Prof. Vogel and another by Mr. Marcher; it is, to a great extent, personal, each one declaring the other to be mistaken; according to a note from the editors that discussion is herewith closed.

Theory of Alternating Current Motors.—"La Lum. Elec.," Feb. 24, contains a mathematical article of some length by Mr. Guilbert.

TRANSFORMERS.

Short Circuiting in Coils.—Mr. Steele, in discussing Mr. Kapp's paper, abstracted elsewhere, described a method of detecting short circuits, consisting of suspending a rod of iron horizontally and moving it in the direction of the leakage lines; if any turns are short circuited, leakage will be produced and the iron rod will suddenly dip, being attracted to the point of short circuit; to determine whether it is in the primary or secondary coil, each one is tested separately.

Leakage in Transformers.—In Mr. Kapp's paper on testing iron, abstracted elsewhere, he calls attention to the fact that the losses in a transformer become less after some weeks of use, which he believes to be due to the coils having become thoroughly dried; this loss in the primary coils due to leakage is quite appreciable when compared with the true iron losses.

Efficiency.—Mr. Steele, in discussing Mr. Kapp's paper, abstracted elsewhere, stated that much improvement had recently been made in the efficiency of transformers, the (iron?) loss in the Kapp transformer being only 0.95 per cent. at full load, the full load efficiency being 97.4; a table is given for the iron losses and efficiency of several Kapp transformers.

ARC AND INCANDESCENT LIGHTS.

Illumination.—In a recent lecture on "Illumination and Nearsightedness," by Dr. Cohn, abstracted in the "Elek. Anz.," March 1, he shows that nearsightedness is often due to poor illumination; 10 metre candle (equal to very nearly one candle at one foot) he gives as the minimum illumination which should be used for reading; daylight at an open window is equivalent to about 300 metre candles (equal to about 28 candles at one foot); he concludes that the only suitable light which should be used in the future is the electric light. Mr. Henry, in "La Nature," Feb. 24, also gives the same figure for a minimum illumination for reading and writing without fatigue to the eyes; for normal daylight on a well exposed surface he gives 50 candles at one metre (equal to about 4.7 candles at one foot); for the light of the sun he gives 50,000 candles at one metre; the smallest illumination that can be detected by the eye, he says, is the equivalent of one candle at a distance of 3.4 miles.

Relative Light and Power of Gas.—In the "Elek. Anz.," Feb. 22, Mr. Schwartze abstracts Mr. Bourquin's recent article mentioned in the Digest some time ago, showing that more light can be obtained by using the gas in gas engines for generating electric light than by burning it directly.

Colored Photography.—According to "La Lum. Elec.," Feb. 24, the electric light can be used in this process.

TRANSMISSION OF POWER.

Rotary Phase Transmission.—In a recent lecture by Prof. Silvanus P. Thompson, abstracted in the Lond. "Elec. Rev.," March 2, and commented on editorially in the Lond. "Elec.," March 2, he showed some interesting experiments, one of which was to place an ordinary porcelain plate in the centre of a horizontal Gramme ring without commutator or shaft, on which is placed a large hollow copper egg; on generating a rotating field by means of a three-phase current, the egg rotated and finally spun on its end. In another experiment, which is more novel, a horseshoe magnet was rotated, a sheet of copper was cut with two slots lengthwise so as to form the equivalent of three parallel conductors having common connections at their ends; on placing one of the ends of this over the rotating magnet, a magnetic needle placed over the other end began to revolve, thus illustrating in a simple way the transmission of power by three-phase currents; the apparatus is illustrated in the Lond. "Elec. Rev."

ELECTRIC RAILWAYS.

Liverpool Overhead Railway.—Two papers, one by Messrs. Greathead and Fox and another by Mr. Parker, are given in abstract in the Lond. "Elec." and Lond. "Elec. Eng.," March 2; the former deals with the civil engineering features and the latter with the electrical features. In the latter the mean value of seven tests gave an efficiency of 88 per cent. between the indicated horse power and the electrical horse power on the line; on a run of 5.1-8 miles in 24 minutes 57 seconds and in another in 23 minutes and 47 seconds, with stops of 25 seconds at each station, the power required was 44.4 indicated and 46 electrical horse power respectively; the effect which a large number of trains had in bringing down the maximum current per train was very apparent, with seven trains it was twice and with twelve trains only one and a half times the average current per train, the average demand for power, continuously, being 37 electrical horse power per train; when seven trains were running, the coal used was 22.5 pounds per train mile and for the later summer months about 17 pounds; the actual working costs for the later summer months were a little less than 8 cents per mile; it was found that the line could be run at a cost well within that guaranteed by the contractors.

Cost of Traction in Marseilles.—According to "L'Ind. Elec.," Feb. 25, the accounts of the Marseilles railway, which was constructed by a French and a Swiss company, show that the cost of traction, including wages, power, repairs and maintenance, exclusive of the road, is 22.4 cents per car mile.

Regulations.—A report of the discussion of the Board of Trade rules is given rather fully in the Lond. "Elec.," March 2, and in abstract in the Lond. "Elec. Rev." The subject is discussed also in a long editorial and in some notes in the Lond. "Elec.," March 2.

Underground Railway in Budapest.—Some further details regarding this proposed road are given in the "Zeit. fuer Elek.," Feb. 15.

Electric Parcel Wagon.—According to the Lond. "Elec. Eng.," March 2, parcel vans run by storage batteries are to be introduced in London; the working cost for a two-horse vehicle will be 4 cents per mile, one charge being capable of running thirty miles.

Heilmann Locomotive.—The Lond. "Elec. Rev.," March 2, gives a well illustrated description, being apparently a translation of the one of Mr. Hospitalier, already mentioned in these columns. In a communication of Mr. Lea, in the same issue, he replies to the recent criticisms of that journal. "La Lum. Elec.," Feb. 24, contains a very well illustrated description.

Long Trolley Wires.—Several of the German journals call attention to the fact that a German wire firm, Hesse & Sons, have succeeded in making single lengths of trolley wire weighing 3,300 pounds.

Genoa Railway.—The description in "La Lum. Elec." is concluded in the issue of Feb. 24.

Railways.—Mr. Richard's profusely illustrated serial, taken apparently from patent specifications, is continued in "La Lum. Elec.," Feb. 24, the greater part being devoted to trolleys and their details.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Balancing a Three-Wire Station with One Machine.—Mr. Thursfield, in a communication to the Lond. "Elec. Rev.," March 2, discusses the scheme of Mr. Gibson, abstracted in the Digest last week, stating that the chief difficulty with two armature windings is that the relation between the E. M. F.s. of the two armatures is necessarily constant and that it is impossible to produce anything but an approximately equal E. M. F. on each feeder, and that the only way in which its regulation could be effected with that apparatus would be by connecting the generator armature on to the

charging switches and the feeders on to the discharging switches; this entails putting the whole load of the station through a part of the batteries, which is out of the question; with the arrangement at the Burnley station (illustrated in the Digest March 3), it is not necessary to put more than half the current in the balancing wire through the batteries.

Central Station Apparatus.—The Lond. "Elec. Rev.," March 2, gives short illustrated descriptions of some of the new apparatus introduced by the English Brush company, which are said to be improvements of an important character, the object being the simplification of central station working and the reduction of risk of accidental stoppages due to carelessness. Among these is the Raworth automatic switch gear for coupling continuous current dynamos in parallel; another is an interlocking switching gear for alternators in parallel, the switch of which cannot be closed until the field and the synchronizing switches are closed and the field fully excited; another is his interlocking switching gear for main feeders; the return current fuse, mentioned in the Digest last week, is also illustrated and described; a universal contact offering a number of advantages is shown and described; it consists essentially of a hollow casting cut lengthwise so as to form a large number of independent spring contacts with large bearing surfaces; an automatic regulator for the Brush dynamo field is described, in which the movements of a lever vary the immersion of plates in water, thus varying the resistance; a device by Mr. Mordey is mentioned for automatically adjusting the brushes of a Brush machine for changes of load, an adjustment which is usually made by hand.

Switchboard.—The large new switchboard for low-voltage continuous currents, just installed in the Carnaby station, which is claimed to be one of the best and most compact, is described and illustrated in the Lond. "Elec. Eng.," March 2.

Switching Dynamos in Parallel.—The apparatus by Mr. Brenner, of Montreal, is described and illustrated in the Lond. "Elec. Rev.," March 2.

First Three-Phase Plant in the United States.—Mr. Jennings, in the Lond. "Elec. Rev.," March 2, calls attention to the fact that the first transmission plant in the United States was at Rock Creek, Cal., designed and constructed by Messrs. Pearson & Keith, of San Francisco, in 1890, a description of which was contained in the "Mining and Scientific Press," of San Francisco, Jan. 3, 1892.

Stockholm.—The "Elek. Zeit.," March 1, gives a long description of this continuous current, three-wire system, in which accumulators are used; it contains a large number of well selected illustrations showing numerous details and views.

London.—Major General Webber's paper is continued in the Lond. "Elec. Rev." and Lond. "Elec. Eng.," March 2, and concluded in the Lond. "Elec.," in which the discussion also is given.

Nottingham.—The description of this plant is concluded in the Lond. "Elec. Eng.," March 2, in which a large number of illustrations of the architectural features are given.

Isolated Plant in France.—"L'Elec.," Feb. 24, gives a description of a small accumulator plant, which is claimed to have been very well designed; several good illustrations are given of the principal connections.

Central Stations.—"L'Ind. Elec.," Feb. 25, publishes as a supplement under separate cover the very complete table of statistical information regarding central stations in France at the beginning of the present year, which table was noticed in the Digest Feb. 24.

Electric Elevators.—It has been proposed to erect elevators between the low and the high portions of the city of Berne; with these, 8 h. p. obtained from water power can

transport 1,900 persons a day through a height of about 90 feet.

Central Station Engines.—The Lond. "Elec. Rev.," March 2, contains a number of communications by engine builders and others.

Evaporative Condenser.—The Lond. "Elec.," March 2, gives an illustrated description of a form used on the Continent.

Steam Turbine.—"La Nature," March 3, contains a well-illustrated description of the Laval steam turbine.

WIRES, WIRING AND CONDUITS.

Electric Lighting of Ships.—Mr. Muitt in the Lond. "Elec. Rev.," Feb. 23, does not agree with Mr. Kennedy in advising the adoption of single wiring and that compasses are not affected any more than by double wiring; he refers to experiments, which he describes and which show that this does not appear to be the case; it has been found that on some ships where the single wire has been used, disturbances of the compass from 3° to 7° occur when groups of lights are thrown on and off; he advocates strongly the double wire system, which has also other advantages. The Lond. "Elec. Rev.," March 2, contains a number of communications on this subject; Mr. Martin states that after ten years' experience with over 200 vessels, he has no hesitation in saying that the single wire system is far more troublesome and more liable to cause fires; armored wire exposed in any way stood little better than good teak casing, which latter, he says, if properly put up stands as well as anything that could be used, provided galvanized iron pipes are used in parts where the wire might be exposed to moisture; he criticises Mr. Kennedy's devices, mentioned in the Digest last week, stating that much trouble has been caused with these improved fittings, the fault being invariably in the fitting or back block, even in the installations made by Mr. Kennedy himself; in conclusion he recommends strict supervision and frequent tests by inspectors. Mr. Kennedy, in replying to the criticism of Mr. Muitt, mentioned in the Digest last week, states that it does not prove much one way or the other, as leads are never run in the way they were in those tests. Mr. Walker thinks most of the trouble lies in the acceptance of the lowest bid, which generally means poor workmanship.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Signaling Without Wires.—The Lond. "Elec. Eng.," Feb. 23, abstracts a Society of Arts paper of Mr. Preece, in which after referring to the experiments described in his recent Congress paper, he mentions a series of experiments made near Frodsham, the very satisfactory results of which will shortly be published; he states that given the localities between which it is desired to communicate, it is a mere matter of calculation to show what is to be done; it will be quite easy to speak between France and England across the Straits; ordinary apparatus was used and it was found that speaking by telephone across a space of 11-4 miles was practicable and easy, the sounds being so loud as to be sufficient to form a call; the apparatus consisted of 100 dry cells, a rapidly revolving rheotome and a Morse key; two Bell telephones joined in parallel acted as receivers; for transmission of speech, granular carbon microphones were used, through which a current of two amperes was maintained. He believes to have shown that earth conduction was not the principal factor; he found that the apparatus worked best for one particular frequency, proving the presence of resonance, but this effect far exceeded in magnitude that due to the natural pitch of the disc; conversation by telephone was possible but not practicable. In conclusion, he refers to cosmical electricity, stating that "it is not a wild dream to say that we may hear on this earth a thunderstorm in the sun." The paper is given also in abstract in the Lond. "Elec. Rev.," March 2.

Multiple Switchboard of Great Capacity.—"La Lum. Elec.," Feb. 10, gives a short description of a new multiple switchboard serving for 30,000 and even 48,000 subscribers, said to be "astonishingly simple in its construction," one switchboard for telephonic service, by Mr. Sieur, which is while the largest at present in use is said to be for 6,000; owing to the want of a figure, the description is not very clear; it is taken from "Jour. Teleg.," the date of which is not given.

Pacific Cable.—The Lond. "Elec. Eng.," March 2, contains a note and an editorial on the proposed all British Pacific cable.

Communications between England and India.—In the Lond. "Elec. Rev.," March 2, Mr. Walker gives a further communication on this subject.

Telephone in Europe.—The "Jour. Teleg." for February gives in detail the charges in a number of European countries; the "Elek. Anz.," Feb. 22, contains a short article on this subject consisting of a brief summary.

Bronze Wires in Telegraphy.—The "Jour. Teleg." for February contains an article by Mr. Buels in reply to one by Mr. Miller.

ELECTRO-CHEMISTRY.

Purification of Sugar.—The "Elek. Rund.," No. 9, states that Mr. V. Lippman experimented with an electric process in a French beet root sugar factory; the juice is treated with a current of 30 to 40 amperes and 4 to 5 volts between electrodes of zinc, the albumen is thereby coagulated, carrying down the impurities as does also the zinc oxide which is formed, leaving the juice free from zinc; an important advantage of this process is that it avoids the necessity of heating the juices, which is apt to be injurious.

According to "La Lum. Elec.," Feb. 10, Mr. Dupont, a chemist, has shown that with a liquor having a coefficient of 23 and a degree of purity of 83, he has obtained by an electric process a coefficient of 200 and a degree of purity of 99.5 and even more, the cost not being greater than that of the usual process; further information is promised.

Purification of Lead.—Lond. "Elec.," Feb. 16, describes briefly a process for the recovery of the silver and the production of chlorine; chlorides of calcium and magnesium are decomposed with lead nitrate; from the lead chloride so produced chlorine is obtained by electrolysis, while the nitrates are heated for the recovery of the nitric acid, which is used to dissolve the crude lead forming lead nitrate; silver is precipitated from this by the addition of spongy lead.

Is Chemical Change the Reverse of Electrolysis?—In an editorial on this subject the Lond. "Elec. Rev.," March 2, discusses Mr. Veley's paper in the "Phil. Mag."

MISCELLANEOUS.

Harmlessness of High-Tension Currents.—According to an editorial in the Lond. "Elec. Rev.," March 2, Mr. Blakesley says that the energy of the discharges is mostly expended in radiation which the human body does not check and not in current through the body; Prof. Lodge argued that no serious consequences followed when Mr. Tesla passed his currents through his body, because there was not much energy behind them.

Mine Exploders.—"L'Ind. Elec.," Feb. 25, publishes a well illustrated description of the Manet system, in which a hand driven, self-exciting dynamo is used for generating the current (we understand that this system is used largely in France).

English Patent Office.—The Lond. "Elec. Eng." March 2, suggests some needed reforms, making it more like the system in this country.

French Tariff.—In "L'Elec.," Feb. 24, Mr. Haubtmann gives a resume of the French duties on electric goods.

Judge Ricks' New Opinion.

By a decision rendered Tuesday of last week Judge Ricks, of Cleveland, Ohio, denied the motion of the Universal Electric Company to dissolve the existing injunction obtained against it by the Edison Electric Light Company, restraining the Universal company from infringing the Edison lamp patent. The Universal company moved to dissolve the injunction on the grounds that by reason of a certificate attached to the Edison lamp patent in 1883, which referred to certain foreign patents for the same invention, that patent expired with the English patent last November, or, at any rate, that the Edison company was estopped from contending that it did not then expire.

Judge Ricks, in his opinion, states that as it is conceded by the defendant's counsel that the motion in this case is a close copy of the similar one filed by the Buckeye Electric Company, frequent references will be made to that case, and he proceeds to compare the two. In the Buckeye case the defendant company was organized in February, 1890, just after Justice Bradley had decided that the Sawyer-Man patent was invalid, and when the belief was general and had a substantial foundation that the Edison patent would likewise be held invalid. In the early stages of its business there was no adjudication showing the Edison patent valid and about the same time it had learned of the correction on the Edison patent limiting its life. Further, that there had been negotiations between the Buckeye and Edison companies with a view to consolidation and at the same time a substantial acquiescence in the defendant's infringement was fairly inferable from the acts and conduct of the complainants, and that the investment of the defendant had been largely increased prior to the plaintiffs' revocation of their endorsement limiting the life of the Edison patent. As a consequence the Buckeye company was not at any time a wilful infringer, but had made all of its investments in good faith previous to Judge Wallace's decision.

In the case under consideration, the Universal Electric Company was organized in August, 1892, more than a year subsequent to Judge Wallace's decision and only a few months prior to its affirmation by a final court. Its increased investments seem to have been \$9,000 and \$10,000 in January, 1892, and May, 1893, respectively, the latter subsequent to the date of the complainant's attempted revocation of its grant to the public. In the Buckeye case the court found that the company acted in good faith, relying upon the acts and conduct of the complainant, and that all of its investments were prior to the revocation. While the court declined to say just what rights the public acquired as against the Edison patent in virtue of the voluntary limitation of its life, it did find that the Buckeye company had acquired vested rights that could not be disturbed. In the present case, however, the defendant began business as an infringer, and their last investment was made after the revocation of March, 1893. Again, if the present defense had been offered against an injunction it would not, unlike the Buckeye case, have availed. It could not have shown any such conduct or acts on the part of the complainant as estopped it from claiming the benefits of its revocation of March, 1893, as the Buckeye company could have done in its case, and for these reasons the court did not think the defendant had made a case entitling it to dissolution of the injunction now in force.

Having decided the case upon the facts, and for the reasons stated, the court did not think it necessary to notice the further contentions made on behalf of the complainants, as follows:

(1) That the proceedings in the Patent Office of December, 1893, were entirely void for want of jurisdiction of that office, and that therefore the record made by the office in those proceedings was not a record of which the public were obliged to take notice, and could not be operative, either

upon the complainant or upon any one claiming rights thereunder by reason of the complainant's conduct.

(2) That the proceedings in the Patent Office of December, 1883, were not binding upon one of the complainants in this case, to wit: The Edison General Electric Company, because, at the time said proceedings were instituted, the said Edison General Electric Company had a license from the patentee and his assignee to manufacture under said patents, which license ran to said company, and certain other associates named, and that they could not be influenced or affected by such proceedings in the Patent Office of which they had no notice, and that the interest of the Edison General Electric Company was acquired by it from the owners of the patent prior to any investments made by the defendant in this case.

The court said that both of these propositions, pressed with great earnestness by the learned counsel, might be of very great importance in connection with the case if presented in a different phase; but, as before said, it was now not necessary to consider them in connection with the decision based upon the facts as stated.

Storage Batteries.

We have received an interesting communication from Mr. Alfred Clarke, general manager of the Eastern Electric Light and Storage Battery Company, of Lowell, Mass., in which he refers to the recent paper on storage batteries contributed by Prof. Elihu Thomson to our issue of March 3 as a valuable contribution on the subject and one to be commended to every one interested in storage batteries. He states that the conclusions, being the result of careful investigation, confirm in every way his own experience in the manufacture, use and abuse of the storage battery, but that there is one point that Prof. Thomson omitted, to which he calls attention, as well as to qualify one of the statements in reference to the dangerous condition of sulphation of batteries under certain conditions. "Prof. Thomson states that 'the most economical rate of charging is a low rate.' This is true to a certain extent, but there is a limit to a low rate of charging. Too low a rate, instead of peroxidizing the positive plate will produce the dreaded sulphate of lead and should be guarded against. Gladstone and Tribe in their researches in the chemistry of the storage battery discovered this fact, and recorded it in their valuable work on the subject, and I take the liberty to quote page 11: 'If we take two plates of lead in dilute sulphuric acid and pass a current from only one Grove cell a film of white sulphate, instead of peroxide, makes its appearance on the positive pole, and the action practically ceases very soon. If, however, the current is increased in strength, the sulphate disappears and peroxide is found in its place.' My experience confirms this: hence the danger in attempting to charge a secondary cell from primary cells. To state the matter broadly, a secondary cell ought not to be charged at a lower rate than one-thirtieth of its normal capacity. The best charging rate is from one-tenth to one-eighth. Hence care should be taken in charging with primary cells to ascertain the normal capacity of the secondary cells which will determine the number of primary cells requisite to charge the secondary. The above applies to any means of charging; therefore it is well to remember that there is a limit to the charging current, to go below is positively detrimental."

Mr. Clark also refers to the name "storage battery" as a misnomer, and to the misleading character of the usual analogy with a water tank, in not giving the proper idea of the nature of a storage battery, which, he says, is a chemical combination whose molecular equilibrium is alternately disturbed and restored by an electrical current. Referring to the bright prospect of the storage battery in this country, he says that hitherto its powers have been overestimated

and capacity strained, but that since manufacturers honestly engaged in the business have become conservative in their claims, its applications have begun to extend. Mr. Clark thinks that in view of the successful era about dawning the appearance of a recent challenge from a storage battery manufacturer, which was published in our columns, is unfortunate, not only from its tone, but, as he thinks, from its being apt to mislead and react unfavorably on the public.

A Modern Lighting Plant.

The new electric light plant recently installed at the State Hospital for the Insane at Norristown, Pa., by Harry S. Smith & Co., Limited, of Philadelphia, was turned over by the contractors to the trustees on Feb. 5. The plant has been in operation several weeks and has proved satisfactory in every respect. The plant consists of two direct coupled 125-h. p. units. The dynamos are of the well-known Waddell-Entz type, with external armature of large diameter, enclosing internal field magnets, energized by a single coil of wire supported upon the hollow core joining the front and back magnets, in this case the machines having 10 poles. In these machines the commutators are of an unusually large diameter and with the brush holders and special brush raising and shifting devices are of the latest improved type.

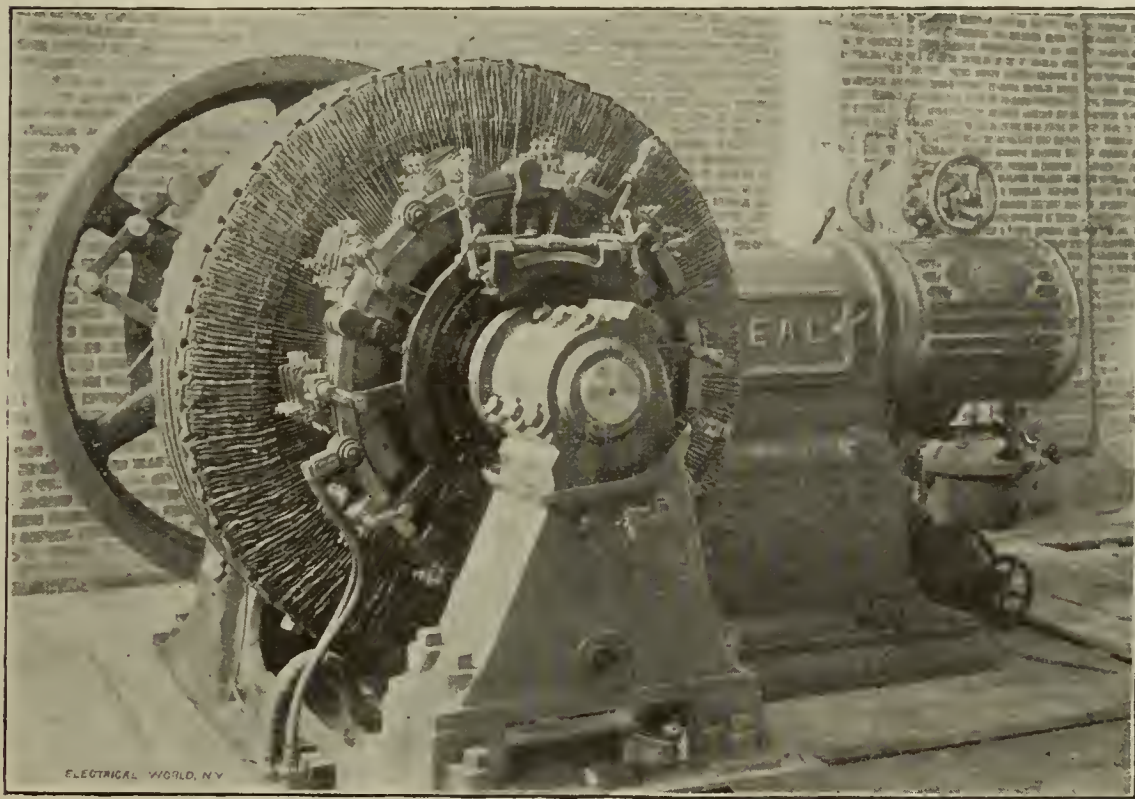


FIG. 1.—DIRECT-CONNECTED ENGINE AND DYNAMO.

These latter devices are so arranged that the brushes can be shifted individually or collectively, each separate brush being capable of adjustment on the commutator. Woven wire gauze brushes are used on both machines. The dynamos are direct connected to two 16 inches by 16 inches Ideal engines manufactured by the Harrisburg Foundry and Machine Works, each engine developing 138 indicated horse power at 250 revolutions.

The engines are furnished with extended shafts of large diameter, each made in one forging, extending through the hub of the armature spider to an auxiliary bearing, the hub being rigidly fastened to the shaft by keys. The engines are especially heavy in construction and together with the dynamos are mounted on heavy cast iron sub-bases of special design. The engines are self-lubricating and the pillar blocks are cast with troughs to catch and carry off oil drippings.

Fig. 1 gives a view of one of the engines and dynamos. Provision has been made for two additional engines and dynamos to complete the plant.

The dynamo connections are lead encased and carried to the switchboard in ducts built in the floor. The switchboard

consists of three panels of black enameled slate mounted in a framework of polished oak. On these panels are mounted the instruments and switches controlling the different circuits. Besides the dynamo switches there are twenty circuit switches to control the lighting of the different buildings, all switches being polished. Each dynamo is furnished with a voltmeter and ammeter. An additional ammeter and voltmeter are so arranged with shunts and switches that the voltage and number of amperes of any of the twenty circuits can be taken at the switchboard. The instruments are station size, with illuminated dials, manufactured by the Weston Electrical Instrument Company. In Fig. 2 is shown the switchboard, one of the instruments having been removed for recalibration.

The plant was installed under the supervision of Dr. W. A. Drysdale, consulting engineer, and no expense has been spared by the contractors to make the installation complete in every way.

The Monthly Meeting of the Massachusetts Street Railway Association.

The monthly meetings and dinners of the Massachusetts Street Railway Association have always been interesting on account of the discussion of practical subjects by practical men, and the one which occurred on Thursday afternoon,

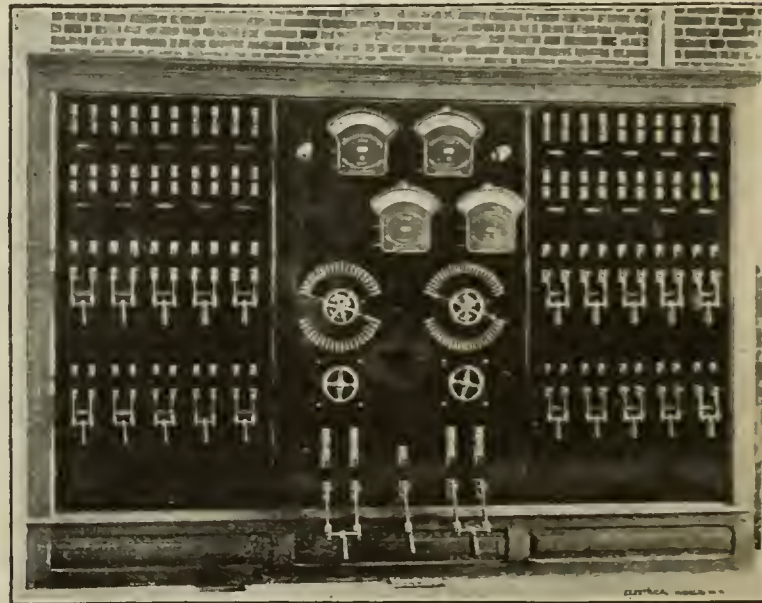


FIG. 2.—THE SWITCHBOARD.

March 8, at Young's Hotel, Boston, was not an exception to the rule. The special subjects for discussion were "Car Wheels" and "Brake Shoes."

Col. J. H. Cunningham, president of the Association, introduced as the first speaker Mr. W. W. Sargent, superintendent of the Fitchburg and Leominster Street Railway Company. Mr. Sargent stated that when his road first adopted electricity they used a wheel made by a New York firm which had given good service; they were now, however, trying some of a different make. The brake shoes they had cast at a local foundry. A soft shoe was used for the reason that it brakes a car more quickly and requires less power for application than a hard shoe. It is necessary, however, to caution the motorman against skidding the wheels. The use of such a shoe also does away more or less with reversing the motor, which is so injurious. In the matter of brake apparatus he suggested the use of a complete auxiliary brake, operated from either end of the car, without the motorman changing his position. Most accidents, especially calamity accidents, occurred by reason of the brake giving way. An emergency brake would undoubtedly overcome this difficulty.

Mr. Benjamin J. Weeks, of the Boston and Quincy Street Railway Company, stated that he had tried all kinds of wheels and up to last winter had used nothing but the ordinary 30-inch wheel, 2½ tread, weighting 325 pounds. Last fall his attention was called to a new style of wheel, the flange of which was cogged, and putting four of these under a single plow he was able to keep his line open with this one plow, the cogs on the flanges acting as cutters. He experienced no difficulty whatever from the wheels slipping. Several railroad men had been out to see the plow and a trial had been made on solid ice, the plow going on the ice almost as well as on the rail, there being very little slipping. In one instance, the plow was halfway between Quincy and North Weymouth when the armature burned out and they came back with one motor, plowing the snow, which was 8 inches deep all the way. He now has a set of these wheels under a box car and has no doubt that they are the coming wheel. In regard to brake shoes, he thought that price was not everything. The ordinary iron shoe if low-priced must necessarily be made of cheap material. If it is tolerably hard metal, it will glaze over and fail to hold the car. If the metal is very soft it is at the expense of the wheel, as it will work very much like a soft grindstone and what may appear to be the most economical shoe will prove the most expensive. In the fall of 1892 he tried one of Safety Brake Company's shoes with wooden plugs, and the following January began to buy the shoes regularly and has used no other since that time. Last June he bought 100 of them. They have lasted from four to five months each. He states that the wooden plugs give more friction with even less pressure on the wheels and stop the car quickly and avoid the usual jerking. The wooden plugs permit the use of a closer grained and somewhat harder metal, which will account for the increased service. This increase may also be due to the less pressure required on the brake.

Mr. E. C. Foster, general manager of the Lynn and Boston Street Railway Company, stated that they had used different types of wheels from different makers, all of which had been fairly satisfactory. The wheels they were now using as a standard were 30 inches in diameter, 2¼ inch tread, ¾-inch flange and weighed 350 pounds. When they first commenced to operate by electricity they used 250-pound wheels, and increased the weight up to 300, and finally to 350 as a standard. Most of the wheels that they have in service under the electrical cars have worn until they became flat, which has been due largely to the amount of duty performed by the wheel, although they have had cases where it was caused by the motorman applying the brake too quickly, thus allowing the car to slip on the rail. The shoe that they have adopted as a standard is one of medium hardness. A very hard shoe would give too great wear on the wheel and a too soft one too great wear on the shoe. They had successfully operated their cars equipped with air brakes last summer. He did not doubt that electricity could be applied to braking cars in case of emergency and at very little expense, not exceeding \$15 per car. This, however, should be used only as an emergency brake. They had also some experience with the track brake, but had some difficulty with this for the reason that a pressure could be created that would raise a car from the rail. Their experience with a sand box has not been very satisfactory, and they have confined themselves for the past season to the ordinary tin pail filled with sand and a fire shovel on the front platform.

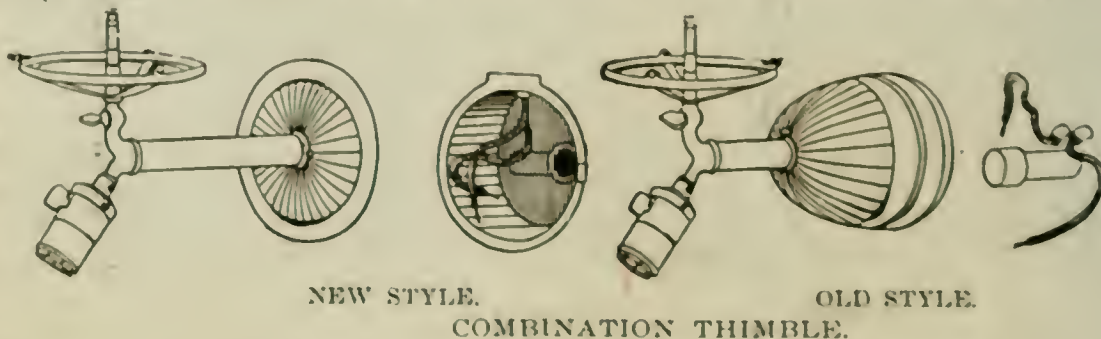
Mr. Maurice Hoopes, of the Lynn and Boston Street Railway, said in regard to reverse brakes that he did not see why more use was not made of the motor for this purpose. There is a demand for a method of stopping cars

over which control has been lost. Such cars if equipped with two motors and a system of wiring which does not parallel the armatures independent from the fields but parallels the two motors, may be stopped usually by simply throwing the reversing switches, and in the case of the S. P. controller equipment, placing the controller on one of the parallel positions. Unfortunately it often happens that instead of one motor overpowering and reversing the field of the other, the two motors build up exactly together, in which case there is no current, and hence no retardation. In order to make the operation of this method a certainty, it is only necessary to replace the ordinary overhead cut-out switch with single-pole double-throw switches wired to disconnect the motors from trolley and connect to ground. With this arrangement, if a motorman loses control of his car in all other ways he may throw off this switch and reverse the car as though power were on. This makes the control of the car entirely independent of the mechanical brake and of power from the line. It has an additional advantage of stopping a car on a slippery track when nothing else will. This is because of the fact that the braking is automatic to the point of slipping without passing it. The cost of equipping a car is very slight.

Mr. G. E. Cutler, of New York, who was the special guest of the Association, discussed the question of accident insurance. He defined the various kinds of casualty and liability insurance, giving the experience of different companies, and argued in favor of the formation of an accident insurance company by street railway companies, a matter which the Association has had under consideration for some time. It was voted to refer the question to the Executive Committee, with authority to appoint a sub-committee if necessary. A vote of thanks was given Mr. Cutler for his able address.

A Combination Thimble for Gas and Electric Fixtures.

A useful device has recently been introduced on the market by the Miller Electric Construction Company, of



Pittsburgh, Pa., to provide for the arrangement of the connections of the gas and electric light fixtures within thimbles or shells embedded within walls or ceilings, thereby permitting of the use of small canopies for covering the mouths of the shells or thimbles.

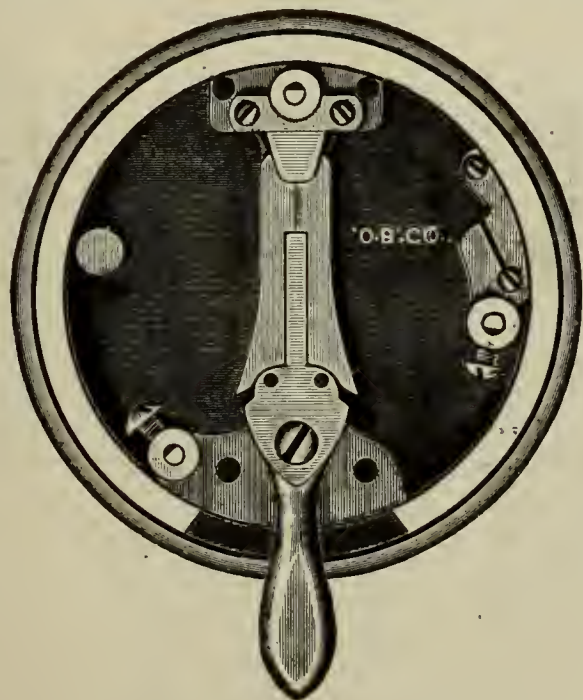
By the old method the gas pipes are usually so arranged in houses that the outlet ends project from two to four inches from the side walls or ceiling, and on account of the size of the insulating joints and fuse-blocks, and the length of the projecting ends of the gas pipe, the canopies used for concealing these parts are, on account of their size, nearly as unsightly as the joints and fuse-blocks themselves. By the new method the thimbles are so arranged in the walls or ceilings that their front edges will be flush, or approximately so, with the outer surface of the plaster. In case no fixture is desired where the thimble is located, a cover can be screwed into the mouth of the thimble and can then be papered over or otherwise concealed. All the connections, such as insulating joints, fuse-blocks, etc., can be arranged within the thimble, which can be closed with a small flat canopy. Thimbles designed for brick walls are provided with reinforced seats for the heads of the screws employed in se-

curing them in position, but the thimbles for frame partitions or ceilings are provided with wings, whereby they may be secured to the studding.

The thimble will also afford protection against fire, as in case of the leakage of gas at the joint and its ignition by the electric current, the flame will be confined within the thimble, which is preferably lined with asbestos, thereby preventing the ignition of any adjacent woodwork. The thimble can be used in connection with gas fixtures alone, in which case the nipples may be omitted, or the thimbles may be secured in walls or ceilings, without connecting with a gas pipe, as a support for electric fixtures, which can be screwed directly to the inwardly projecting nipple.

A Headlight Switch.

The accompanying cut shows a view of a three-point quick break headlight switch, manufactured by The Ohio Brass Company, of Mansfield, Ohio. The use of this switch simplifies car lighting when the electric headlights are used, as one switch only is necessary to control the entire circuit. It is three and one-half inches in diameter and seven-eighths of an inch deep over all. The metal parts are mounted on a slate base which is provided with a metal covering, and the whole switch presents an ornamental appearance, in keeping with the other interior furnishing of the car. The blade of the switch has pivoted side pieces or wings, which are normally held together by a spring fastened to the under side of it. In breaking a circuit a positive motion is given to one of the wings of the blade which leaves the contact piece first by the centre arm which is rigid to the handle. The other wing, however, is held between the contact lips of the binding post until the shoulder on the switch handle strikes against its projected flange. It is then forced out of the lips and the tension which is thus placed on the spring tends to draw it quickly into its normal position. The switch is placed in circuit between



HEADLIGHT SWITCH.

the lights in the body of the car and the headlights, to which independent wires are run from the binding posts of the switch and then grounded. In this way a series of five lamps is always maintained. Either headlight can be controlled independently of the other or the entire circuit cut in or out at will.

A New Direct Current Arc Generator.

The results of extended and elaborate experiments, carried on for a long time by the Westinghouse Electrical and Manufacturing Company, with a view of obtaining a dynamo

that would better fulfil the requirements of direct current arc lighting than any heretofore in use, are embodied in its new direct current arc machine, which we illustrate.

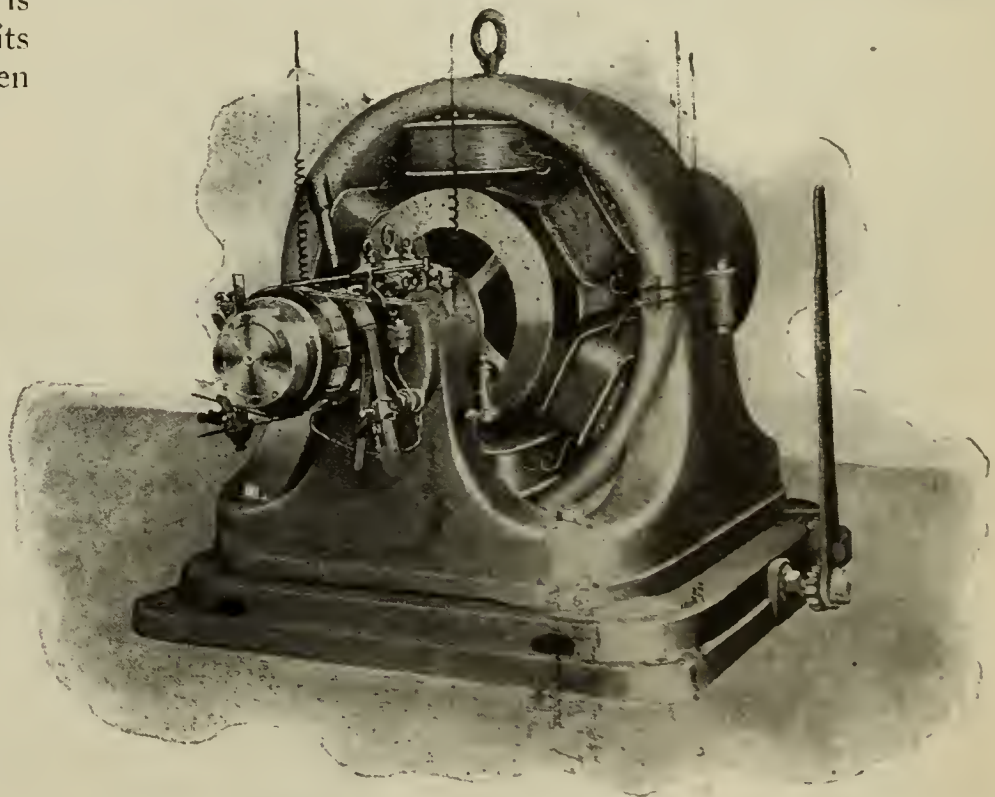
Though the new machine differs very radically in construction from former types, it belongs to the well-known open coil continuous current class, which is acknowledged to offer special advantages for arc lighting work.

A machine of this class delivers a uni-directional though not continuous current, for while the electromotive force of the terminals does not change its sign, it nevertheless pulsates or fluctuates. This pulsating of the electromotive force gives a steady mean value to the current, and makes it particularly adapted for arc lighting, as its pulsating character keeps the mechanism of the lamps in a slight but constant vibration, thereby rendering them less liable to become slow in action or altogether fail to feed.

The new machine in general appearance is similar to the Westinghouse standard alternating current dynamos, that is, it consists of a circular cast iron yoke parted horizontally and having inwardly projecting poles. The armature is of the toothed type with lathe wound coils, especially heavily insulated.

The public are thoroughly familiar with the advantages of the toothed armature, which avoids the use of band wires and allows the replacing of an injured coil with but small outlay of time and money. The use of lathe wound armature coils secures any desired degree of insulation, a most important point in the construction of every arc dynamo. The armature is supported in self-oiling bearings with spherical seat, so that the machines are self-aligning. The bearings are cast solid with the lower half of the field, thereby securing great strength and rigidity of construction.

A particularly strong point claimed for the machine is the system of regulation. It has absolutely no regulating devices or walls traps such as have heretofore been the accompani-



DIRECT CURRENT ARC GENERATOR.

ments of all constant current machines. Regulation is effected, as in the Westinghouse alternating current arc machines, by the reactive effect between the winding of the field and the armature. The generator may be short circuited and run without injury, and is absolutely self-regulating throughout its entire range of load.

With the use of direct currents, the commutator has always been considered the weak point of the system. Consequently particular attention has been paid to the securing of satisfactory results here. This has been accomplished by the use of a new type commutator which presents a large bearing surface for the brushes and which has the segments sepa-

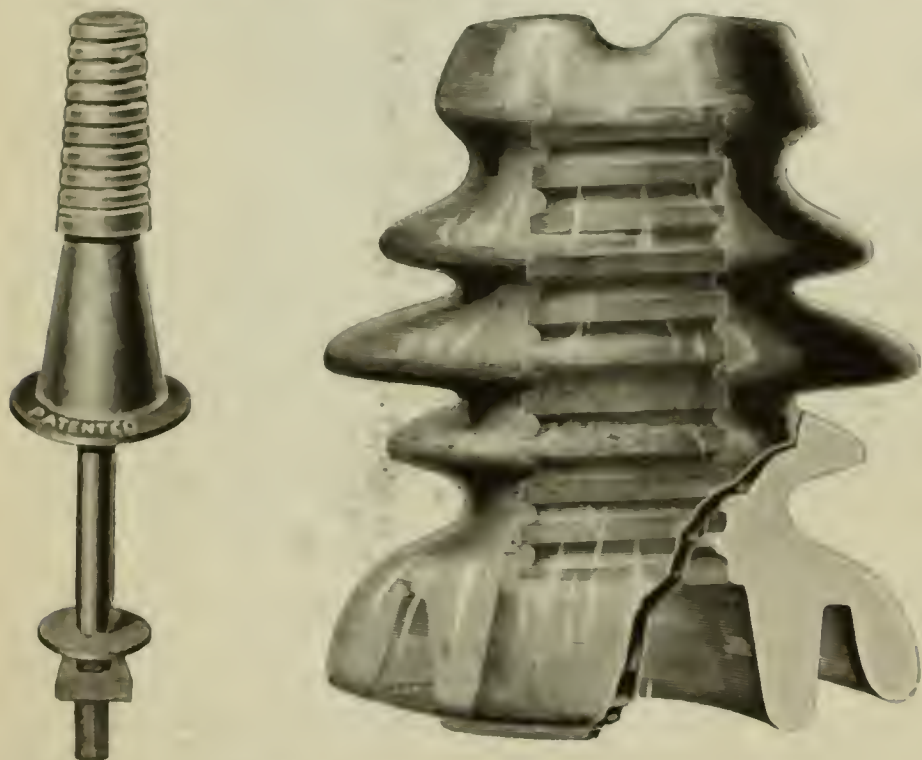
rated by half an inch of insulation, so that the machine is particularly free from vicious sparking. Four sets of copper brushes collect the current without the use of "blow-outs" or other troublesome devices intended to avoid sparking.

The field coils are connected in series with one another. The exciting current is supplied from a separate low voltage machine so that the use of high potentials in the field windings, a menace to insulation and life, is avoided. An efficiency of over 90 per cent. is claimed for the new machines, which far exceeds anything heretofore available, as the best direct current series arc machines are ordinarily very inefficient. The speed varies from 750 revolutions for 60-arc 91-2-ampere machines to 950 revolutions for 25-arc machines.

The lamps supplied with the machine are of the rack feed type, affording the excellent method of regulation secured in the Westinghouse constant potential lamps. In the construction of these lamps particular attention has been paid to making them rigid and durable, thus enabling them to give long continued service with a minimum amount of repairs. The lamps are designed to suit the requirements of all kinds of service. The outdoor lamps are plain in appearance, but weatherproof. The indoor lamps are made in a variety of forms with brass or galvanized iron mountings, and with plain or fancy globes. The lamps use a plain or coppered carbon 5-8 inch in diameter, and they will give 14 hours' life with one trimming. These lamps are designed to be used on any direct current series arc system which supplies 91-2 amperes. The lamps are supported from strong non-combustible metal hanger boards. Each lamp is supplied with an automatic cut-out, so that when the carbons are burned, or if any accident happens to the lamp, it is automatically cut out of circuit without disturbing the other lamps in use.

Pole Fittings.

We illustrate some pole fittings made by Fred. M. Locke & Co., Victor, N. Y., consisting of an "indestructible" insulator pin, and an insulator, both of which present some novel features. The transposition insulator illustrated is



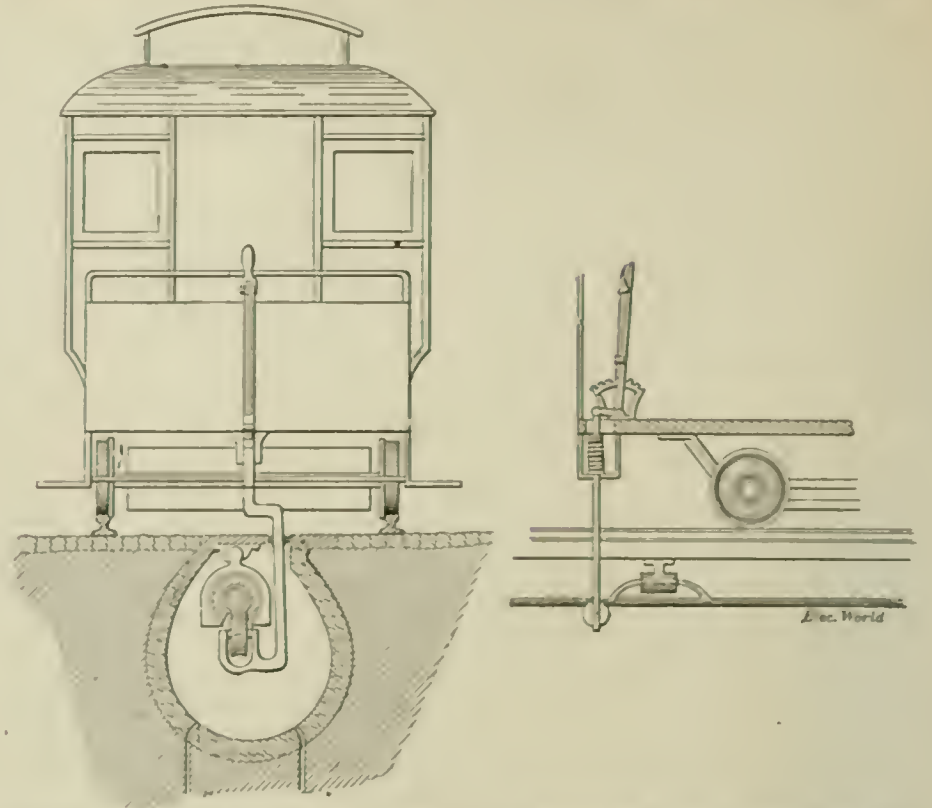
NEW INSULATOR AND PIN.

made of a special quality of transposition glass. The same firm manufactures a triple petticoat insulator, for use where light insulation is needed.

New Conduit System and Insulator.

Dr. Charles H. Bowen, of Washington, D. C., has recently been granted letters patent for a conduit street rail-

way system, illustrated in Figs. 1 and 2, which also show the details of the contact mechanism. The method of insulation shown in Fig. 2 is illustrated in detail in Fig. 3. The in-



FIGS. 1 AND 2.—NEW CONDUIT SYSTEM AND INSULATOR. Insulator consists of a hanger of rubber with a slot underneath and a groove or recesses on its upper interior surface.

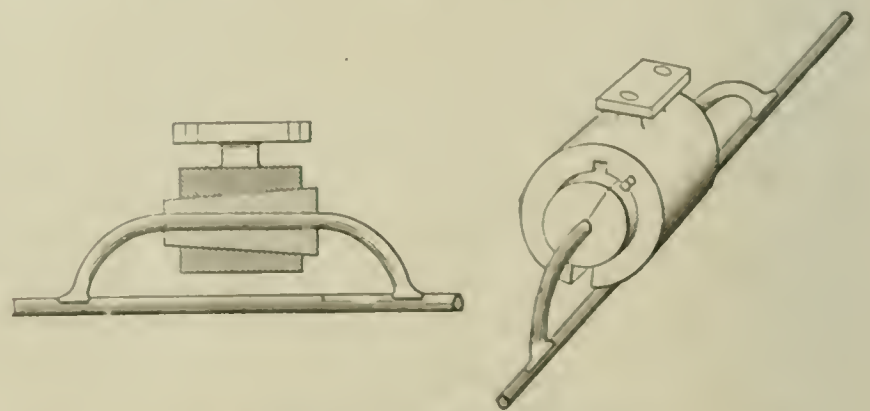


FIG. 3.—NEW CONDUIT SYSTEM AND INSULATOR.

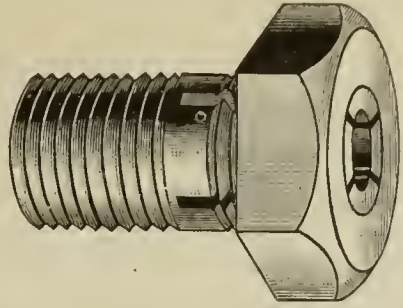
In the hanger is placed a conical divided glass insulating sleeve provided with lugs on its outside surface whereby the sleeve is locked in place by turning the lugs.

Street Railway Bonding Chucks.

There is probably no part of an electric railway system so important as the bonding of the rails, and one to which so little thought heretofore has been given. Engineers frequently make elaborate calculations as to the amount of copper feeder wire required, and as a result of this have submitted reports to their directors and companies, drawing the fine line of economy between interest on the investment of copper on the one side and the increased cost of the coal pile due to the other. These statements and reports are of little value for the reason that they are all based upon the track resistance being of a fixed and certain quantity. The difficulty is not with the science, but the fault lies entirely in the practice.

In electric railways the track is a part of the circuit, and therefore an element of resistance in the track is as serious a matter as it would be if in the feeders of the line; and in any such system of track bonding where there is a possibility of loose contact, this element becomes so uncertain as to not alone make these calculations above referred to of but little value, but frequently result in such a loss of energy and drop of pressure as to cause the burning out of the motors upon the line, and thus run up the cost of maintenance to a prohibitive figure. And where the cause of this drop is not understood, extra copper is installed without benefit.

With the bond we illustrate, manufactured by Stern & Silverman, 707 Arch street, Philadelphia, it is claimed that



STREET RAILWAY BONDING CHUCK.

the contact is always positive between the bonding chuck and the rail and the wire, and the condition such that loose contact is a matter of impossibility. It is true that a slightly additional amount of labor is required to install these bonds, but this is nothing in comparison to the amount of copper feeder that is required to compensate for the losses occasioned by other forms of electrical bonds.

Portable Recording Wattmeter for Street Car Testing.

It is frequently necessary in electric street railway practice to test the power consumption of the cars, and heretofore the General Electric Company has furnished a 500-volt meter mounted rigidly within a mahogany box for this purpose. This was, however, found not to be without faults. The mechanism being rigidly mounted, the meter was subjected to violent jars which frequently interfered with its accuracy, shortened its life and rendered it unsatisfactory. Experiments have been going on for some time past to evolve a satisfactory portable recording meter for the purpose named, and the General Electric Company now announces one which will satisfy the many requirements of street railway service.

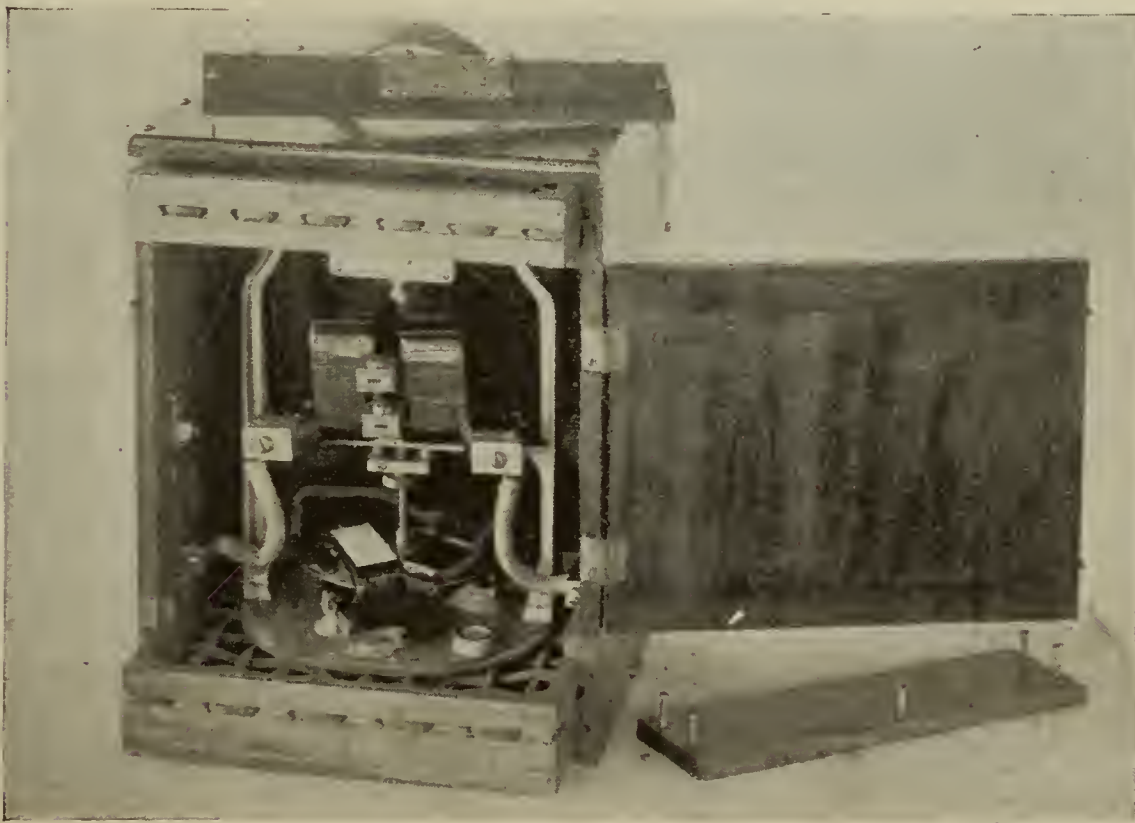
The meter in question consists of a Thomson recording meter mounted on a skeleton metal frame and having a ca-

agitation or shocks, and renders its accuracy reliable. It is the first time that this system has been applied to the recording meter, and it is a feature which will recommend it to all street railway men. The meter may be used placed upon the floor of the car with absolute safety and convenience, and gives perfectly accurate readings.

This portable meter is normally rated at 25 amperes. In testing street cars, however, the current will frequently, for short intervals, very greatly exceed this, as when starting or upon heavy grades, but this meter is so constructed as to record these sudden bursts of current accurately; and enormous overloads may be carried through the meter for short intervals without detriment to the instrument or impairment of its accuracy.

Graphite Sight Feed Lubricator.

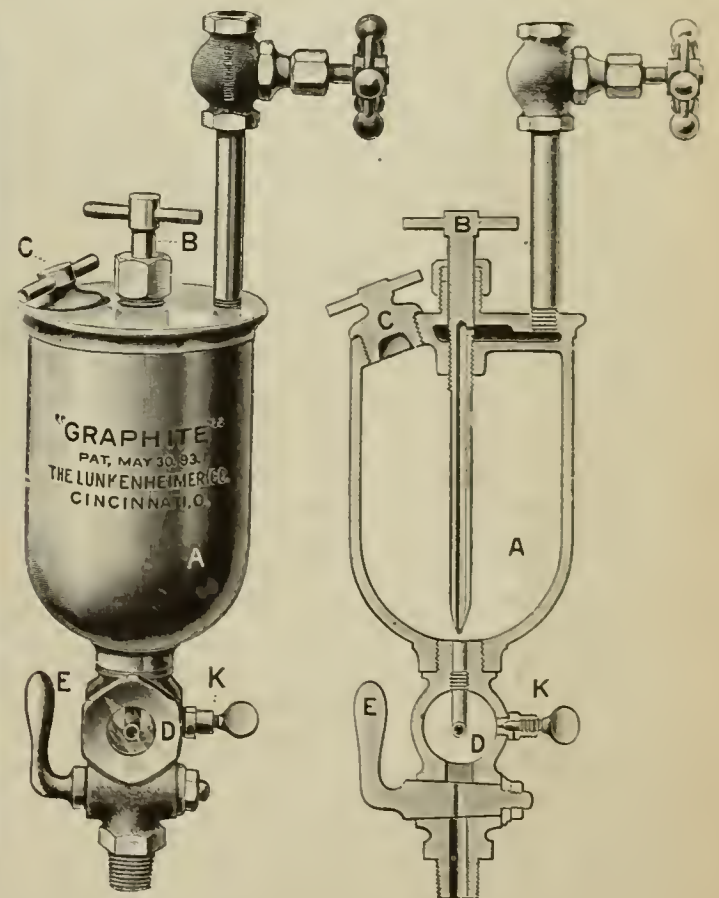
It is well known by engineers generally that pure flake graphite is far superior to oil or any other lubricant, when properly applied to steam engine cylinders, but being a dry powder and not mixing well with oil, the difficulty has been to properly supply it to steam chests and cylinders of engines and pumps. A lubricator, which we illustrate, that not only feeds the graphite automatically and continuously in desired quantities, but also does it visibly, by passing through a sight feed, has recently been placed on the market by the Lunkenheimer Company, Cincinnati, Ohio. The cup should be attached like any ordinary sight-feed oil lubricator to the steam pipe above the throttle, but can also be attached below the throttle or on the steam chest, with the upper steam connection above the throttle. Referring to the cup, *A* is the graphite reservoir, *B* the graphite regulating valve, *C* the filling plug, *D* the bullseye sight feed chamber, *E* the feed regulating valve, and *K* the drain valve. The lubricator is operated as follows: Close the globe or steam valve and stop cock *E* and then take off the filling plug *C*, and fill the reservoir with graphite. After replacing the filling plug, first open the globe or steam valve, then open the stop cock *E*, then regulate the flow of graphite by valve *B*; next regulate the stop



PORTABLE RECORDING WATTMETER.

capacity of 25 amperes at 500 volts. It is mounted within a polished wood carrying case about two-thirds the size of the former type. Instead of being rigidly mounted in the case the meter is suspended between two networks of interlaced rubber cord, or, as it were, between two rubber hammocks. This method of suspension saves the meter from violent

cock *E* carefully, and leave it so regulated that the desired flow of graphite is fed visibly out of the nozzle *D* in the sight-feed chamber. As graphite is a very superior lubricant, and a very small quantity will last a great while, it should be used very economically, as a continuous feeding is not necessary, the feed being occasionally shut off.



Financial Intelligence.

The Electrical Stock Market.

NEW YORK, March 17, 1894.

GENERAL ELECTRIC, after being very strong during the first part of the week, was made the target of bear attacks in later days, and lost a portion of its gain. In these raids upon the stock's quotations, the bears were helped along by realization sales on the part of the bull pool that engineered the rise from 32 to 44, and were anxious to rake in some of their 12-point paper profits. The decline of the last few days has naturally been accompanied by a flood of bear stories. A director is quoted as saying that the General Electric Company is at the present time doing a business of but between \$600,000 and \$700,000 per month, or about \$8,000,000 a year. He adds: "We hope to pay some dividends by and by, when the capital account is adjusted. The deficit to be shown in the annual report will be large enough to satisfy anybody." Again, it is stated that the accounts of the Northwest branch are in bad shape, and that orders are again falling off at such a rate that, as soon as the present contracts for motors are filled there will be another reduction in forces at the Lynn works. Boston and New York holders have, moreover, been somewhat disappointed—and have manifested their feelings by selling stock—at the failure of the management to give out the long predicted statement, showing that the company had no floating debt, which was promised by March 1. The dividend question is still a matter of the greatest uncertainty. It has not yet been decided whether or not to pay the deferred dividend on the preferred in April, as some directors now are in favor of waiting for the regular June period of distribution, when they will declare the whole payment of 7 per cent. On the other hand, the friends of the property are as enthusiastic as ever in their behalf in the company's future. Especially great things are presaged from the General Electric Company's connection with the Cataract Electric Company, which has harnessed Niagara Falls for the generation of electricity, and which has just secured a contract which gives the use of State canal lands for the distribution of electrical power all over the State. The Cataract company has secured most advantageous terms in its agreement with the State. Among the capitalists most largely interested in the Cataract Electric Company are J. Pierpont Morgan, William K. Vanderbilt, H. McKay Twombly and other leaders in the General Electric Company, and it is but natural to assume that the operations of the Cataract company will result in the placing of large orders for equipment and supplies with the General Electric Company. No mention has recently been made by insiders regarding earnings, and the report to be handed in at the next month's annual meeting is awaited with a deal of interest.

WESTERN UNION TELEGRAPH stock monopolized Wall Street attention at times in the earlier part of the week. The stock has gone off a couple of points on the publication of the adverse quarterly report presented at the directors' meeting on Wednesday. The directors declared the regular quarterly dividend of 1¼ per cent., but the statement shows that this amount was not earned in the quarter ending March 31 next. The net earnings for that period are estimated at \$1,050,000 as against \$1,584,434 last year and \$1,549,637 two years ago. As there are \$94,820,000 stock outstanding, only 85-100 of 1 per cent. was earned on the stock, and, in order to pay the full dividend of 1¼ per cent., the directors will have to draw upon their surplus to the extent of \$378,737. The comparison of net earnings shows a shrinkage of 33 per cent. in spite of extensive economies in the operating department. Not content with this, the bears lay stress on the fact that the directors are borrowing money to pay dividends, when the physical condition of the property is far from good. There really is no harm done to the company, as the Western Union is financially strong enough to do this for some time, but it creates a very bad impression. Insiders hasten to assure stockholders that things are not really so bad as would appear from the report just published. The loss in net revenue is fully explained, they say, by the reduced volume of business, and would have been greater, had not operating expenses been reduced 16 per cent. Moreover, the March quarter is the worst one in the year, and a deficit of \$378,800 in that quarter, according to insiders, is practically certain to be made good by the surplus of some succeeding quarters. For instance, there was a surplus in the December quarter of \$308,094, and, if the two quarters are taken together, there is only a deficit of \$70,643 to be made up, against which the Western Union has an accrued surplus of nearly \$7,000,000.

AMERICAN BELL TELEPHONE has been very strong in Boston, advancing chiefly on the covering by shorts, who have been scared by the increasing indications that the company will get desired legislation in the matter of the proposed increased capitalization. The opposition to the new stock issue has been almost entirely withdrawn, and there is no question but that the petition of the company will be speedily granted. None the less lower prices for the stock may still be counted on. True, the regular quarterly dividend of 3 per cent., payable April 16, has been

declared, as expected by stockholders, but the anticipation that the rate is likely to be cut before the year is ended is gaining ground in view of threatened competition. With an issue of new stock coming (which may or may not be sold by auction), and the consequent increase in dividend requirements, a considerable decline in the price of the stock would seem to be an almost assured certainty.

THE EDISON ELECTRIC ILLUMINATING COMPANY of Brooklyn advanced this week its quarterly dividend rate from 1¼ to 1½ per cent., making the annual rate 6 instead of 5 per cent.; in consequence the stock has advanced several points. The company's officials state that the business is spreading at a most gratifying rate, and the increased dividends are ample evidence that it is making money. The contract for lighting Brooklyn streets is likely to be given, for the greater part, to the Edison company.

THE EDISON ELECTRIC ILLUMINATING COMPANY'S stock of Philadelphia has shown considerable strength recently. The stock, which was quoted two weeks ago at around 120, is now sold at 132, and it is reported a few shares have gone as high as 140. This security is an 8-per cent. dividend stock, and is considered one of the most valuable of Edison Illuminating properties.

THE NEW ENGLAND TELEPHONE AND TELEGRAPH COMPANY will receive tenders for the sale to it of \$500,000 of the first series of 6 per cent. bonds, due April 1, 1899; in no case will the company pay more than \$1,020 and accrued interest for any \$1,000 bond. The New England Telephone Company is now offering to lease magneto telephones for use on private lines for \$1 per annum for each instrument. It is also offering to lease the magneto call bell for \$3 per annum. This bell is an essential part of the telephone, unless some other form of signal, such as an electric call bell or tapper can be employed, without adversely affecting the use of the telephone.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES' trustees have expended \$200,000 additional in the purchase of preferred stock at an average price of \$4.9 per share.

ELECTRIC TRACTION COMPANY STOCK has again been pressed for sale in Philadelphia on account of the inability or unwillingness of holders to pay the remaining installments. This week \$10 per share was payable, and an additional \$15 per share is due April 16, when the stock will be full paid.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York.....	50	20	35
Detroit Electrical Works.....	10	2	3
Cleveland General Electric Co.....	—	85	90
East River Electric Light.....	100	—	65
Electric Con. & Supply Co., pref.....	15	15	16
Electric " " " com.....	15	15	17½
Edison Electric Ill., New York.....	100	97	97½
Edison " " " 1sts.....	—	103	104
Edison Electric Ill., Brooklyn.....	100	102	105
" " " Boston.....	100	112	115
" " " Chicago.....	100	125	130
" " " Philadelphia.....	100	130	132
Edison Electric Light of Europe.....	—	—	3
" Bonds.....	—	80	85
" Ore Milling.....	—	10	11
Fort Wayne Electric.....	—	—	4½
General Electric Company.....	100	41½	42
" " " deb. 5's.....	—	81½	85
Interior Conduit and Ins. Co.....	100	20	30
Mount Morris Electric.....	—	—	65
Westinghouse Consolidated.....	50	32	33
" " " pref.....	50	40	50
Western Union Telegraph.....	—	85¾	85¾
American Bell Telephone.....	—	181	182

New Incorporations.

EAU CLAIRE, WIS.—The Brooklyn Electric Light Company has been incorporated here. Fitch Gilbert is president, R. E. Rust is vice president and George T. Thompson is secretary-treasurer.

THE LOUIS K. COMSTOCK COMPANY, Chicago, Ill., capital stock \$20,000, has been formed to engage in the business of general electrical engineering and construction, etc. L. K. Comstock, F. S. Richmond and P. V. Cary are the promoters.

THE LYNN MANUFACTURING COMPANY, Portland, Me., capital stock, \$10,000, has been formed to manufacture and deal in all kinds of electrical supplies. A. T. Hallbauer, Lynn; J. C. Barr and R. H. Weld, Jr., Boston, Mass., are the promoters.

THE BROOKVILLE ELECTRIC LIGHT COMPANY, Eau Claire, Wis., capital stock \$15,000, has been formed to an electric lighting business. R. E. Rust, G. T. Thompson and F. Gilbert are the promoters.

THE VALPARAISO MANUFACTURING COMPANY, Valparaiso, Ind., capital stock, \$10,000, has been formed to manufacture electrical instruments, etc. The incorporators are J. W. Elam, F. S. Wenk, G. Crumppacker, C. B. Woodard and J. W. DuLaney.

THE CLEARFIELD AND CONEMAUGH RAILROAD COMPANY, Clearfield, Pa., capital stock \$1,350,000, has been formed to construct and operate an electric railway in Clearfield and Cambria counties. J. Morgan Cooper, G. D. Prentice and C. H. Sackrider are the interested parties.

THE CENTRAL ELECTRIC ELEVATED STREET RAILWAY COMPANY, Philadelphia, Pa., capital stock, \$200,000, has been

formed to construct and operate an elevated electric railway in Philadelphia and to Bustleton, a distance of 333 miles. William J. Hamilton, J. Blair and J. Armitage are the promoters.

THE MADISON LIGHT AND POWER COMPANY, Chicago, Ill., capital stock \$10,000, has been formed to do wiring for arc and incandescent lamps, manufacture electrical apparatus, furnish electrical and steam power, etc., etc. The promoters of this concern are G. H. Shipley, E. P. Ames and F. J. Baker.

THE TOLEDO, MAUMEE AND PERRYSBURG ELECTRIC STREET RAILWAY COMPANY, Toledo, Ohio, capital stock \$150,000, has been formed to build or acquire and operate electric street railway. The organizers are J. K. Tillotson, F. M. Ohl, L. G. Richardson, D. Atwood and N. McCarty are the incorporators.

THE TOPEKA-HARRISON TELEPHONE AND ELECTRICAL COMPANY, Topeka, Kan., capital stock \$25,000, has been formed to build and operate telephone lines and to deal in electrical machinery. S. J. Bear, A. K. Rodgers, W. H. Rossington, James Smith, J. G. Waters, Topeka, Kan., and H. S. Buck, Stewardsville, Mo., are the incorporators.

CHESTERTOWN, MD.—A bill has been introduced at Annapolis by Senator Hepbron to incorporate the Chestertown Light, Heat and Power Company, capital stock \$500,000, to furnish light and electric communication between Chestertown and Chesapeake Bay. George H. Sharp, John D. Urie, John K. Aldridge, Charles T. Westcott, and William D. Burchinal are interested.

ALBANY, N. Y.—The Cataract General Electric Company has been chartered to supply electricity with which to operate boats. Thomas C. Platt, of the United States Express Company, New York; Charlton T. Lewis, counsel to the Mutual Life Insurance Company, of New York, and William Martens, of L. Von Hoffmann & Co., New York, are interested. Frank W. Hawley, of Pittsford Farms, near Rochester, N. Y., is vice president.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
41 Park Row New York, March 17, 1894.

THE STOREY MOTOR AND TOOL COMPANY, through a typographical error, advertised in our last issue as being located at No. 20, instead of 120, Liberty street.

BROOKLYN, N. Y.—Sealed proposals will be received at the office of the superintendent of the Brooklyn Bridge, 179 Washington street, Brooklyn, to April 5 for plans, specifications and estimates for lighting the bridge cars by electricity; also for heating and propelling them. C. C. Martin is chief engineer.

THE OKONITE COMPANY, LTD., 13 Park Row, is presenting to its friends and patrons a handsome piece of desk furniture, consisting of a glass paperweight, with a small clock in the interior. The combination is very neat, and the timepiece keeps very good time—neither of which is true of most articles of this kind.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., March 17, 1894.

THE PROJECT to place electric wires underground is causing much agitation in Boston and vicinity, hearings being held by legislative and aldermanic committees almost daily.

THE BURYING of overhead wires is still being considered by State and city legislative committees, but any immediately definite legislation is regarded as doubtful by those who ought to be in a position to judge.

THE TRANSIT COMMITTEE of the Massachusetts State Legislature is still busy upon hearings relative to a subway in Boston. General Francis A. Walker, president of the Institute of Technology, recently testified that he regarded elevated roads as the least satisfactory of all modes of solving the question of rapid transit. The subway would, he thought, prove at least a temporary solution, and would perhaps prove the foundation of a more extensive system. Whenever it was necessary to relieve the restrictions it would pay for itself. On general principles he was opposed to the referendum, but if there were any peculiar or exceptional circumstances in connection with their proposition he would not be averse to submitting it to the people for their approval or rejection.

ON LAST SATURDAY EVENING, in response to an invitation from Mr. C. W. Holtzer, 24 gentlemen, nearly all of whom were members of the old Boston Electric Club, assembled at dinner at Young's Hotel, Boston. The idea was to obtain expressions as

to the advisability of organizing another electric club in Boston, and the feeling was unanimously in favor of it. It was thought that with the experience of other clubs as a guide, a club might be formed which could be made both instructive and profitable. The occasion was a very enjoyable one, indeed, and Mr. Holtzer was the recipient of universal congratulations. Mr. W. J. Denver, assistant manager of the New England Telephone Company, and a past president of the Boston Electric Club, officiated as toastmaster in his usual happy manner. Remarks favoring the organization of a club were made by Messrs. Ridlaw, Hewins, Orford, Farnham, Lang, Tuckerman, Caldwell, Adams Ross, Hathaway and Key, and before final adjournment it was voted that Mr. Denver, Colonel Hewins, Mr. Ridlaw, Mr. Holtzer and Mr. Ross act as a committee on further organization. Those present were: C. W. Holtzer, W. J. Denver, Colonel E. H. Hewins, J. M. Orford, W. S. Hill, I. H. Farnham, E. J. Boynton, S. G. Stiness, G. L. Lang, G. W. Adams, F. M. Kimball, E. L. Caldwell, F. S. Palmer, C. W. Gates, R. F. Ross, F. E. Donahoe, W. A. Hathaway, C. R. Remington, S. W. Leedon, E. S. Pillsbury, W. S. Key, H. G. Tuckerman, W. E. Holmes, Frank Ridlaw and W. D. Warner.

Pittsburgh Notes.

PITTSBURGH, March 17, 1894

THE McKEESPORT AND WILMERDING ELECTRIC RAILROAD has ordered a new 40-foot freight car to be equipped with two 40-h. p. Westinghouse motors. This is made necessary by the great increase in freight traffic the company has experienced on its line.

THE ALLEGHENY COUNTY LIGHT COMPANY of this city, at a meeting of the board of directors yesterday afternoon, declared a dividend of 1½ per cent. This is the first dividend the company has declared since 1890, and it is expected that it will be continued permanently.

A FEW DAYS AGO ground was broken for the erection of an electric fountain, which the Pittsburgh Traction Company will donate to the city. The fountain is to be constructed in Schenley Park, and the electric plant to be used in connection with the fountain will also furnish current for the lighting of the park.

J. H. CARR, a young man of McKeesport, and a former employee of the Westinghouse Electric and Manufacturing Company, has invented an electric bicycle which is pronounced by experts to be a remarkable and ingenious production. The battery of the machine is placed beneath the saddle. The bicycle has no pedals, but simply two bars for foot-rests. It is said that the machine can be run at a wonderful speed.

English Notes.

(From our own Correspondent.)

LONDON, March 7, 1894.

THE TESTING OF HOUSE INSTALLATIONS.—The City of London Electric Lighting Company has sent a circular to its clients, offering, for an annual fee of 10 shillings, to send around competent inspectors at regular intervals to test the insulation of their house wires, and to report generally upon the condition of their fittings. This idea should prove at once remunerative to the company, and useful to the consumers.

ELECTRIC RAILWAYS.—The tunnel electric railway, which it is proposed to run from the terminus of the London and South Western Railway, which is on the south side of the Thames, into the city, bids fair to be the first completed of the many underground electric railways for which Parliamentary powers have been obtained for some little time. At the recent annual meeting of the London and South Western Railway Company it was agreed to guarantee the company about to construct the electric railway a dividend of 3 per cent., all profits above the sum necessary to pay this dividend being divided between the shareholders of the London and South Western Company and the Electric Railway Company. An interesting paper was read by Mr. Greathead and Mr. T. Parker before the Institution of Civil Engineers last evening on the Liverpool overhead railway. It was stated that the average actual coal consumption on the Liverpool overhead railway was about 16 pounds per train mile for trains of about 38 tons weight, sitting 114 persons and running at an average speed of 12 miles an hour; the coal being bituminous slack. Mr. Greathead was very enthusiastic about the excellent qualities of the electric motor for traction purposes. He showed that the weight of the electric motors on the Liverpool line was only 20 per cent. of the weight of the full train, whilst the weight of the steam locomotives on most of our London suburban lines was 40 per cent. of a fully loaded train. He also showed that on the Liverpool line, the adhesion taken is one-seventh of the weight on the driving wheels, amounted to 115 pounds per train, whilst on the underground the figure was only 61, and similarly the tractive effort at starting in pounds per ton of train was in the case of Liverpool 120 pounds and in the case of the underground only 71. There were several of our best known railway

managers and engineers present at the meeting, and considerable astonishment was expressed by them at these figures, and at the remarkable high general efficiency of the line.

News of the Week.

Telegraph and Telephone.

ARKADELPHIA, ARK.—The City Council has granted a franchise for the construction of a telephone line.

BLACK ROCK, NEAR BUFFALO, N. Y.—Thomas Fitton, of 978 West avenue, is at the head of a movement among the members of the Black Rock Business Men's Association to organize a telephone company.

WASHINGTON, PA.—The Washington Telephone Company, represented by John D. Braden, and the American Telegraph and Telephone Company are asking for a franchise for constructing their respective lines, and the matter will come up at the next meeting of the Council.

Electric Light and Power.

ELKHORN, WIS., residents are asking for electric street lighting.

WINNETKA, ILL.—Electric lighting is being talked of for Winnetka.

COCHRAN, GA.—W. H. Mobley is in the market for electrical machinery.

STURGIS, MICH.—Sturgis residents will vote on issue of \$20,000 electric light bonds.

WEST JEFFERSON, OHIO.—The matter of putting in an electric light plant is being considered.

SELMA, ALA.—The Gas and Electric Light Company has added another 50-light arc dynamo to its plant.

NEW BRIGHTON, S. I.—The contract for lighting New Brighton will be advertised for sale April 1.

BLUE EARTH CITY, MINN.—A franchise has been granted to O. J. Clarke to put in an electric light plant.

EASTON, PA.—The Common Council will issue \$12,300 in bonds, of which \$3,000 is for an extra dynamo and belting.

OTTUMWA, IOWA.—The Coughlan Electric Company is seeking for a franchise to erect an electric light plant.

OMAHA, NEB.—The Pardee Company is seeking a 30 year franchise for the operation of an electric light plant.

ADRIAN, MINN.—The town has voted \$13,000 to be expended in putting in a waterworks and electric light plant.

BLISSFIELD, MICH.—The village will soon vote in the matter of granting an electric lighting franchise to a private company.

THOMASVILLE, GA., will now have incandescence lights, as the electric light company has added a 1,000-light alternator to its plant.

OSHKOSH, WIS.—Bids will be received to March 20 for the lighting of the city by electricity. W. T. Ellsworth should be addressed.

BALTIMORE, MD.—A bill has been introduced into the House at Annapolis to authorize Baltimore to purchase and operate an electric light plant.

MENOMINEE FALLS, WIS.—C. W. Fraser, city clerk, has been instructed to ascertain the approximate cost of putting in an electric light system.

MINNEAPOLIS, MINN.—The Cooper-Compton Electric Company will extend its operations. John Martin is president and A. W. Hastings is secretary.

MINNEAPOLIS, MINN.—F. W. Cappellen, city engineer, reports to Council the cost of a municipal plant, and plans and specifications have been prepared.

QUITMAN, GA., has recently closed a contract for a municipal electric plant. The apparatus to be installed consists of a 50-light arc dynamo and a 500-light alternator.

GRIFFIN, GA., has purchased the arc light plant in use for lighting the streets, and has added a 1,000-light alternator. The plant will be operated as a municipal plant.

TOLEDO, OHIO.—The Memorial Hall trustees have instructed the committee to look into the matter of electric lighting for the building, and report at the next meeting.

ROCKVILLE, CONN.—The directors of the Gas and Electric Company have voted to put in a steam engine in place of the gas engines, to furnish power for the electric light station.

FLATBUSH, LONG ISLAND, N. Y.—James Deighan has received the contract to build an electric light plant for Flatbush and Parkville, and he will be ready to supply light about May 1.

CINCINNATI, OHIO.—The Gerdes Hotel property, at Fifth and Home streets, is to be remodeled at a cost of \$21,000, to include elevators and electric lights. Dittee & Wisenall are the architects.

ATHENS, GA.—The committee on light has reported in favor of either purchasing the plant of the Athens Gas Light Company or buying a new plant, to cost about \$15,000. T. P. Vincent is chairman.

MEADVILLE, PA.—There is a deadlock in the Meadville Council in the matter of appointing a committee to investigate the electric light plant. It is admitted that its condition should be improved.

LILLY, PA.—Craig & Bowers are solicitors on behalf of Edward O'Brien, George Brandt, M. K. Piper, John R. Kelly and John Leap, who wish to form the Lilly Electric Light, Heat and Power Company.

DETROIT, MICH.—Plans and specifications are being made by Donaldson & Meier for the erection of a business building for the Palms estate, for Edson, Moore & Co. The building is to be lighted by its own electric plant.

POTTSVILLE, PA.—Sealed proposals will be received by the comptroller of Schuylkill County to 2 P. M., March 20, for lighting the court house and city prison by electricity or gas during the year commencing April 1. B. R. Severn is comptroller.

NORTH TONAWANDA, N. Y.—A committee, consisting of Trustees Fuller, Gillespie and Pitts, has been appointed to draft a bill for presentation to the Legislature, granting the village power to buy and operate at any time an electric lighting plant.

BUFFALO, N. Y.—The report in favor of a municipal electric light plant was voted upon, and it was decided to postpone indefinitely any action. Alderman Smither was father of the movement for a municipal plant, and he will soon again bring the matter up.

ST. JOSEPH, MO.—The St. Joseph Traction and Lighting Company has been granted a franchise for operating a steam plant. Mr. W. T. Van Brunt, superintendent, together with four councilmen, inspected the plant at Springfield, Ill., recently, and reported most favorably. They have already secured contracts for heating a number of the city buildings and also several large hotels and business blocks. This plant runs 24 hours a day and has about 1,800 h. p.; they intend utilizing their exhaust steam for this purpose.

KEARNY, NEAR NEWARK, N. J.—The Citizens' Improvement Association, of which G. B. Reid is president and H. C. Greene and L. F. Bloodgood are prominent members, are agitating for a municipal electric lighting plant at an estimated cost of \$20,650. The present electric light contract expires on the 1st of April, and it proposed to endeavor to obtain a two-thirds majority in favor of the municipal plant. It was decided to wait until the Legislature passes upon the pending bill to allow the construction of such plants.

CINCINNATI, OHIO.—Sealed proposals will be received at the office of the Board of Administration to April 4, for one complete electric lighting plant, to be erected and ready for service at Eden Park pumping station, to consist of a 10 arc dynamo and a 100 incandescence lamp dynamo, with suitable engines. Bidders are to furnish all specifications and state proposed make of dynamo and engine, the plant to be completed ready for steam connection, which will be furnished by the Cincinnati water department. A. P. Butterfield is clerk.

THE WICOMICO FALLS MILLING AND ELECTRIC COMPANY, Salisbury, Md., R. M. and W. T. Johnson, proprietors, has purchased the pole line, franchise, etc., of the electric light plant which was recently burnt out at that place, and which was formerly operated by steam. They have also purchased the water power privileges, which are said to be second only to those on the Brandywine River, and have installed three Victor turbines, and constructed and thoroughly equipped a new station building. They have now running four Edison dynamos in tandem with good success, the total capacity being 2,500 lights.

The Electric Railway.

TOWANDA, PA.—The prospect is favorable for an electric railway from Towanda through Troy to Mansfield.

HANNIBAL, MO.—Charles T. Hayward, Dr. D. H. Shields and others are promoters of the proposed road between Hannibal and Philadelphia.

TORONTO, ONT., CANADA.—R. Meek is before the City Council on behalf of Mr. T. Yarker and others, to build an electric road on the island.

PARKERSBURG, W. VA.—City Council has granted right of way for the proposed electric line. D. B. Judd, of New Haven, Conn., is interested.

NEW ORLEANS, LA., is having trouble with electrolysis of water mains along the line of the St. Charles Avenue and Carrollton Electric Railway.

READING, PA.—The chartering of the Reading and Womelsdorf Railway Company means the building of a 42-mile trolley road between those two points.

LOS ANGELES, CAL.—The county supervisors will receive bids on March 28 for a 50-year franchise for a street railway company. T. H. Ward is county clerk.

POTTSTOWN, PA.—H. E. Crilly, of Allentown, Pa., has been awarded a contract for the building and wiring of the Ringing Rocks Electric Railway, to be completed by May 1.

OAKLAND, CAL.—Ira Bishop, receiver of the Consolidated Piedmont Cable Company, has been authorized to borrow \$16,000 to defray cost of changing the motive power to electricity.

BANGOR, ME.—Conrad Miller, president of the Bangor and Portland Railroad, states that the officials are considering the extension of the lines from Nazareth to Catasauqua, via Bath.

WEST HARTFORD, CONN.—The selectmen of West Hartford have voted to accept the plans offered by the Hartford and West Hartford Horse Railroad Company for a trolley line to their town.

BALTIMORE, MD.—The Baltimore City Passenger Railway asks for leave to extend its lines to Lauraville. It proposes to build an electric line, if the Turnpike company does not prevent it.

HOLYOKE, MASS.—The Board of Aldermen have granted a franchise to the People's Electric Railway Company to cover 9½ miles of streets, and the road to be located exclusively in Holyoke.

HARRISBURG, PA.—The Clearfield and Conemaugh Railroad Company, capital stock \$135,000, has been chartered to build a railroad from Belsena, in Clearfield County, to Johnstown, a distance of 60 miles. S. M. J. McCarrell, of Harrisburg, is president.

NEWBURGH, N. Y.—Captain James M. Dickey and others interested in the proposed electric street railway are now getting consents of property owners along Water and Golden streets and Broadway.

ELIZABETH, N. J.—An ordinance has passed granting the New Jersey Consolidated Traction Company the right to operate a system of trolley cars through the streets of Elizabeth, the lines to be in operation by July 4.

DANSVILLE, N. Y.—The building of the new electric street railway to the Lackawanna station is again a topic of conversation. Dr. James H. Jackson, Superintendent Holstead and Messrs. Blake & Beebe, contractors, are interested.

JACKSONVILLE, FLA.—The street railway company is preparing to adopt electric cars on its lines. It has closed a contract for track material, and expects to contract for electric apparatus within the next 60 days. Ten car equipments will be needed.

LOCKPORT, N. Y.—The Lockport "Journal" states that there is a well defined opinion that W. C. Reed, a prominent electric railway contractor, has secured right of way for an electric road between Lockport and Williamsville and branches of same.

BRIGANTINE, N. J.—The contract for the rebuilding of the railway of the Brigantine Transit Company, at Brigantine, N. J., opposite Atlantic City, has been awarded to Stern & Silverman, of Philadelphia, and it is to be constructed of trestle all along the beach.

SAVANNAH, GA.—The street railways of this city have all been consolidated. The Electric Railway Company, of Savannah which some time ago bought up the Savannah Street Railway, has now scooped in the City and Suburban and all its lines. The consolidated lines are under the management of the Electric Railway Company, with Mr. J. S. Collins as president.

Miscellaneous Notes.

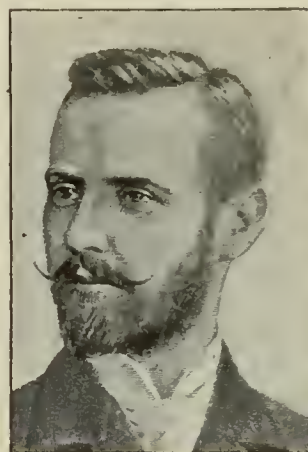
THE COTTON STATES EXPOSITION, to be held in Atlanta, Ga., in 1895, is already an assured success. In three days the people of Atlanta raised \$159,360 of the total \$200,000 they propose to give. The exposition is to be held at Piedmont Park. Mr. Fred. Law Olmstead has been telegraphed for to lay out the grounds. Director-General H. E. W. Palmer says he intends having the electrical exhibits a special feature of the exposition, which is to open Sept. 1, 1895, and to run three months.

STATISTICS OF STREET LIGHTING BY ELECTRICITY.—The National Statistical Association of Washington, D. C., under the management of Mr. Allen R. Foote, has undertaken a work of great importance to central station officials, in collecting, for the benefit of companies about to make new contracts for street lighting, data relative to the prices paid for street lighting throughout the country, and the service rendered for the compensation paid. The collection of these data will be of great value to all interested in the question. The plan of the Statistical Association is well devised, and its consummation rests entirely with the companies; if they co-operate with the association, and furnish promptly and accurately the information asked for, valuable results will undoubtedly be secured, and it seems that the desired object cannot be obtained in any other way.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS will hold its 85th meeting at headquarters, 12 West 31st street, New York City, on Wednesday, March 21, at 8 P. M. A paper will be presented by Prof. William A. Anthony, of Vineland, N. J., past president, "On the Effect of Heavy Gases in the Chamber of an Incandescent Lamp." The discussion will be opened by W. Lispenard Robb, of Hartford, Conn. For the convenience of Western members, and in accordance with recent action taken by the Institute, a meeting of members residing in Chicago and vicinity will be held on the same date and hour at the Armour Institute, corner of 32d street and Armour avenue, Chicago. Prof. D. C. Jackson, of Madison, Wis., has been invited to present the paper of Prof. Anthony at Chicago, and Prof. B. F. Thomas, of Columbus, Ohio, to open the discussion.

Personal Notes.

MR. O. T. CROSBY will, on May 1, sever his connection with the General Electric Company, and in connection with Mr. J. G. White, of the New York firm of constructing engineers, will do business under the name of the White-Crosby Company. The company has been incorporated for the sake of convenience, but the association will be that of partnership. Mr. Crosby presented his resignation several months ago, but found it difficult to leave the post he occupied. Mr. Crosby is eminently fitted for the line of work he is taking up, and the new firm will undoubtedly meet with the success that the recognized abilities of its members merit. Mr. Crosby has had a wide experience in the electric



railway field. He was born in Louisiana, and passed most of his boyhood in Brookhaven, Miss., from which place he entered the United States Military Academy in 1878, graduating four years later second in rank in a large class. On receiving his commission as an officer in the engineering corps, he was stationed at Willets Point, N. Y., and after two years there was sent to New Orleans for river and harbor duty. In May, 1887, he obtained a six months' leave of absence and soon after resigned and joined the Sprague Railway and Motor Company, soon assuming the duties of superintendent of that company. He retained this position for about 2½ years, and then connected himself with the Weems Electric Railway Company and performed the well known experiments in high-speed railroading at Laurel, Md., which gave us so much information on atmospheric resistance, and which placed him prominently before the public. Mr. Crosby then joined the staff of the Thomson-Houston Company, and after the consolidation remained with the General company, assuming charge of the railway department, where he has taken a prominent part in the development of the street railway business of the company.

Trade and Industrial Notes

GEORGE CUTTER says that his new swivel pole pulley is "just the thing," and he can show nice orders to back his statement.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., has appointed S. N. Blake, of Elmira, N. Y., contractor for the Mather apparatus in northern and western New York State.

ELLIS D. LASH AND LYMAN HANES, of Martin's Ferry, Ohio, have completed a system of open circuit fire alarm attachments to the regular Gamewell system to operate a bell in each fireman's house.

MR. ROGERS, of the Eddy Manufacturing Company, paid a recent visit to Atlanta, Ga., on business with the Atlanta Traction Company. This company has changed its two 80-h. p. Eddy generators for two 150-h. p. Eddy dynamos.

THE R. THOMAS & SONS COMPANY'S office is now amalgamated, its warehouse being at 142 Lake street, Chicago, where Mr. J. E. Way will be permanently located, and all communications and orders sent to above address will have prompt attention.

PEPPER & REGISTER, Provident Building, Philadelphia, Pa., write us that they have secured the contract for bonding the lines of the Electric Traction Company, and that the bond adopted will be that manufactured by the Technic Electrical Works.

FRED. M. LOCKE & CO., Victor, N. Y., are meeting with much success with their indestructible insulator pin, triple petticoat insulators and transposition insulator. Among other large users is the Westinghouse Electric and Manufacturing Company, Pittsburgh.

THE W. T. C. MACALLEN COMPANY, 416 Atlantic avenue,

Boston, has issued its 1894 catalogue of solid sheet mica insulating material, for electric railway work and other purposes. Numerous trolley overhead devices are illustrated, and several forms of gas insulating joints.

Mr. E. O. WAYMIRE, secretary and treasurer of the Dayton Fan and Motor Company, is spending some days in Chicago making arrangements for the handling of his company's electric fan motor outfits. This company is placing on the market a new and exceedingly handsome ceiling fan.

L. S. STARRETT, Athol, Mass., sends us a copy of his 1894 catalogue of fine mechanical tools, to which a number of additions have been made, including new squares, gauges, milling cutters, a speed indicator and several others. The catalogue is well illustrated and should be on file in every workshop.

THE GENERAL ELECTRIC COMPANY, through its Southern office, has recently sold the following: Quitman, Ga., a 50-light arc and a 500-light alternator; Griffin, Ga., a 1,000-light alternator; Thomasville, Ga., a 1,000-light alternator; Selma, Ala., a 50-light arc; Courtland Manufacturing Company, Seneca, S. C., an 800-light incandescent plant; Lanett Cotton Mills, West Pond, Ga., a 900-light plant.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., has received an order from the Calumet and Hecla Mining Company for a new iron building, to be 40 feet wide and 125 feet long and covered on the roof and sides with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron. Also an order from the E. W. Bliss Company, Brooklyn, for the iron work of a foundry extension.

THE ELSON AND BREWSTER ENGINEERING COMPANY, who are the New York representatives of the W. S. Hill Electric Company, of Boston, are obliged for the second time within a year to move into larger quarters, and can now be found at 143 Liberty street, where, with better facilities and a larger stock, they will be better prepared than ever to take care of their constantly increasing trade.

THE VIADUCT ELECTRICAL MANUFACTURING COMPANY, of Baltimore, manufacturers of telephone appliances, bells, etc., is as busy as bellers. A visit to this company's factory would convince any one of the activity existing in the telephone supply business. One of the many orders just booked by this company is that of 1,000 district telephone messenger call boxes of its own design, with all the appurtenances thereto for the City of Mexico.

THE GOUBERT MANUFACTURING COMPANY have removed from 32 Cortlandt street, New York, where they have been located for many years, and now occupy more commodious headquarters at 14-16 Church street, corner of Cortlandt. The new offices are attractive in appearance, and in their arrangement and furnishing offer every convenience for taking care of the large business done by the company in the "Goubert" feed water heater and "Stratton" separator, of which they are the sole manufacturers.

J. HOLT GATES, with headquarters at 1138 and 1140 Monadnock Building, Chicago, has become Western contractor for belted railway and lighting generators and motors of the Mather Electric Company, of Manchester, Conn. Mr. Gates is well known in the trade through his recent connection with the Siemens-Halske Electric Company and the Waddell-Entz Company, and has the reputation of being one of the most successful and energetic hustlers in the West, which argues well for the success of the re-organized Mather company's apparatus in that territory. Mr. Gates was working for the Mather Electric Company only one day when he sold two 500-light dynamos.

THE CHROME STEEL WORKS, of Brooklyn, N. Y., whose product is the well known Chrome cast steel, is a busy establishment. The abundance of orders which has kept these large works running full time with full number of hands during the past year, despite the lengthy period of general trade dullness, speaks volumes for the high favor which this material has obtained in this country. Chrome steel is very hard, tough and dense, will not deteriorate by the continued application of great heat, and can be worked successfully in large masses. These qualities adapt it especially for the manufacture of such castings as gears, wheels, pinions, hammer dies, etc., for general machine construction, and its use in this connection is extending rapidly.

THE SAFETY ELECTRIC BRAKE COMPANY, 30 River street, Chicago, Ill., has issued a prospectus calling attention to the features of its electric brake. A separate handle is not used with this brake, the mechanism of the controller being such as to apply the brakes and run the car with the same operating handle. Equipments are installed complete, replacing controllers now upon the dashers by simple and thoroughly well made controllers, including the full brake mechanism. Generally the old wiring upon the car body may be used throughout. The controller is furnished with thoroughly reliable reversing gear. The car is operated in either direction from either controller, and while operating in either direction the electric brake may be applied by the simple reversal or continuous movement of the single operating handle.

THE GENERAL ELECTRIC COMPANY has just closed a

large contract with the Cataract Construction Company for the furnishing of about 2,000 h. p. of apparatus to be used in the plant of the Pittsburgh Reduction Company at Niagara Falls, the apparatus in question transforming the two phase current delivered from the station of the Cataract company at 2,500 volts into continuous current at 160 volts for the use of the reduction company. The plant of the Pittsburgh company is located at about 2,500 feet from the Cataract company. There will be furnished eight 200-kw. step-down transformers and four 370-kw. revolving transformers, for transforming two phase current into continuous current. It is believed that this will be the largest plant of the kind in the world, and the installation will mark an interesting step in the development of the use of multiphase currents for transmission purposes being again transformed into direct currents at the point of utilization. In addition to the apparatus above mentioned, the General company also furnishes the necessary switchboard and appliances to handle the same.

THE STANWOOD MANUFACTURING COMPANY, Chicago, has set apart a portion of its large factory at 17th and Clark streets for repair work, and has fully equipped it with all necessary machinery and appliances to carry on, in the best possible manner, this new departure. This company is now in a position to repair, on the shortest notice, everything electrical, from the largest dynamo or motor to the small and delicate testing instruments in daily use everywhere. The services of Mr. Earl Atkinson have been secured as superintendent. Mr. Atkinson has had an exhaustive experience in building and repairing electrical apparatus of all kinds. He began his mechanical career when 17 years of age, and after serving a number of years in the large machine shops of English & Humber, of Toronto, became connected with the Ball Electric Company, of the same city, and in 1888 entered the marine shops of the Delamater Iron Works, of New York City, where, in a short time, he became foreman. After the death of Mr. Delamater, Mr. Atkinson entered the laboratories of Thomas A. Edison, at Orange N. J., and soon became the head of the department there. Later on he went West, and until recently has been in the employ of the General Electric Company.

JOHN B. McCORMICK, the widely known turbine manufacturer, of Holyoke, Mass., has issued what is perhaps the most unique calendar that has appeared for many a year. On the upper part of the calendar is printed a well executed engraving entitled "An Allegory" (a copy of which appeared in our advertising columns on March 10, page xxi.), consisting of a central picture with a Greek architectural framing. The flanking columns are decorated with different forms of water wheels, turbines, and at the foot of one, a picture of a double turbine forming the body of a camel, below which is the following inscription: "A double hump discovered and exhumed in the vicinity of Keene, N. H. Supposed to have run away from the battlefield (at the Holyoke Water Power Company's testing flume), and chose as a hiding place the locality in which it was found." In the central picture the main figure is that of Hercules, with a turbine for a body, facing another turbine (the only one in propria persona), upheld by female personifications of science, mechanical genius and understanding, which he addresses in these words: "Behold! a greater than I is here." Surrounding Hercules are a number of dismembered dragons with turbine bodies and similarly constructed human and animal forms. Issuing from a mouthpiece attached to the triumphant turbine is the following: "I was conceived and brought forth by Thought, born of Wisdom, and was guided through adversity and along the dark paths of ignorance and superstition by Understanding, assisted by Science and the cultured head of Mechanical Genius. I am here to assist in interring the old, and prepare for the welcoming of the new—the twentieth century. I will grind a parchment from the trees of the forest, that Truths may be recorded thereon. I will create electrical forces to carry them to the uttermost ends of the earth, that the veil of ignorance may be lifted, never again to be let down. I will cause the busy wheels of industry to revolve more rapidly, that the burdens may be lifted from the poor and oppressed, and thus assist in fulfilling the prophecies of the great Victor Hugo. Owners and users of water power should procure a copy of this remarkable production for their offices.

WESTINGHOUSE, CHURCH, KERR & CO. have removed their offices from No. 17 Cortlandt street, where they have been for ten years, to the Havemeyer Building, No. 26 Cortlandt street. Although only ten years old this firm is now recognized as "an old established house." It may be said that there is scarcely another firm of just the same kind, for they are not agents, although selling the products of others; they are not exactly manufacturers, although owning and operating shops covering ten acres of ground in Chicago; they are not precisely consulting engineers, although consulted by a large clientage; they cannot properly be styled contractors, although constantly executing important contract work. They are rather a kind of their own making, wherein professional engineering, consulting, manufacturing and contracting, and especially the developing of new things are combined, and they claim that this idea is original with them. The general plan of the company seems to be the development of one thing at a time, and when that is in condition to need no further attention, its manufacture and sale are conducted through or-

dinary channels, and another new product is taken up. Among the various undertakings which have been successfully developed by the company are the Westinghouse engine, invented by Mr. H. H. Westinghouse and built by the Westinghouse Machine Company, for the perfection of which Westinghouse, Church, Kerr & Co. are responsible. They were also among the earliest and strongest advocates of subdivided power. In the change from simple to compound engines some years ago, they claimed to have had some hundreds of compound engines sold and in operation before other engine builders were fairly alive to the demand. In the mechanical stoking of coal they were also early in the field, and have been leaders in its development. The utilization of mechanical exhaust draft was another thing which they early took up, and which has been thoroughly developed in their hands. The steam loop is still another evidence of their foresight. The latest special subject which they have taken in hand is refrigeration and ice-making. They have an excellent and simple form of compressor and condenser, and have introduced various improvements in the methods

of construction of refrigerating plants, and have perfected a new and radical process of manufacturing artificial ice. Throughout the financial depression of the past six months or more, Westinghouse, Church, Kerr & Co. have been one of the few firms that have held a substantial trade, which is due in part to their business methods, and in part to their diversity of interests. Their new offices consist of a suite of four large rooms and private hall on the sixth floor of the Havemeyer Building, and they are to be congratulated upon their larger and better accommodations.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED MARCH 6, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

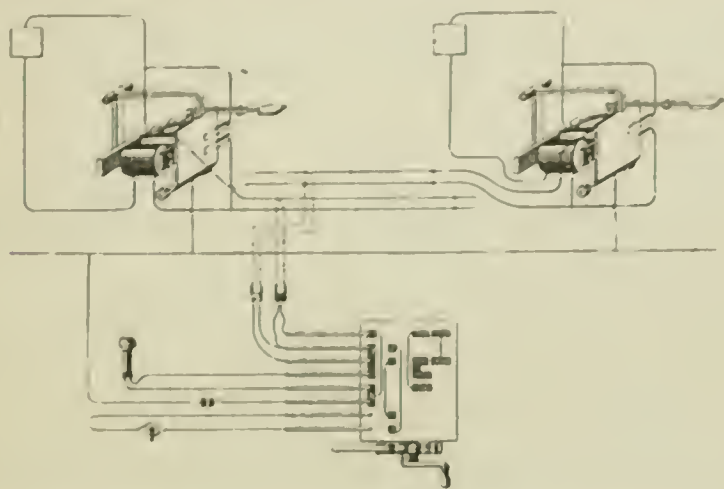
- 515,751. **ELECTRIC SWITCH SIGNAL**; T. L. and N. W. Dalton, Sandy Hill, N. Y. Application filed Aug. 5, 1893. The combination of a signal circuit and a trolley circuit, of a forked contact piece between the same and a trolley contact, one of the circuits lying in the crotch of the fork, whereby the trolley wire is moved in contact with the signal wire and the signal operated.
- 515,755. **ELECTRIC MOTOR**; G. S. Bunn, New York, N. Y. Application filed July 29, 1893. A dynamo or motor having a field magnet so mounted that it can approach and recede from the armature, and a brake for the armature controlled by such movements of the field magnet.
- 515,761. **SYSTEM FOR SIGNALING AND COMMUNICATION**; T. F. Gaynor, Louisville, Ky. Application filed Dec. 30, 1891. The combination with a circuit having a call box mechanism, of an armature mechanism adapted to actuate a combined stamp and answer back mechanism.
- 515,762. **ELECTRIC SIGNAL BOX**; T. F. Gaynor, Louisville, Ky. Application filed Feb. 4, 1892. The combination of a shaft having a series of signal wheels loosely and rotatably mounted thereon, and separate keys fitted to the shaft and signal wheels for rotating them.
- 515,778. **ELECTRIC METAL WORKING**; H. Lemp, Lynn, and W. S. Moody, Chelsea, Mass. Application filed May 26, 1891. The combination with a secondary bar or conductor, of two adjustable contacts in electrical connection with an intermediate part of the bar, and adapted to bear upon the work placed between the terminals of the secondary.
- 515,779. **STRAIN INSULATOR**; H. H. Luscomb, Hartford, Conn. Application filed Nov. 4, 1893. An insulator consisting of a pair of eyes having integral shanks, bearing washers of laminated insulating material, and enlarged heads integral with the shanks, but insulated from each other, and a sectional metallic drum surrounding the enlarged heads and the washers on the shanks.
- 515,797. **TELEPHONE RECEIVER**; C. Selden, Baltimore, Md. Application filed Dec. 10, 1889. The combination of a diaphragm and two or more magnets, the pole ends of which are disposed near the diaphragm, the magnets being connected and placed in circuits, forming links in a chain of induction.
- 515,806. **ELECTRIC LIGHTING SYSTEM**; H. J. Wells, Osceola Mills, Pa. Application filed Aug. 20, 1892. The combination of a single rotary shaft having separate pulsators mounted thereon, contacts leading current from the generator to each pulsator, constant pole transmitters mounted on the shaft on each side of the pulsators, the transmitters being connected with separate contacts of the pulsators, and separate working circuits connected to the transmitters.
- 515,822. **ELECTRIC CABLE**; T. J. Dewees, Palmyra, N. J. Application filed Dec. 15, 1893. An insulated electric conductor having a moisture absorbing material, such as lime, applied to its insulating covering.
- 515,827. **WATER ALARM FOR BOILERS**; C. A. Hatch, Hartford, Conn. Application filed March 23, 1893. In a water alarm, the combination of baskets depending from a lever, and a float or buoy located between the baskets and adapted to sound an alarm or close an electric alarm circuit as the float is raised or lowered.
- 515,845. **TELEGRAPH REPEATER**; W. E. Sloan, Chicago, Ill. Application filed July 14, 1893. This comprises two electromagnets and armatures therefor, the movements of which operate to open and close main and local circuits, each magnet being provided with two sets of coils, both of which are in the main circuit when the latter is closed, and only one of which is in circuit with the local battery when the main circuit is open.
- 515,850. **ELECTRIC ARC LAMP**; J. J. Wood, Fort Wayne, Ind.

- Application filed June 7, 1893. The combination with an armature and armature lever of a strip of conducting material arranged to conduct the current between the armature and lever, and a spring plate overlying the strip and serving to press it into conductive contact with the armature lever.
- 515,882. **DYNAMO ELECTRIC MACHINE**; J. E. Maynadier, Taunton, Mass. Application filed Aug. 30, 1893. This comprises a plurality of field magnets, shafts and ring conductors, belt conductors connecting one edge of each ring conductor to one shaft with a ring conductor on the other shaft; and conductors connecting the other edge of each ring conductor with a ring conductor on the same shaft.
- 515,885. **ELECTRICAL TRANSMISSION OF POWER**; C. F. Scott, Pittsburgh, Pa. Application filed March 27, 1893. A main generator, a motor generator driven thereby, and a circuit fed by the latter, in combination with a supplementary generator, the field magnet strength of which is controlled by the current from the motor generator, and the electromotive force of which is added to that of the main generator.
- 515,900. **ALTERNATING CURRENT MOTOR**; C. E. L. Brown, Baden, Switzerland. Application filed June 13, 1893. A non-synchronous alternating current motor, having its induced winding provided with a collector and brushes connected and adjusted to produce poles in the induced winding, the position and action of which poles produce a turning moment and start the motor, and means for producing the short circuiting of the induced winding, after the motor has attained its normal speed.
- 515,905. **SPLICE COVERING FOR ELECTRIC WIRES**; T. J. Dewees, Palmyra, N. J. Application filed July 25, 1891. A tubular sheath of paper having an internal diameter substantially equal to that of the twisted joint of the wires, and supported at its middle directly by the twisted joint, and at its ends by the insulation of the two wires.
- 515,907. **HANGER FOR TROLLEY WIRES**; G. Forbus, Williamsport, Conn. Application filed September 6, 1893. The combination with two plates, of teeth or projections on the inner faces thereof.
- 515,939. **TELEPHONE EXCHANGE SYSTEM**; E. Pope, Quebec, Canada. Application filed Aug. 3, 1892. The combination with a subscriber's circuit, of a test battery normally in connection therewith and mechanism controlled by the subscriber for breaking the connection with the test battery.
- 515,971. **PORTABLE REGULATOR FOR ELECTRIC CURRENTS**; E. E. Ries, Baltimore, Md. Application filed April 4, 1893. This comprises means for graduating the flow of current, a plug adapted to incandescent lamp sockets, and connection for coupling the current graduating devices to a translating device.
- 515,977. **ALTERNATE CURRENT MOTOR**; W. Stanley, Jr., J. F. Kelly and C. C. Chesney, Pittsfield, Mass. Application filed April 1, 1893. The method of operating electric motors, having independent field magnets and mechanically connected armatures, the coils of which are connected together in closed circuit, which consists in setting the poles of one field at an angle to those of the other, and directing through the two fields respectively alternating currents of different phase, and then when the motor is brought to speed, turning the poles of the two fields into alignment and directing through both alternating currents of the same phase.
- 516,025. **ELECTRIC CIRCUIT BREAKER**; D. S. Schureman, Rockford, Ill. Application filed July 19, 1893. This consists of a frame gear supported in a frame, having a pivotal connection with a stationary support, an armature holding the frame stationary, an electromagnet when energized causing the armature to release the frame, and an electric connection with the frame, which is changed after the frame has been released.
- 515,940. **TELEPHONE SYSTEM**; E. Pope, Quebec, Canada, Ap-

plication filed Sept. 2, 1892. The combination with the subscribers' circuits of separate test wires normally without battery connections, respectively therefor, two sources of current under control of an operator, and means for connecting said sources of current respectively with the test wires of any two subscribers' circuits.

515,960. AUTOMATIC CUT-OUT FOR INCANDESCENT LAMPS; E. H. Johnson, New York, N. Y. Application filed May 17, 1893. A separate switch, composed of two wires located in soldering proximity and bridged by an arc inducing material, which is normally an insulator, but which, by heat, is reduced to a conducting state, in combination with separable circuit connections.

515,962. ALTERNATING CURRENT MOTOR; J. F. Kelly, Pittsfield, Mass. Application filed March 27, 1893. The method of



NO. 515,939.—TELEPHONE EXCHANGE SYSTEM.

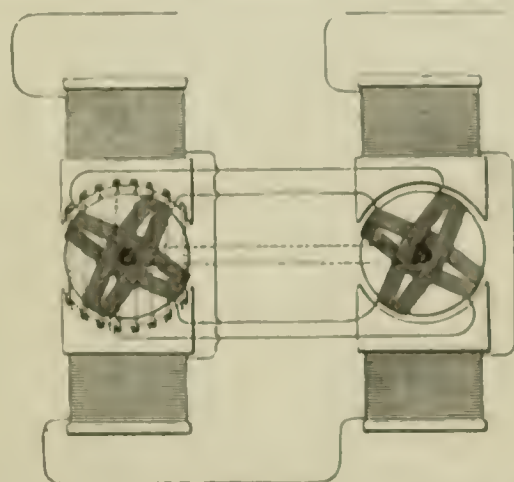
operating motors having independent fields and rigidly connected armatures, which consists in energizing the fields simultaneously by alternating currents of the same phase, and energizing the armatures by alternating currents of different value. (See illustration.)

515,969. REGULATING SOCKET FOR ELECTRICAL APPARATUS; E. E. Ries, Baltimore, Md. Application filed Jan. 24, 1893. A reaction coil and a holder for the same, composed of two blocks of refractory material, clamped together and to the reaction coil by the shell of the socket.

515,970. ELECTRIC CURRENT REGULATOR; E. E. Ries, Baltimore, Md. Application filed Feb. 2, 1893. A rheostat, consisting of a carbon helix, having convolutions of gradually increasing thickness, and means for compressing the helix and thereby short circuiting the convolutions upon each other by insensible degrees. (See illustration.)

516,038. AUTOMATIC SWITCH FOR STORAGE BATTERY USE; T. A. Willard, Norwalk, Ohio. Application filed July 1, 1893. The combination of a shunt wound magnet in combination with its armature, provided with poles and wound with coils in series with the main circuit, an armature lever supporting the armature, contact point adapted to close the main circuit when the magnet attracts the armature, and a spring adjustment therefor.

516,043. THERMOSTAT; E. Barney, Schenectady, N. Y. Appli-



NO. 515,962.—ALTERNATING CURRENT MOTOR.

cation filed Sept. 20, 1893. This comprises a conducting base having a post mounted in a box thereon, a blade secured to the post, formed of materials of differing expansibility riveted together, posts insulated on the base, contact screws mounted horizontally in the posts and extending opposite the free end of the blade, binding screws insulated on the base and connected with the contact posts, and a third binding post on the base and in electrical contact therewith.

516,071. ELECTRIC HEATING APPARATUS; A. E. Appleby, Boston, Mass. Application filed Jan. 16, 1893. This comprises a core externally coated with an insulating material, and provided with a continuous seamless, electrically deposited metal-

lic shell covering and extending over the ends of the core.

516,095. ELECTRIC RADIATOR; S. B. Jenkins, Boston, Mass. Application filed March 29, 1893. A series of removable sections, each provided with an interrupted flange, or row of cores, in combination with electric heating devices applied to the said cores, and fastening and supporting devices for the sections.

516,152. ELECTRICAL HEATER; A. Cochrane, Lowell, Mass. Application filed Jan. 6, 1893. The combination of a tube, covered externally with a non-conductor of heat and electricity, a helix wire of high resistance, a perforated tube inclosing the helix and tube, but of such diameter that there is a space formed between the outer and inner tubes, and ring shaped heads in which the ends of the tubes are secured.

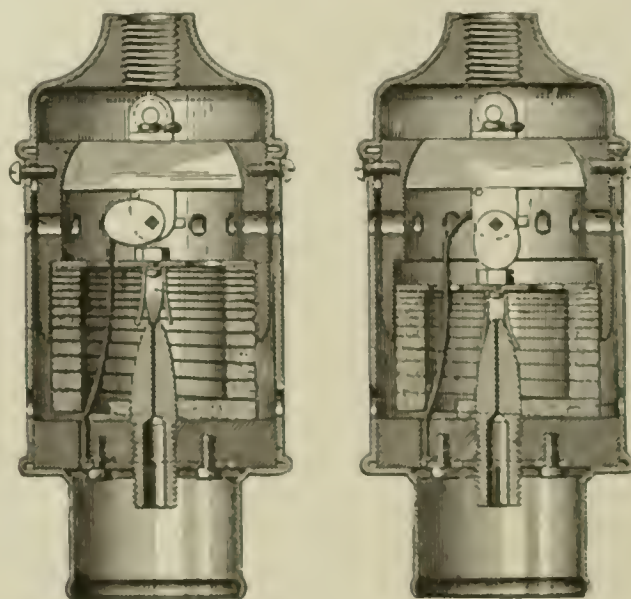
516,161. ELECTRIC CABLE JOINT; T. C. Lee, New York, N. Y. Application filed Aug. 14, 1893. A splice in an electric cable or similar flexible lead covered construction having protecting sleeves applied about the cables at the joint, and extending outside the joint.

516,167. APPARATUS FOR GENERATING STEAM BY ELECTRICITY; H. E. Rider and J. H. Lewis, New York, N. Y. Application filed Feb. 17, 1893. An electric heater, consisting of an electric conductor of sufficiently high resistance to develop heat on the passage of a suitable electric current therethrough, an insulator surrounding said conductor, and a wrapped covering wound upon the insulator.

516,170. ARMATURE FOR DYNAMO ELECTRIC MACHINES; M. Waddell and J. B. Entz, Bridgeport, Conn. Application filed May 13, 1893. In an armature, the combination of a spider of magnetic metal and a fastening of non-magnetic metal united thereto.

EXPIRED FEB. 20, 1894.

187,674. CIRCUIT CLOSER FOR BURGLAR ALARMS; W. H. Sawyer, Philadelphia, Pa. Filed Jan. 16, 1877. The combina-



NO. 515,970.—ELECTRIC CURRENT REGULATOR.

tion of a case, spring, insulators and valve seated contacts.

EXPIRED MARCH 6, 1894.

188,163. COUPLINGS FOR RAILROAD TRAIN TELEGRAPHS; E. J. McRavey, F. W. McRavey and J. Schwartz, Milwaukee, Wis. Filed April 13, 1876. A coupling consisting of two parts, each constructed of two springs, separated by an insulating portion running diagonally between them.

188,179. FIRE ALARM TELEGRAPH REPEATERS, C. H. Pond, Jackson, Miss. Filed Feb. 26, 1877. A transmitter actuated by a local battery in combination with main line magnets, the transmitter being controlled by the local points of the loop in which the circuit is first interrupted.

188,180. FIRE ALARM TELEGRAPH SIGNAL BOXES, C. H. Pond, Jackson, Miss. Filed Feb. 26, 1877. A signal box having a vertically moving circuit bar dropped by gravity when its containing box is opened to a position for signaling and raised by a spring driven train to signal.

188,181. FIRE ALARM TELEGRAPH REPEATERS, C. H. Pond, Jackson, Miss. Filed Feb. 19, 1877. A mercury tube acting to close the circuit immediately after it is broken, thus putting the apparatus in condition to respond to the next break.

188,182. SIGNAL BOXES FOR FIRE ALARM TELEGRAPHS; C. H. Pond, Jackson, Miss. Filed Feb. 19, 1877. A device for releasing an alarm train held in position by a hook, a rack bar released from the gear by a plunger, and a secondary train falling by gravity whenever the main line circuit is broken by the operation of any box.

188,183. BELL STRIKERS FOR FIRE ALARM TELEGRAPHS; C. H. Pond, Jackson, Miss. Filed Jan. 4, 1877. A tripping device for operating valve mechanism of a single pneumatic engine, the piston rod of which operates the bell hammer.

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No. 13.

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1884 " 82 " " "	1891 " 325 " " "
1885 " 100 " " "	1892 " 316 " " "
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THE HEILMANN LOCOMOTIVE.

At first sight the Heilmann system of electric traction seems to have little to recommend it to American engineers, and were it not for the serious attention which it has received in France, and the evident ability with which the details have been worked out, it would excite little or no interest on this side of the water. Among the strongest arguments in favor of the system are, that it admits of higher speeds being attained, the locomotive is more flexible, there is less wear on the rails, and tractive power is more economically generated and better distributed. In answer to most of these claims it may be said that in America no practical difficulty has been met in attaining a speed of over 100 miles with steam locomotives, and that the Empire State Express has even reached a speed of 114 miles without showing that this was at all a limit. Experience with high speeds has also shown that injury to the track from the "pounding" action of a steam locomotive is largely a bugbear. Even if some evils were mitigated by this system, the complication of machinery, including eight motors under the locomotive, would introduce other and perhaps much greater evils. The claim of greater economy in the use of fuel even cannot be accepted in the absence of direct data. It is said that a modern steam locomotive can produce a horse power under favorable conditions with 2.7 pounds of coal, and we cannot see that this can be equalled with the most economical engine than can be used in the Heilmann system, taking into consideration the losses between the generator engine and the axles of the locomotive.

THAT \$50,000 PRIZE.

It is rumored that the Metropolitan Traction Company applied the original time limit and withdrew its offer of a \$50,000 prize on March 1, assigning as a reason for not extending the time that the State Railroad Commission had not accepted its offer to act as a referee. A daily newspaper has published a statement supposed to emanate from the traction company to the effect that more than 1,500 plans had been submitted in competition by inventors. In return for the time and trouble thus expended inventors have received no benefit whatever, while the traction company has had placed at its temporary disposal, at no cost to it, a collection of ideas from which, had it so chosen, it could have obtained information of great value if the original intention of using some conduit system on its lines is to be carried out. It is not too much to say that inventors have not been fairly treated in this so-called competition. The time allowed to construct and operate a practical system was so absurdly short that it was taken for granted, assuming that the competition was to be a real one, that it would be extended. The condition that the State Railroad Commission should act as a referee was also seen to be an impossible one, as lying entirely beyond the province of that body, but here again the promise of the passage of a bill to give the necessary authorization was doubtless relied upon. It is true that such a bill was introduced in the Legislature, and might, it seems reasonable to suppose, have been easily pressed to passage, but, as far as we know, it was never heard of after its first introduction. It is little likely that inventors will soon again allow themselves to be thus trifled with, and the whole affair is very little to the credit of the corporation concerned.

INSTITUTE LOCAL MEETINGS.

Those who have favored the policy of holding local meetings of members of the American Institute of Electrical Engineers, the adoption of which at one time seemed problematical, will feel gratified at the complete confirmation of their views through the brilliant success of the inaugural meeting held in Chicago last week. Every promise is given by this new feature toward the extension of the usefulness of the Institute and the growth of its prestige, while the national interest that will thus be taken in its conduct will go far toward suppressing petty practices in its management. One point in this connection still requires attention, and that is to provide for the many who would attend the meetings and yet are either not members or not eligible to membership. At the recent Chicago meeting, for example, only about one-third of those in attendance were members, and it is probable that every meeting there and in New York would be largely and regularly attended by non-members, such as students and others, if some provision existed for attaching them to the meeting in an auxiliary capacity. Aside from the further extension of the usefulness of the Institute through the adoption of this policy is the question of assisting by this means in providing for the local expenses. If all of the Chicago members were to contribute pro rata to the expense of a stenographic report and the other incidental expenses, the amount would approach that of the annual Institute dues, while at the several other places where local meetings are possible, it would exceed this sum. We trust that among the other matters requiring legislative action that will come before the annual meeting of the Institute this will be included, and we would suggest that the Chicago membership, being most directly affected, take the initiative and present a plan for consideration, which might also include other points that their experience has suggested would further contribute to the success of local meetings.

THE PROVISIONAL MAGNETIC UNITS.

The most important step ever taken by the American Institute of Electrical Engineers was the adoption at the recent meeting of the several provisional magnetic units which have been before it for consideration for some time. Should the units fail to meet with acceptance much of the prestige gained by the Institute by its able work in connection with the recent International Electrical Congress will be lost, but happily this is an eventuality little probable of realization. The units provisionally adopted are not, as supposed by many, the same as those that were considered at the Chicago Congress. The latter were a system in which arbitrary magnitudes were assigned in order to more nearly correlate magnetic units with the existing practical electrical units. The result, however, was unfortunate, not only in the extremely impractical values of several of the units, but also in the lack of a proper relation between the proposed gilbert and gauss. In the criticisms from foreign electrical bodies and other authoritative sources, the system was almost unanimously condemned, and in almost every case an opinion expressed that the magnitudes of the C. G. S. magnetic units were such as to render that system the proper one for practical adoption, and the action of the Institute seems to be based on this verdict. In view of the extreme improbability of ever successfully devising any coherent practical system on the lines of the one condemned at Chicago, and of the fact that the magnitudes of the C. G. S. offer no real practical difficulties, it may be concluded that there can be no valid criticism to their adoption as practical units, particularly as they have been thus used for years. The criticism in regard to the names, however, is not without reason. It is contended that the policy of giving Greek names to the C. G. S. units should be observed; that all of the proprieties will be violated by a mixed system in which the dyne and erg will

be jostled by the oersted and gilbert. On the other hand, it is said that thus far no Greek names have been proposed for the magnetic units, even by those who have most strenuously urged that such should be adopted; that as the magnetic units are to be practical units, they should have the same nomenclature as the other practical units; and that the opportunity thus given to pay homage to other great names in electrical science should not be sacrificed to mere purist considerations. As the adoption of the names of the units will depend almost entirely upon practical men, there is little doubt as to which argument they will favor. In regard to the names themselves, every one will recognize the justice of honoring Weber and Gauss, one of whose names at least should have been used with the older system of practical units. As the founders of the systems of measurement upon which all units are based, they deserve a recognition which, now being given, should go far to outweigh the demands of purists for Greek names. As much cannot be said, however, for the other two names, gilbert and oersted. While the former had perhaps one of the greatest minds of his century, yet we are not aware that the "De Magnete" had the slightest influence on the development of electromagnetism, either directly, or indirectly through influencing the minds of the real fathers of the science. Oersted's claims are still less; his discovery of the deflection of a magnetic needle by a current, even if the first as regards time, is of the class that implies the exercise of no other faculties than those of sight and curiosity—both equally possessed by a child. With names at hand like those of Franklin, Maxwell, Hertz, Kelvin and others there is reason for objecting to the choice of gilbert and oersted. Of the four units the gauss is particularly welcome. Instead of referring to the intensity of induction of a material as so many lines of force per square centimetre we can now say that the working flux of wrought iron is, for example, 15,000 gaussess, etc., thus, besides the convenience, enabling much more concrete ideas to be formed. Next in order of usefulness is perhaps the weber, as we can now express the fields of dynamos very concisely in megawebers instead of in so many million lines of force, dynamo fields ranging from two to 100 megawebers in value. At present the field of usefulness of the oersted and gilbert seems to be rather restricted. With, however, something tangible and concrete now to work with, we may soon expect the oersted to play the same part in magnetism that its analogue, the ohm, does in electricity, with the consequent result of greatly simplifying magnetic calculations. While the practical values of reluctances will be small, the history of telegraphy has shown that the use of prefixes are unobjectionable, and we may therefore expect that the use of millioersted will cause no inconvenience. Whether the gilbert, which is practically the value of an .8 ampere turn, will displace the expression now used is problematical, though the magnitude is particularly convenient. Should it not do so, no other unit of magneto-motive force can do better, as it is extremely improbable that any change will ever be made which will enable such a unit to express the value of an ampere turn by unity, or by ten or one of its powers. The workers in practical electricity have now presented to them a system of practical magnetic units which seems as well, if not better, suited to their needs than any yet devised. With them its failure or success entirely lies, for however much the devotees of pure science may object (we are not aware that they will generally object), if the system once becomes generally used in electro-technics they will be compelled to fall in line. While the system will be presented for adoption in Europe, the verdict of this country, on account of its preponderating practical influence, will determine the verdict of the world, and therefore American electricians have a double reason for giving the matter the careful consideration which it deserves.

Coupling Alternators in Parallel.*To the Editor of The Electrical World:*

I desire to call attention to an error of omission in Mr. Steinmetz's paper describing his most successful attempts in synchronizing alternators. The machines used have been made for several years and are not used in parallel, because as at present installed they cannot safely be coupled nor economically run.

Obviously then there is something different in the method of driving these machines which is important. On this important point Mr. Steinmetz says nothing whatever.

I am inclined to think that if any one takes Mr. Steinmetz seriously and runs his machines up as described, the results in some cases would be disastrous.

Will Mr. Steinmetz then inform us how the alternators were driven and what type of engine was used, as it has for some time been known that the parallel running of alternators is purely a mechanical problem—not an electrical one?

Gloucester, N. J.

WILLIAM SMITH HARRY.

Referring to Mr. Harry's question on the mechanical conditions which have to be fulfilled for successful parallel running of alternators, I may state that there is only one condition, and that is that the alternators are run at exactly the same frequency, or, in other words, that the number of poles $\times$ number of revolutions is the same in all machines which shall be run in parallel.

Before throwing the alternators in parallel, it is necessary therefore to bring them to exactly the same frequency. It is not necessary, though desirable, for avoiding an instantaneous fluctuation in the system, that the alternators which shall be synchronized are brought to about the same voltage.

Equality of frequency, however, means not only equality of number of revolutions $\times$ by number of poles, but means that during each revolution the speed must be constant and uniform. Especially in direct connected generators, driven by badly regulated steam engines with insufficient flywheel capacity, during each revolution the speed may fluctuate considerably, which is disadvantageous for good parallel running.

Before attempting to synchronize alternators, it is necessary, therefore, to determine whether the driving power, as transmission, etc., is such as to enable the alternators to run at the same frequency. This is best done by loading both alternators up to full load independently and then noticing whether the phase indicator shows if the frequencies are near enough the same. If this is not the case, the speed has to be varied by adjusting the engine speed, changing the pulley, etc., so as to get the alternators to run at the same frequency. As soon as this is the case they may be thrown into parallel at any time without any further precautions and without any danger of getting into trouble.

CHARLES P. STEINMETZ.

The Meeting of the American Institute of Electrical Engineers.

The eighty-fifth meeting of the American Institute of Electrical Engineers was held Wednesday evening, March 21, at headquarters, 12 West Thirty-first street, with President Houston in the chair.

By a vote of the meeting the report of the Committee on Units and Standards was taken from the table. The discussion on the units proposed for provisional adoption was participated in by Messrs. Houston, Kennelly, Crocker, Geyer and Pupin, who advocated the adoption of the report, and by Messrs. Wolcott, Hutchinson and Bradley, who criticised it. Special stress was laid by several of the first named speakers on the convenience for teaching purposes of having definite names for units, and it was also claimed that practical men had difficulty in understanding the significance of a unit until

a concrete name were given. Mr. Wolcott objected to the use of proper names for C. G. S. units, and advocated the substitution of Greek derivatives similar to erg and dyne. Dr. Hutchinson took the ground that the names proposed, weber, gauss, oersted and gubert, had been repudiated by the International Congress irrespective of their magnitude, and therefore stood little chance of being considered in other countries. Mr. Bradley thought that the names should be submitted to the various foreign electrical bodies before being adopted. The first criticism was met by the argument that as the proposed units were practical units they should have names of the same character as the other practical units, notwithstanding the difference in magnitude. In answer to the criticism of Dr. Hutchinson, it was maintained that as the function of an international congress is merely to approve what has already been generally adopted by the electrical public, the action referred to had no significance in view of the fact that the units laid before it then had not this recommendation, and that any system would first have to pass through a state of probation, as proposed, before active consideration by such a congress could be given. In answer to Mr. Bradley, it was explained that the units were to be merely previously adopted; and therefore his objection did not apply.

Prof. W. A. Anthony then read his paper on the "Effect of Heavy Gases in the Chamber of an Incandescent Lamp," which maintained that the use of bromine vapor in the chamber prevented blackening and maintained the candle power and efficiency more uniform. In the discussion Prof. Robb supported the views of Prof. Anthony, and Messrs. Howell and Doane strongly opposed them and advocated the superiority of the vacuum lamp; a great portion of this part of the discussion was merely a resume and extension of various points brought up in the recent Novak lamp suit by the same gentlemen. Written communications from Elihu Thomson and E. P. Thompson were read, and remarks made by Messrs. Moses, Hammer, Doane, Olan Bohm and others. The discussion lasted until almost midnight and extended much beyond the scope of the paper. There was a substantial agreement that the cause of blackening is the evaporation of the carbon filament, and that the presence of a dense vapor retards it, but the difference of opinion as to the ultimate benefit of such a vapor was wide. Through the courtesy of the Metropolitan Telephone and Telegraph Company, the American Telephone and Telegraph Company, and the Chicago Telephone Company, telephonic communication was established between the Chicago meeting, where Professor Anthony's paper had been read, and was being simultaneously discussed. The possibility of bringing distant audiences in touch with the author of a paper was satisfactorily established, and before adjournment, President Houston, at New York, spoke over the wire to attentive listeners in both cities, extending congratulations upon the success of the dual meeting, and informing the Chicago members that the report of the Committee on Units and Standards had been approved. About eighty members and guests were present at the New York meeting, and forty in Chicago.

At the council meeting in the afternoon, the following Associate Members were elected:

Agnew, Cornelius R., New York City; Billberg, C. O. C., Philadelphia, Pa.; Bliss, William L., Brooklyn, N. Y.; Carichoff, E. R., New York City; Coho, Herbert B., New York City; Galletly, J. Fred., Chicago, Ill.; Jackson, Henry, Horwich, Bolton-le-Moors, Lancashire, England; Keller, Edwin R., Philadelphia, Pa.; Kirkland, John W., Schenectady, N. Y.; Phillips, Leo A., Newark, N. J.; Rouquette, William F. B., New York City; Rowland, Henry A., Baltimore, Md.; Smith, J. Brodie, Manchester, N. H.; Volt, Dr. Ernst, Munchen, Germany.

The following Associate Members were transferred to full membership upon recommendation of the Board of Examiners:

Almon, Geo. H., Boston, Mass.; Egger, Ernst, Vienna, Austria;

Brenner, W. H., Montreal, P. Q., Haskins, Clark C., Chicago, Ill.; Fitzmaurice, James S., Sydney, N. S. W.

Upon recommendation of the Sub-Committee on Papers and Meetings, it was voted to hold the annual and general meetings of the Institute in Philadelphia, May 15 and 16.

As required by the rules, the council also canvassed the nominations received from the membership during the month of February, and prepared the following ticket for the coming election, ballots for which will be issued in April: For President, Prof. Edwin J. Houston; for Vice Presidents, Prof. Wm. A. Anthony, Prof. Francis B. Crocker and Mr. James Hamblet; for Managers, Messrs. A. E. Kennelly, W. D. Weaver, Chas. S. Bradley and Wm. B. Vansize; for Treasurer, Mr. Geo. M. Phelps.

THE CHICAGO MEETING.

The meeting was called to order by Mr. Edward Caldwell, and upon motion of Mr. B. J. Arnold, Mr. Hibbard was named chairman. Prof. Anthony's paper was then read by Prof. D. C. Jackson, of the University of Wisconsin. The discussion was opened by Mr. F. E. Jackson, of the General Electric Company, who had come from the Harrison, N. J., lamp works to exhibit diagrams of Edison and Novak lamps, and reply to some of Prof. Anthony's statements, the same points being made as at the New York meeting by Mr. Howell. Further discussion was carried on by B. J. Arnold, Ludwig Gutmann, and Mr. Kammer, of the Sunbeam company. Prof. Stine also took a hand in the discussion by reading quite a lengthy paper prepared in advance. Prof. Jackson then answered a number of questions and closed the discussion on behalf of the author of the paper. Before the discussion the meeting adjourned to an adjoining room, where about 40 receivers were connected with the Institute headquarters at New York, and listened to President Houston's conversation; all could hear very distinctly, and this feature of the first local meeting was thoroughly enjoyed. At the close of the discussion of the paper, a vote of thanks was tendered to Mr. Hibbard, as the representative of the Chicago Telephone Company, and to Mr. Hall, as the representative of the New York company, for the use of the telephone lines, and also to Prof. Jackson and to Mr. F. E. Jackson for their interest in coming such long distances to attend the meeting. Prof. Stine and the Armour Institute, which have placed admirable facilities at the disposition of the local meeting, also came in for a very hearty vote of thanks for their hospitality. Prof. Stine, B. J. Arnold and Edward Caldwell were appointed a committee to devise means to pay local expenses and to arrange from time to time for the holding of meetings. Among the members present, besides those mentioned above, were Lieut. Rodman, Mr. McFadden, Mr. Comstock, C. C. Haskins, and others. Among non-members were Mr. Terry, of the Sunbeam company; Mr. Kammer, of the same company, and a number of telephone people, and others connected with the city Electric Light Inspection Department, the entire attendance numbering more than forty.

Lamp Socket Decisions.

Judge Cox last week, in the case of the Edison Electric Light Company against the Syracuse Electric Engineering and Supply Company, rendered an opinion in regard to four patents relating to incandescent lamp sockets.

One of these (No. 265,311) is a fundamental patent covering sockets adapted to be placed upon a gas pipe or other suitable support and provided with contact plates for the circuit terminals. This patent was declared valid, but it was also decided that it had expired in December, 1891, with the Russian patent.

Another fundamental patent (251,596), relating to the com-

bination of the interior insulating portion of a socket with circuit connections and an exterior metal portion forming a covering, was declared invalid.

Two patents covering the Edison type of socket and the use of a removable rubber ring in a socket were sustained.

Communications with Vessels.

While electricians are trying to solve the problem of communication with a vessel by electrical means, others are apparently having great success with a very simple acoustic apparatus consisting of an ordinary bell as a transmitter and a metallic diaphragm as a receiver; the two must be tuned to the same note, in which case the water at a sufficient depth will transmit the Morse signals quite readily.

The Lighting of New York's Greatest Avenue.

About a year and a half ago the low tension system of street lighting was introduced for the first time in New York on Fifth avenue. It had been found that some such device must be resorted to, for series arc lamps were little demanded on that avenue for commercial purposes, and the expense of laying the wires for conduits for street lighting alone was so great as to be practically prohibitive. Accordingly the Edison Illuminating Company solved the difficulty very satisfactorily by employing a low tension system, in which a pair of arc lamps on each post were used instead of a single lamp with dead resistance, as had been the case in previous attempts at low tension arc lighting. Each of these lamps, which were of the Bergmann type, manufactured by the General Incandescent Arc Light Company, took five amperes at approximately 50 volts, so that practically the same amount of energy was used as in the high tension arc lamp on the series circuit. The low tension system also possessed a number of advantages over its older rival. In the first place it was possible to connect the lamps directly to the Edison low tension mains, thus effecting a great economy and adding to the convenience and flexibility of the system; secondly, the light was more effective on account of better diffusion, as the casting of shadows was practically obviated.

An ornamental post was employed made in three parts, the base, the shaft and the arm section. Instead of placing the resistance in the hood of the lamp, it was located in the base, and the lamps were lowered and raised from within the shaft, to which access was had by means of a door in the base, the key of which was carried by the trimmer. The lamps are fed by a sliding contact, so that when they are lowered the current is entirely shut off and the trimmer is perfectly safe from even a low tension shock. The lamps are supplied from the mains by the ordinary house service method, wires running through the gas pipe which forms the centre part of the shaft.

One of the great advantages of this system of lighting is the ornamental appearance of the posts and the lamps, which greatly surpass in this respect the older type of series lamp. This system has been found to operate most satisfactorily during the past eighteen months, and the only criticism passed upon it was that the avenue was not as brilliantly lighted as had been anticipated. The Edison company recently decided to overcome this difficulty by doubling the number of lamps, and accordingly have inserted at the centre of each block another post carrying two lamps. There are now 114 posts, which, with two lamps each, makes a total of 228 lamps. This has had the desired effect, and as may be seen from the illustration on the opposite page, Fifth avenue is one of the most brilliantly illuminated thoroughfares in the city. At the same time the light is much more soft and pleasing than that which is given by high tension lamps.



Elec. World N. Y.

FIFTH AVENUE BY NIGHT.

Laboratory Notes.—XVII.

BY LIEUT. F. JARVIS PATTEN.

Before leaving this subject, it seems worth while to inquire what the nature of the field will be when produced by two independent currents having quite different frequencies, one having a frequency that is some whole multiple of the frequency of the other, and the two acting as before in the same magnetic system along axes at right angles to each other.

The simplest case is that shown in Fig. 44, which indicates two currents, x and y , the latter having just double the frequency of the first, and their zero periods occurring at the same instant. Dividing the time period t_0 to t_1 , as before, into a convenient number of equal parts and plotting the intensities and directions of the resultant forces, we

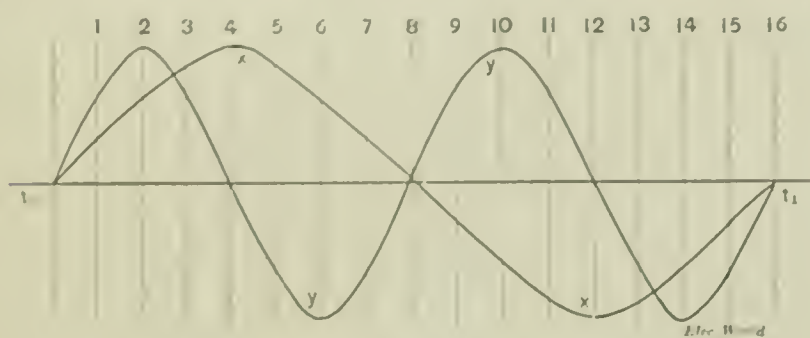


FIG. 44.

determine the points 1, 2, 3, etc., Fig. 45, of a singular curve that indicates clearly the action of the field with respect to the axes XX and YY during one complete period of the current of lower frequency xx , which cycle is constantly repeated. Here the field has some resemblance to a rotary

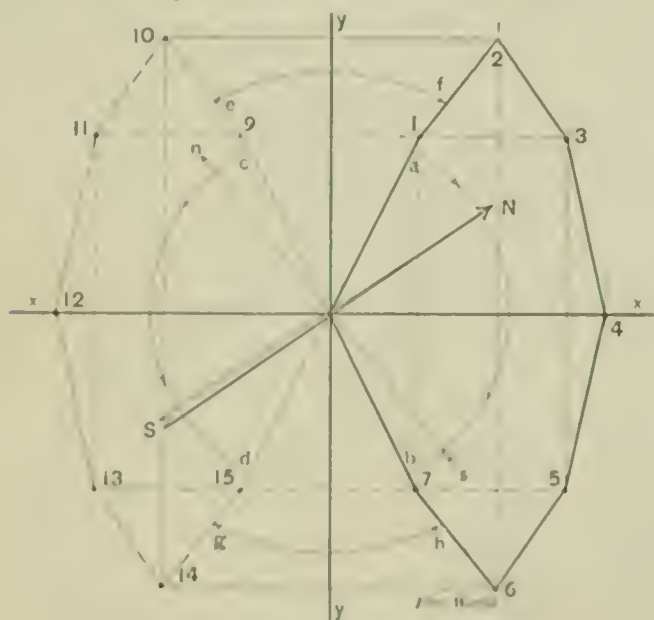


FIG. 45.

field, but reverses polarity at every half revolution and then goes backward; thus it swings through the arc a to b with the clock, and then reverses and swings over the arc c to d against the clock, making a field of reversing polarity, like a single alternating current, but one that also rotates through a part of the circumference. With sufficiently low frequencies such devices may find some use for synchronizing apparatus and serve to show what a variety of moving field can be obtained by combinations of two currents in a single system.

Figs. 46 and 47 show the effect of two currents, xx and yy , that have frequencies of three to one, and Figs. 48 and 49 show the motion of the field when the currents have frequencies of two to three. The effect here is peculiar, as there is an almost complete rotation of the field, with the intensity varying comparatively little, as indicated by the full curve; then the direction of motion reverses and makes an almost complete revolution in the opposite direction, as shown by

the dotted curve. Examining the two figures, we see that if the current indicated by the curve yy is reversed at each half cycle, that is, at the time corresponding to the ordinate

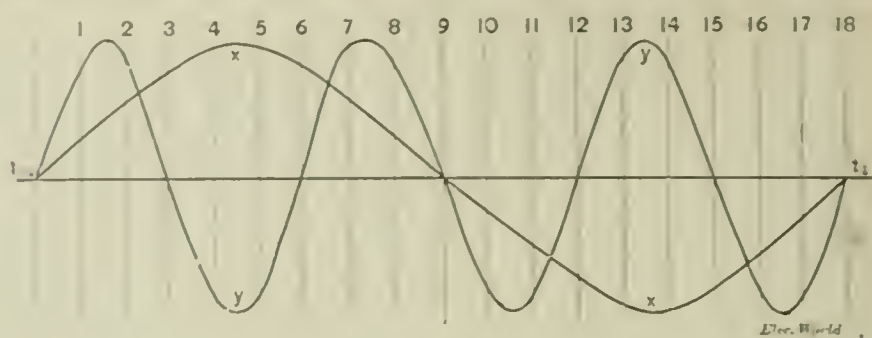


FIG. 46.

12, in Fig. 48, then the field due to the last half cycle would be identical with that due to the first half and a pulsating rotary field would result that describes nearly a complete revolution, and then jumping an arc of about 45 degrees, re-

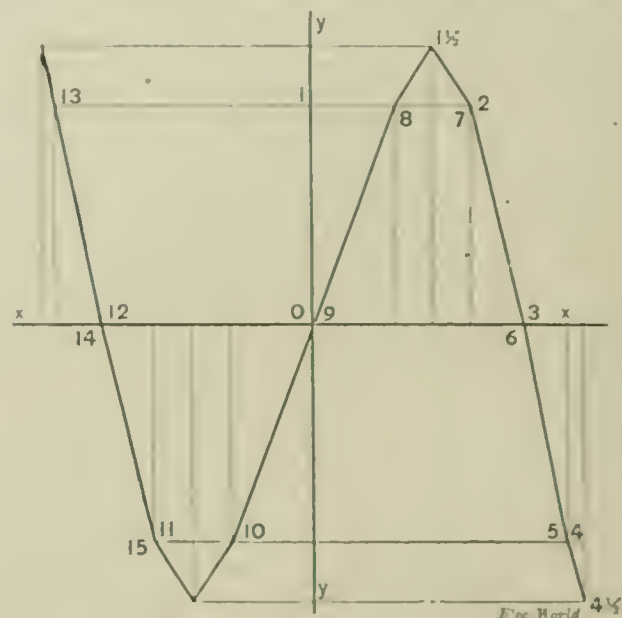


FIG. 47.

peats itself, which may be likened to rotary motion in which there is one dead point in a revolution instead of two or more, as is generally the case.

Though resorting to the rectification of such currents to obtain a desired effect is a little like begging the question, as we are then practically returning to the construction of a sort of direct current machine, it is none the less interesting to see what possibilities these different modifications will offer. We have thus far considered only the behavior of these currents of different frequency where both are applied to the same magnetic field or acting along different axes of the same magnetic system.

If one of them be applied to a ring field, as before, and the

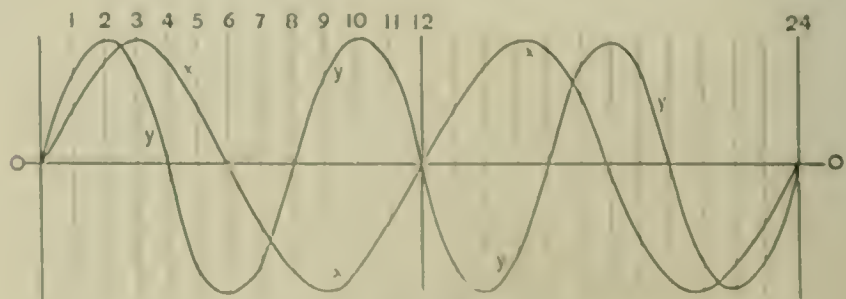


FIG. 48.

other to the revolving part, or armature, an entirely new set of combinations will arise.

As an illustration of this, take the two currents indicated in Fig. 49, having frequencies of one to three, and let the low frequency current xx be introduced to the revolving part, or armature, and the one of higher frequency, yy , to the field, as indicated in the diagram, Fig. 50, which represents a ring field where the higher frequency current yy enters at three equi-distant points, 120 degrees apart, and

leaves at three others intermediate between them, thus making a six-pole field.

The other current is introduced to the revolving part through a pair of brushes, and a two part commutator, as shown. The current in the field and the field poles will reverse three times to one reversal of the armature, and if the

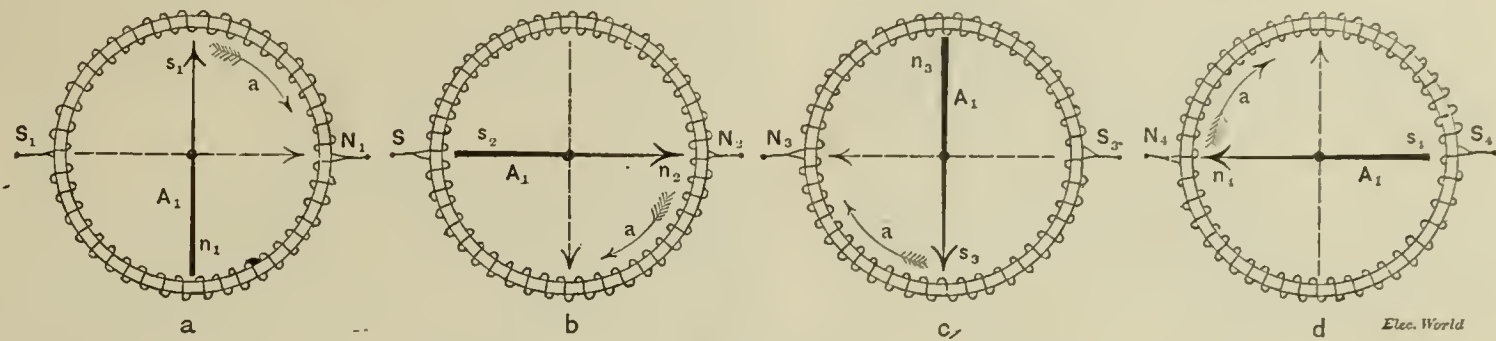


FIG. 51.

current in the latter is rectified at each half revolution, continuous rotation will ensue in this system by the rectification of the current of slow period only. Thus, suppose the armature with a north polarity, as indicated by the arrow pointing to the left, it will tend to leave this position and go one way or the other toward a south pole; suppose that motion ensues clockwise, then when the armature reaches the next pole of the field it will have changed to north, and

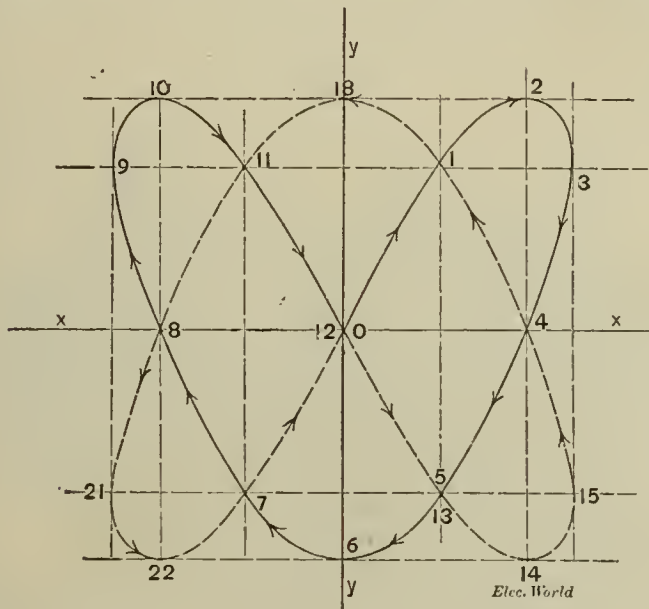


FIG. 49.

motion will continue because the armature has not changed its polarity; the same thing will happen at the next pole, the field poles changing as the armature approaches them continues the movement in the same direction until three poles have been passed, when the armature would reverse direction, owing to reversal of its current, but at this point

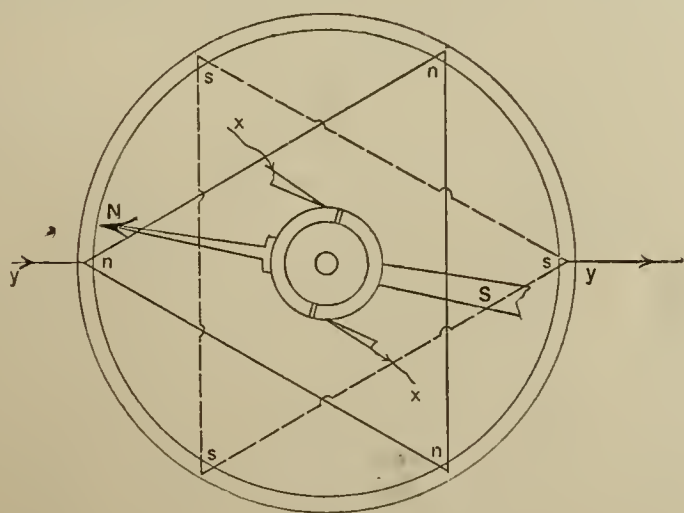


FIG. 50.

the commutator rectifies the armature current for the next half revolution and motion continues in the same direction.

A machine can be made operative, however, with currents of different frequencies in the fixed and moving parts without the aid of commutator or any rectifying devices. Take, for instance, the two currents indicated in Fig. 44, hav-

ing periods of two to one, and let the current x of lower frequency be supplied to a ring field at the extremities of a given diameter, while the other is supplied to the armature A_1 of the machine, shown in the diagram in Fig. 51, in four successive positions, a, b, c, d , of a single revolution.

In the starting position, 51a, the polarities are as indi-

cated, and motion will be clockwise. When, however, the armature has turned a quarter revolution, as in position b , its current begins to change, and there is repulsion at both poles of the field in the same direction as the former attraction. When another quarter revolution is completed, as at c , both field and armature simultaneously change polarity in such a way as to continue the motion by attraction at both poles, and by change of the armature current after another quarter, while the fields still remain the same, repulsion again takes place for another quarter, thus completing the cycle, and motion continues this way, if the machine can once be started, which operation is attended with the difficulties common to a single phase machine, which it is in one sense of the word, as there are two dead points in each cycle, or single revolution.

By using an auxiliary device, however, this machine can be made self-starting. The plan hardly requires illustration. Another ring field is supplied by two circuits at right angles to each other; in one of these the field current is introduced as before, and in the other a transformed current that is derived from the first in such a way as to produce a slight rotary field effect, which acts upon an independent closed circuited armature secured to the same spindle as the other. The effect of this second armature being always in the same direction, will start the first and bring it to synchronism, when the starting device can be dispensed with.

(To be continued.)

On Parallel Working with Special Reference to Long Lines.*

BY W. M. MORDEY,

In his reply at the end of the discussion on his Niagara paper, Prof. Forbes alluded to some experiments which he had witnessed, and which he considered showed that alternators of my design would not run properly in parallel. The passage is as follows: "At the time when I recommended the Mordey machine I said that, before deciding to adopt it, tests must be made with a resistance between the dynamos in parallel. Does Mr. Mordey forget that, when he kindly placed at my disposal the means of making this test, by putting 'sunbeam' lamps in series—that is to say, between the two dynamos working in parallel—the lamps went up and down in brightness with the periodicity of a few seconds, and that the tendency was to rise to maximum brilliancy, showing that the dynamos were rather working in series than in parallel? From the moment of those experiments, I felt that that type of machine was not suited for our purposes, though I never mentioned that until I was compelled to by Mr. Mordey's claims for his special mode of working." I heard his remarks with the utmost astonishment, as the experiments, rightly interpreted, appeared to afford the very strongest proof of the exceedingly powerful synchronizing

* Extract from a paper presented to the London Institute of Electrical Engineers.

effort exerted by these machines, and because I then heard a contrary view expressed for the first time. And in another passage Prof. Forbes stated that they must have alternators at Niagara that will run without any synchronizing or waste current.

The matter is of some moment, and demands an explanation. With your permission, I will make this explanation the text and starting point of a paper on parallel working, and on the allied subject of the use of alternators as synchronous motors. The experiments were made in July, 1891, and were mentioned in the "Electrical Review" and elsewhere, in each case as having afforded an illustration of the thoroughly satisfactory parallel working of alternators when directly coupled to high speed engines—a matter with regard to which there was at that time some uncertainty. It had been supposed that some flexible or yielding coupling was necessary between the engine and alternator. For my own part, I never had any doubt on the subject; but in order to place the matter beyond dispute, some tests were carried out by the Brush Electrical Engineering Company and Messrs. Willans and Robinson. The former provided two of my alternators, the latter fitted them to two Willans engines. Among others, Prof. Forbes received an invitation to witness the trial, and was present.

When all the tests of ordinary parallel working had been satisfactorily carried out—including shutting the steam off the engine driving one of the alternators, and then applying a brake to its flywheel in a vain attempt to force it out of step—a further test was made (as an interesting experiment bearing on the subject of synchronous motors) to ascertain what would occur if the two alternators were coupled together with a resistance between them so great that the resistance alone would be sufficient to absorb the whole power of one machine, even if the machine at the other end were at rest; and the remarkable fact was established that even under these conditions (which would be absolutely absurd or impossible in practice) the two machines did not break out of step. The resistance used consisted of "sunbeam" lamps, which happened to be the only suitable resistance available. These lamps, being made for 80 volts and about 5 amperes, would have a resistance, hot, of about 20 ohms each, and a much higher resistance when cold—probably more than 30 ohms. Seven of these lamps were placed in series between the alternators. There was no other external circuit. It was then found that there was a current passing through them which rose and fell with a slow pulsation; the alternators, although not actually breaking out of step, evidently getting a good deal out of true co-phasal synchronism, and only being pulled in when this slowly pulsating current rose to a considerable amount. Synchronism being regained, the current decreased again. This current was not measured, but was probably about seven amperes, as the lamps were a good deal over incandesced. The experiment was then discontinued. Properly interpreted, this test appeared to show that even when a line of an enormously high resistance was interposed between two alternators arranged to run in parallel (or one as generator, the other as synchronous motor), and when no adjustments were made to help them to keep together, the tendency to get out of step was corrected with a surprising amount of success, the correction, instead of being instantaneous and powerful, as with machines connected through a small resistance only, being sluggish, and greatly weakened by the very high resistance of the line.

To show how utterly unfair and unjust Prof. Forbes' interpretation is, and to reassure those who may desire to use synchronous motors, it is only necessary briefly to examine the conditions of the test. The two alternators used in the experiment were 37.5-kw. 2,000-volt machines. At full load each would therefore give nearly 20 amperes. Now, suppose it is desired to run one machine as a generator, driving

the other as a synchronous motor (to take the illustration that may best suit the case of power transmission over a considerable distance), it will be seen that if the line is to be designed to give such a percentage loss as is proposed for the Niagara-Buffalo transmission—that is, 3.5 per cent.—the loss at full load should be 70 volts, and the maximum current being, say, 20 amperes, the line resistance should be 3.5 ohms. In the actual experiment, the machines did not break out of step even when the line resistance was more than 100 ohms—that is, relatively more than 30 times greater than Prof. Forbes proposes to use even for his long distance transmission. This is the more striking as a proof of their powerful synchronizing when it is considered that even if it had been intended to expend the whole power of the generator in the line, that line should only have had a resistance of 100 ohms. That these machines did not act quite perfectly in parallel under these conditions, even with no load, is not to be wondered at. The only cause for surprise is that they exerted any sensible synchronizing effort at all. It is exactly as if an attempt had been made to run two 1,200-kw. alternators in parallel through a line constructed to allow a reasonable loss for a couple of 40-kw. machines. Even unloaded, such a test would be unreasonable. * * * *

The condition of entire absence of synchronizing current or of correction can only be obtained by driving by engines that are very even in power always. I think this is more likely to be approached by turbines than by reciprocating engines. By "synchronizing current" I do not mean necessarily an actual current passing from one alternator to the other—this only occurs when one of them is driven as a motor—I mean the variations of the current contributed by each machine to the circuit. But I would like to point out that the condition laid down by Prof. Forbes as an essential—namely, that they must have alternators at Niagara that will run without any synchronizing or waste current—is an absolute impossibility. Alternators will run without synchronizing current only when there is no necessity for them to exert any synchronizing effort. However, I am glad to find that Prof. Forbes has set himself to solve this problem of getting an alternator motor to run without any current (for that is what it amounts to), because I am sure that in solving it he will also have disposed forever of that other interesting problem—making a motor that will run without any back E. M. F. This is a new and significant outcrop of the "perpetual motion" idea.

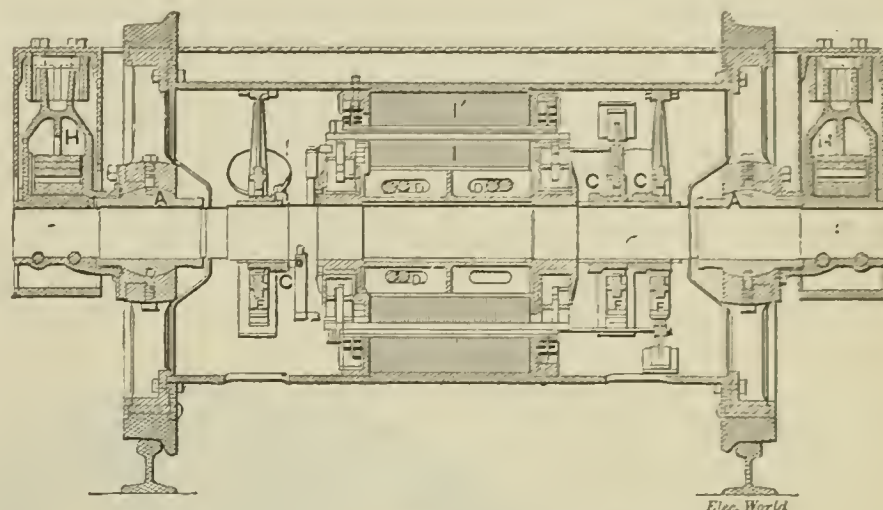
I am sure that if Prof. Forbes had really considered or understood this matter he would not have expressed the opinion which I have quoted. At the same time, I wish to say I am convinced that his criticism was not unfair by intention. At the end of the passage quoted from Prof. Forbes, it will be seen that he states that he had never mentioned the matter until compelled to do so by some claims of mine for a special mode of working. I do not know what claims are referred to, nor do I know what compulsion he was under; but I do know that in making these statements publicly, without first mentioning the matter to me or to some of my colleagues and giving us an opportunity of expressing our views or giving an explanation, he exhibited a want of courtesy and of ordinary consideration which I venture to think quite exceptional. In the frequent friendly conversations which I have had with him there have been ample opportunities for the discussion of such matters. No doubt he had a right to advise his company as he thought proper; but I maintain that, without the very fullest justification for his statements, he had not a right to come to this Institution, and in the most public manner utter charges seriously affecting the character and capabilities of a trading company's manufactures. I submit that in his strictures on the synchronizing power of my alternators he was absolutely without such justification.

The Heilmann Electric Locomotive.

The Heilmann electric locomotive, which was tried in January on the Havre section of the Chemin de Fer de l'Ouest in France, is a wide departure from the usual methods of electric traction, and at first sight seems to rather mark a retrograde movement than an advance. The system consists of a locomotive which carries a boiler and engine to furnish power to an electric generator, which supplies current to gearless motors on the eight axles of the locomotive.

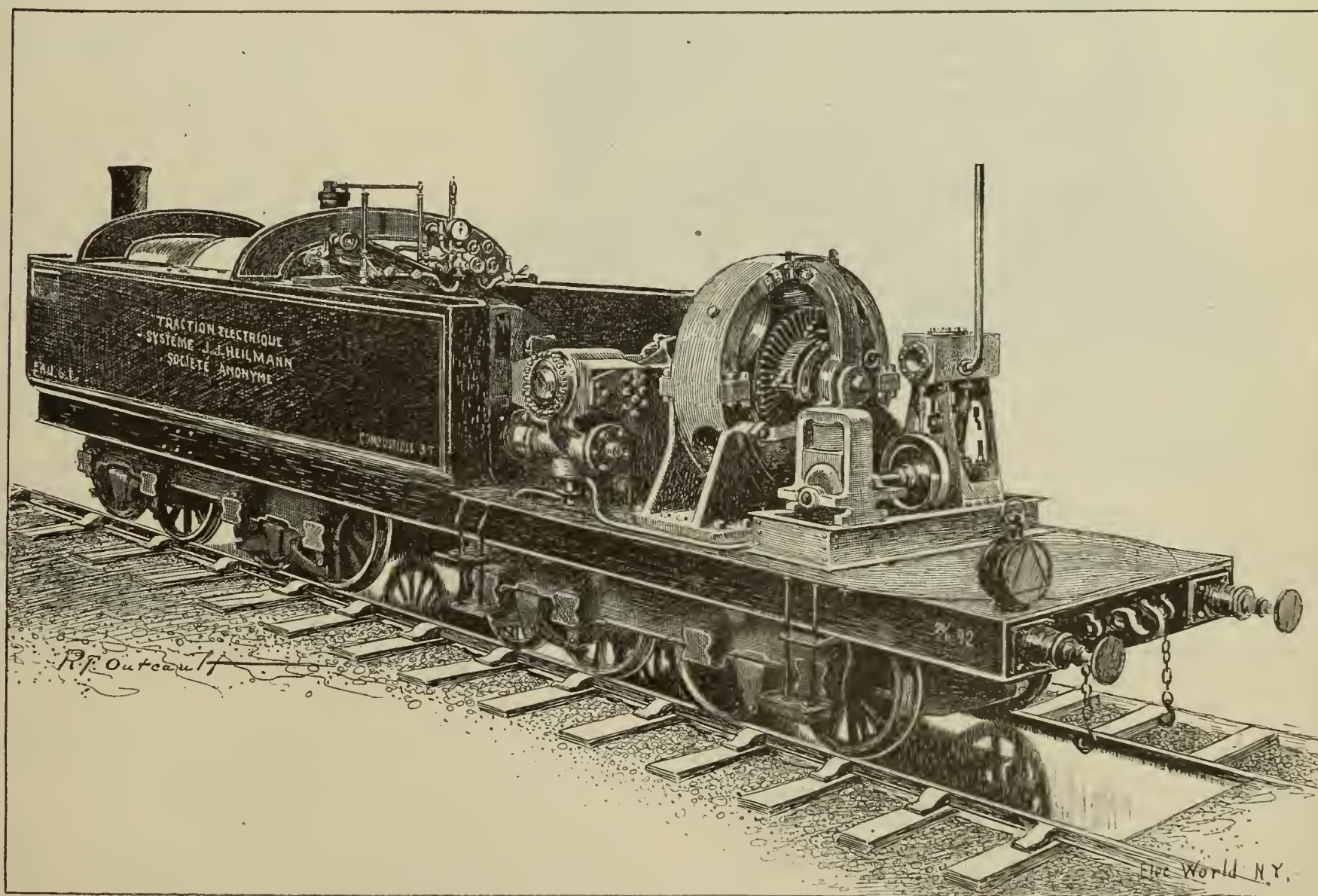
It is claimed that by this method of driving a greater stability or smoothness over the steam locomotive is attained at high speeds, due to the smaller wheels that can be used at a greater number of revolutions and the absence of oscillations. The adherence and flexibility are greater, as a greater weight can be distributed and in a more advantageous manner with sixteen wheels than with four, to which the steam locomotive is limited in order to possess sufficient flexibility to round curves. The boiler capacity in the new system can be made much larger, and by the use of economical engines power can be supplied more cheaply even at the points of final application than with wasteful locomotive engines. Accessory advantages claimed are that all parts of

the pressure is 160 pounds. A coal bunker and water tank of 6 and 10 tons capacity respectively are placed on each side of the boiler. The engine is of the compound type, the high and low pressure cylinders being on opposite sides of the cranks, which are at an angle of 180 degrees. Its weight is



MOTOR OF HEILMANN LOCOMOTIVE.

11,000 pounds, or 20 pounds per effective horse power. The consumption of steam is 23 pounds per horse power hour.



HEILMANN ELECTRIC LOCOMOTIVE.

the machinery requiring attention are readily accessible and as directly under the eye of the attendant as the machinery of a steamship; the analogy is further carried out by the fire room and machinery being entirely separated. The lubrication is more efficient and easily attended to, and the track is subjected to lighter wear on account of the absence of the "pounding" incident to the use of steam locomotives.

The locomotive is 52 feet long between buffers, and supported by two trucks with four axles each, with an electric motor on each axle; the entire weight is 110 tons.

The boiler is of the marine locomotive type with a corrugated furnace. It is 26 feet in length and somewhat over 6 feet in diameter, with 1,550 square feet of heating surface;

The engine is direct connected to a 6-pole ring armature, continuous current dynamo, which is so wound as to work with three, two or even one pair of carbon brushes. The external diameter of the frame is 79 inches and of the armature 49 inches. The dynamo is separately excited by a compound dynamo run by a small engine, and with 360 revolutions produces an available horse power of 600, with a maximum horse power of 800 with 800 revolutions. If the dynamo stops at one of the engine dead point, the exciter is connected to the armature for an instant, which causes the former to work as a motor and carry the engine beyond the dead point.

The motors have four poles and steel frames cast in a

single piece. The toothed armature is 25 inches in diameter, with a large air gap to reduce eddy currents. It is mounted on a steel tube, supporting the whole weight, which is fitted on the axle with a bushing of woodite, an elastic insulating material impervious to oil. The steel tube terminates at one of its extremities in an elastic coupling, which prevents jerking in starting. The eight motors form two groups, each comprising four motors coupled in parallel. In starting the two groups are connected in series and then in parallel after a certain speed has been attained.

At the trials in January a load of 90 tons was hauled up gradients of 3 and 8 in 1,000 respectively at a speed of 50

current induced in the secondary coil; and if this exciting current be increased until the voltmeter indicates 100 volts and be maintained constant, we can then replace our high permeability core with one we desire to test.

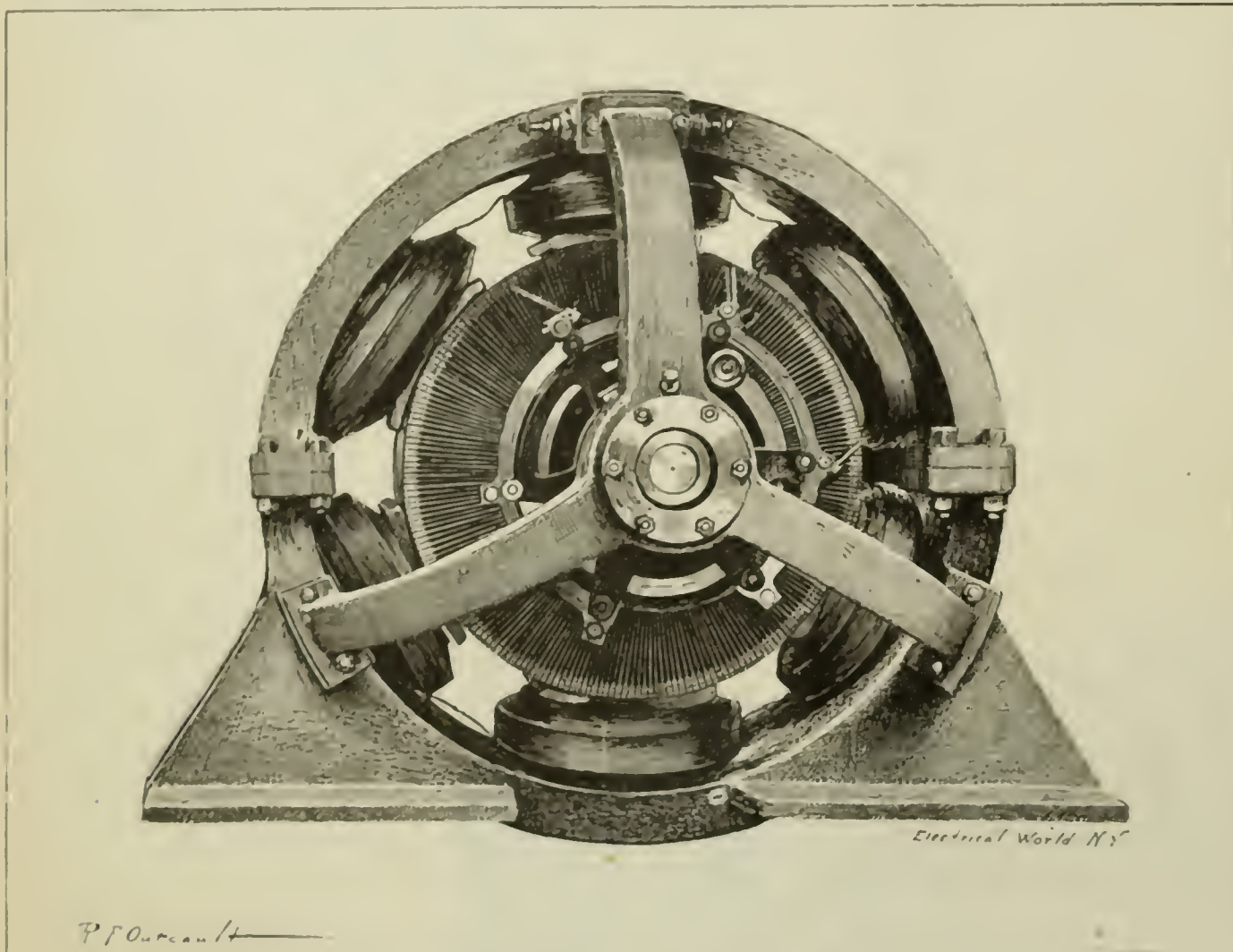
All the conditions now being the same as at first, except the primary core which we are testing, the voltmeter in the secondary will indicate in proportion to the number of lines of force cutting the secondary coil. The number of these lines of force depends upon the permeability of the metal being tested, and if the voltmeter now indicates but 75 volts we may know that the permeability of that piece of iron is but 75 per cent. of that of the first.

Such an instrument as this is very easily constructed, the only part not readily at hand in almost any workshop or laboratory being a standard bar to compare with, but even this is not necessary where it is only wanted to determine the best of a few samples of iron.

Of course it is understood that an alternating current is used as an exciting current, and that any alternating current voltmeter will do for use in the secondary.

I might add that where it would be inconvenient to maintain a uniform exciting current, two of these instruments (just alike) could be used, one for the standard bar and one for the iron to be tested, the primaries being connected in series, thus taking the same current. Two voltmeters would be used, one in each secondary, and compared directly with each other.

For further accuracy the standard to be tested could be changed from one instrument to the other and the voltmeters compared again.



GENERATOR OF HEILMANN LOCOMOTIVE.

miles per hour in the former case and 35 miles in the latter, the train being in regular duty for several days.

A Modified Instrument for the Determination of the B & H Curves of Iron.

BY H. W. SCHROEDER.

An article on this subject, which appeared in The Electrical World of Feb. 24, 1894, called to my mind a very simple method invented by myself some time ago for measuring the relative permeability of different grades of iron.

I use a soft $\cup$ -shaped yoke, between the legs of which is placed the piece of metal to be tested and around which is wrapped the exciting coil. At the curved end of the yoke is placed a coil which is connected to a voltmeter reading from 1 to 100 volts.

In fact, my instrument may be looked upon as a simple transformer from which the primary core may be removed and replaced by the cores to be tested.

We will treat it as such, and will call the coil surrounding the removable core the primary and the coil at the bent end of the yoke, with which the voltmeter is connected, the secondary.

Now, it follows that if a piece of iron, the permeability of which is high, be placed between the legs of the yoke and used as a primary core, and an exciting current sent through the primary coil surrounding this, there will be a

An Unpatented Improvement in the Magneto Telephone.

BY C. F. GIFFORD.

Now that the fundamental Bell patents on the magneto telephone have expired, the writer desires to give to the public an idea developed by him fifteen years ago.

This idea was simply the application of a closed secondary circuit of low resistance to the exterior surface of the coil of a magneto telephone for the purpose of overcoming self-induction. The principle involved has become familiar from the study of the alternating transformer, etc., but so far as the writer's observation extends it has not been applied to the telephone by others.

Perhaps some mathematician of the class that are wise in their own conceit but not in reality will proceed to show a heavy absorption of energy by this closed secondary. Let him remember that clearness of articulation is the great desideratum in a telephone, and that self-induction is the arch enemy of such distinctiveness. Practically, the loudness of the telephone will not be found in any manner impaired (the writer has found it to be rather the opposite), and the improvement in definition is very marked, especially in case magneto instruments are used both in transmitting and receiving.

A close fitting, thin metal case of any non-magnetic metal (non-magnetic that it may not deflect the magnetic lines in an undesirable manner) in the form of an inverted flat-bottomed cup with the bottom perforated for the projection of the core of the coil, will, when slipped over said coil and properly secured, be found to answer the purpose admirably.

The case may be suitably made of copper or brass, with soldered joints, and may be supplemented by a disc of the same or other suitable metal placed beneath the coil. Cheaper makeshifts of tinfoil, separated from the coil by paper, may be made, but are hardly advisable.

On lines using several instruments in series, the articulation would be improved by also sheathing the coils of the call bells.

Where instruments are "bridged on" or used in multiple, nothing but the coils of the receivers should be sheathed, and battery transmitters should be arranged to shunt by pressing a button, as is now customary.

Condensers properly adjusted and properly used may also serve the same purpose, but the simplification of the above arrangement makes it far preferable.

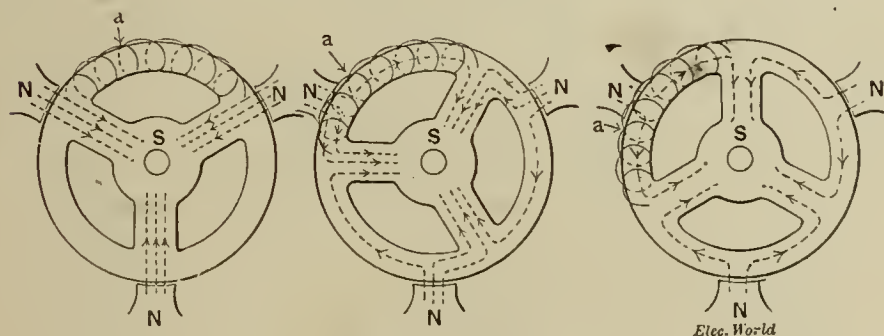
When this arrangement was first used by the writer, the iron grip of the monopoly robbed telephone patents other than their own of any peculiar attractions, so the matter was kept quiet. It might be well for the public to benefit by the above, if they care to, before some bright, "original" inventor tries to lock it up with a "fundamental" patent.

Inoperative Unipolar Machines.

BY G. M. WARNER.

I have noticed several articles recently discussing the probable effect on the magnetic field of rotating either the iron core or the exciting coil, and whether in such cases the so-called lines of force follow the movement of the core or the coil. Many of the cases cited are of interest, though none seem to me to bear directly on the subject, neither proving nor disproving the question in dispute, as all have a rotating spider form tending to bring in various complications.

Take, for instance, Mr. Ford's machine, described in the issue of Feb. 24, the essential features of which I have embodied in Figs. 1, 2 and 3, using less pole pieces to save complication. The stationary poles, *N*, are all of one polarity, the opposite pole being at the centre or hub. The rotating armature is shown in three successive positions one-twelfth of a revolution apart.



FIGS 1, 2 AND 3.

The idea was that the lines leaving the poles, *N*, and entering the armature, cutting the winding, would complete the circuit to the opposite pole by the spokes only, following them in their rotation, thus avoiding the cutting of the winding in leaving the rim.

The failure of the machine to generate any voltage that would affect any direct current instrument was taken as a proof of the falsity of the assumption, but this does not necessarily follow, for granting the assumption to be true, as I surely do, there is still a good and sufficient reason for the experiment resulting as it did.

The failure of the machine to generate any voltage that would affect any direct current instrument was taken as a proof of the falsity of the assumption, but this does not necessarily follow, for granting the assumption to be true, as I surely do, there is still a good and sufficient reason for the experiment resulting as it did.

I know, the general public has a sort of mistrust in mathe-

matical proofs of any kind, so in the following I will confine myself as closely as possible to graphical constructions, first calling especial attention to the law of magnetic circuits, "The strength of the magnetic field equals the magnetomotive force divided by the magnetic resistance."

When we have several paths by which the lines can reach the opposite pole, as in Figs. 2 and 3, by the spokes or across the air space, the number in each path would be inversely as its magnetic resistance. The resistance of air being hundreds of times as great as iron, only an inappreciable amount would leak across this way. The dotted lines in Figs. 1, 2 and 3, representing the lines of force, the arrow heads giving the direction, are drawn on this basis and the particular point to be noticed is the direction in which they thread through the coil *a* in different positions of the armature, viz.: first, in neither direction; second, right-handed; third, left-handed; one-twelfth of a revolution further on it would still be left-handed and one-twelfth further on as in Fig. 1 again. From this we might infer that an alternating voltage could be obtained from the terminals, and part of his experiment seems to bear this out.

There is some tendency in a machine of this character to generate an opposing E. M. F., due to the changing length of magnetic circuit, depending on the relative dimensions and amount of winding, but I do not wish to take space to discuss this, for in all probability the machine in question generated voltage enough to be measured by proper instruments, or these not being at hand, some difference ought to be noticed in the power required to drive it on open circuit and absolute short circuit.

The Underground Trolley in New York.

The Metropolitan Traction Company, it is stated, is now considering a proposition from Siemens & Halske for the installation of an underground system similar to that which has been in use at Budapest for some time, that firm offering to equip the Twenty-third street cross-town line at its own expense. It is also stated that the proposition will probably be accepted, but not without a strong effort on the part of the General Electric and Westinghouse companies to defeat their foreign rival.

The system, if adopted, will be used only on those lines where the traffic is not heavy enough to warrant the expense of a cable. The Belt Line is said to be one on which it can be advantageously applied, as the route travelled is thirteen miles long, and the company has only one stable. The horses, therefore, are worked very hard, especially as there is heavy traffic in the downtown portions of the route, which necessitates frequent stoppages and delay.

This system was fully described in *The Electrical World* of Oct. 24, 1891.

An Alleged Anticipation of Bell.

It is reported that an English officer, named Harrington, has discovered in India a working telephone between the two temples of Pauj about a mile apart. The system is said to have been in operation at Pauj for over 2,000 years. In this connection we may observe that Egyptologists have found unmistakable evidence of wire communications between some of the temples of the earlier Egyptian dynasties; but whether these served a telegraphic, telephonic or other purpose is not stated.

Honors to a Delegate to the Chicago Congress.

Dr. Emil Budde, of the firm of Siemens & Halske, Berlin, has received the honorary title of Professor, in recognition of his services as a delegate of the Imperial German Government to the late Chicago Electrical Congress.

Rope Driving.—X.*

BY J. J. FLATHILK

From these assumptions the following tables of the values of $1 - z$ have been computed.

TABLE IV.—VALUES OF $1 - z$ FOR A WORKING STRAIN EQUIVALENT TO 200 d^2 POUNDS.

Velocity in feet per minute	Value of $1 - z$	Velocity in feet per minute	Value of $1 - z$
1000	0.98	5500	0.58
2000	.94	6000	.59
2500	.91	6500	.41
3000	.87	7000	.32
3500	.83	7500	.22
4000	.78	8000	.11
4500	.72	8500	.9
5000	.65		

It will be seen from the above that when the velocity of the rope is as great as 8,500 feet per minute, $1 - z = 0$, hence $\log r = 0$ and $\frac{T_1}{T_2} = 1$; that is, $T_1 = T_2 = 0$, and, therefore, no power will be transmitted unless the assumed working tension, T , be exceeded.

In average work the lesser arc of contact embraced by the rope—generally on the smaller pulley—will be about 165° , and this value may be assumed for approximate calculations with a working degree of accuracy. If the angle in degrees is known, its value, α , in circular measure, can be obtained from Table V., in which $\alpha = 0.0175 \alpha^\circ$.

TABLE V.—ANGLE EMBRACED BY ROPE

Degree, α°	Circular measure, α	Fraction of Circumference, α/π
105	1.83	0.29
120	2.09	.33
135	2.35	.37
150	2.62	.42
165	2.88	.46
180	3.14	.50
195	3.43	.54
210	3.66	.58
240	4.19	.66

If we now assume the coefficient of friction ϕ to be .31 for a 15° groove, we may obtain the value of the expressions

$$T_1 = T \frac{\phi \alpha (1 - z)}{r} = T,$$

and

$$\frac{T_1}{P} = \frac{r}{r - 1}.$$

In order to simplify calculation, the following table (VI.) contains values of r and $\frac{r}{r - 1}$, which will enable the horse power transmitted by a rope to be determined with a degree of accuracy depending upon the assumption of the coefficient of friction:

TABLE VI.—FRICTION AND TENS MODULI

$\phi \alpha (1 - f)$	$r = \frac{T_1}{T_2}$	$\frac{r}{r - 1} = \frac{T_1}{P}$
0.1	1.11	10.41
0.2	1.23	5.40
0.3	1.35	3.86
0.4	1.49	3.02
0.5	1.65	2.54
0.6	1.82	2.22
0.7	2.01	1.99
0.8	2.22	1.82
0.9	2.46	1.69
1.0	2.72	1.58
1.1	3.00	1.50
1.2	3.22	1.43
1.3	3.67	1.37
1.4	4.06	1.33
1.5	4.48	1.29

The following application will show the use of the tables. Let it be required to determine the horse power transmitted by a rope 1 inch in diameter running at a velocity of 4,000 feet per minute over a pulley with 45° grooves. Assuming

an arc of contact of 165° , we find from Table V. $\alpha = 2.88$; for the required velocity, 4,000 feet per minute, Table IV. gives 0.78 as the value of $1 - z$; therefore assuming the coefficient of friction $\phi = .31$, we obtain

$$\phi \alpha (1 - z) = 0.31 \times 2.88 \times .78 = .69.$$

From Table VI., the value of $\frac{T_1}{P}$, corresponding to 0.69, is about 1.99, and as $T_1 = 200 d^2 = 200$ pounds in the present case, we find $P = \frac{T_1}{1.99} = 100$ pounds; since

$$\frac{P V}{33000} = \text{h. p.}, \text{ there is obtained h. p.} = \frac{100 \times 4000}{33000} = 12.15,$$

represented by the ordinate $l m$ in Fig. 30.

The loss due to centrifugal force may now be obtained by assuming the latter reduced to zero, in which case the factor $1 - z$ is equal to unity; therefore $\log r = .434 \phi \alpha$, from which, with the previous conditions, we obtain $P = 120$ and the corresponding h. p. = 14.5.

This value is represented on the diagram, Fig. 30, by the

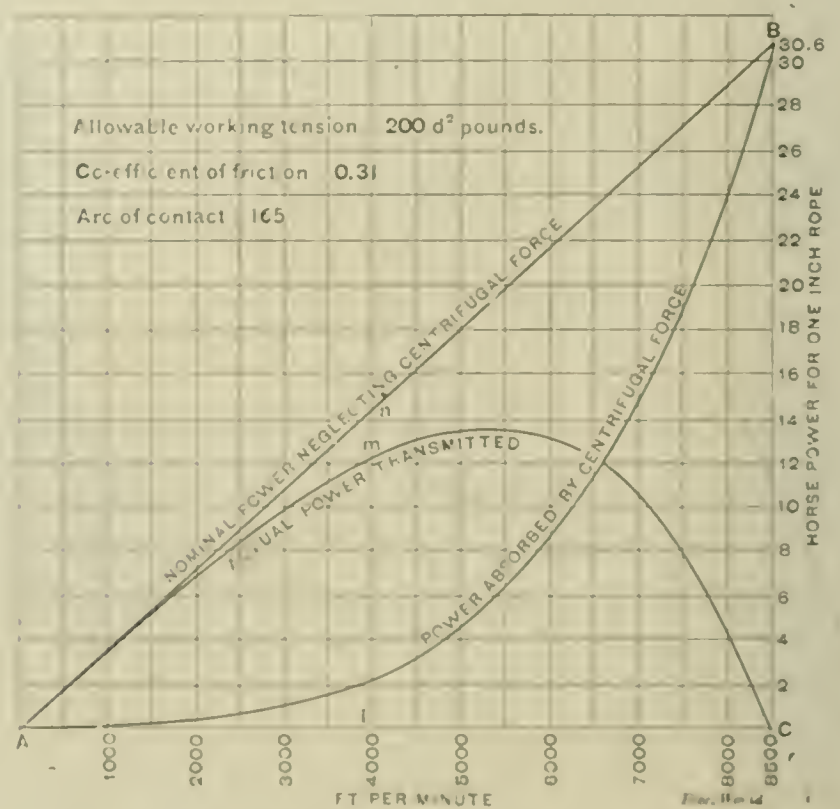


FIG. 30. CENTRIFUGAL EFFECTS IN ROPES.

ordinate $l n$; the difference between $l n$ and $l m = m n$ will then be the loss due to the centrifugal force set up in the rope = $14.5 - 12.15 = 2.35$ horse power.

For any special case where the data are known or may be determined, the formulas and tables already given should be used to ascertain the horse power transmitted, or diameter and number of ropes required for a certain work, as the case may be. For average work, however, it will be found that the assumed values of α and ϕ , previously noted, will give very satisfactory results, and upon these assumptions the writer has computed the following table of horse power, for various sized ropes, running at varying speeds.

TABLE VII.—HORSE POWER TRANSMITTED BY ROPES. WORKING STRAIN = 200 d^2 POUNDS.

Velocity of rope in feet per minute	Diameter of Rope						
	5/8	3/4	1	1 1/4	1 1/2	1 3/4	2
1,000	1.24	2.25	3.57	5.59	8.02	10.85	14.20
2,000	2.70	3.84	6.84	10.68	15.39	20.93	27.36
2,500	3.30	4.71	8.38	13.10	18.86	25.66	33.54
3,000	3.83	5.46	9.80	15.39	21.87	29.74	38.88
3,500	4.30	6.22	11.09	17.33	24.94	34.03	44.35
4,000	4.74	6.87	12.15	18.98	27.33	37.17	48.59
4,500	5.01	7.24	12.89	20.15	29.00	39.45	51.57
5,000	5.20	7.47	13.29	20.76	29.89	40.65	53.15
5,500	5.29	7.60	13.53	21.14	30.43	41.39	54.11
6,000	5.08	7.32	13.10	20.36	29.32	39.77	52.12
6,500	4.74	6.83	12.13	19.00	27.34	37.21	48.63
7,000	4.12	5.93	10.54	16.47	23.72	32.26	42.18
7,500	3.25	4.67	8.32	13.00	18.73	25.42	33.23

The graphic representation of these values, Fig. 31, shows

* For last section of this article see The Electrical World of Feb. 24.

per cent. faster at the increased speed; therefore taking the life of the rope as well as the first cost into consideration, the relative cost to transmit a given horse power at the speeds the effect of centrifugal force in diminishing the power transmitted under an assumed working tension, and would indicate that with tensions of $200 d^2$ pounds the speed should not exceed 5,500 feet per minute. The increasing effect and loss of power due to centrifugal force in the rope can also be seen in the diagram, Fig. 3c, which represents the horse power transmitted by an inch rope under an assumed constant tension of 200 pounds. The straight line AB shows the power which would be transmitted if centrifugal force were neglected, and is obtained by making $\varepsilon = 0$ in the general equation

$$\log r = 0.4343 \Phi \alpha (1 - \varepsilon);$$

the curve AC represents the power transmitted when centrifugal force is taken into account, and the curve AB shows the power absorbed by centrifugal force—this latter curve is obtained by subtracting the vertical ordinates between the straight line AB and the curve AC .

By a consideration of the diagram it will be seen that at speeds less than 2,000 feet per minute the power absorbed by centrifugal force is very small and may be neglected as far as practical results are concerned. Beyond this speed, however, the loss from this cause increases very rapidly, until, as previously shown, at a speed of about 8,500 feet per

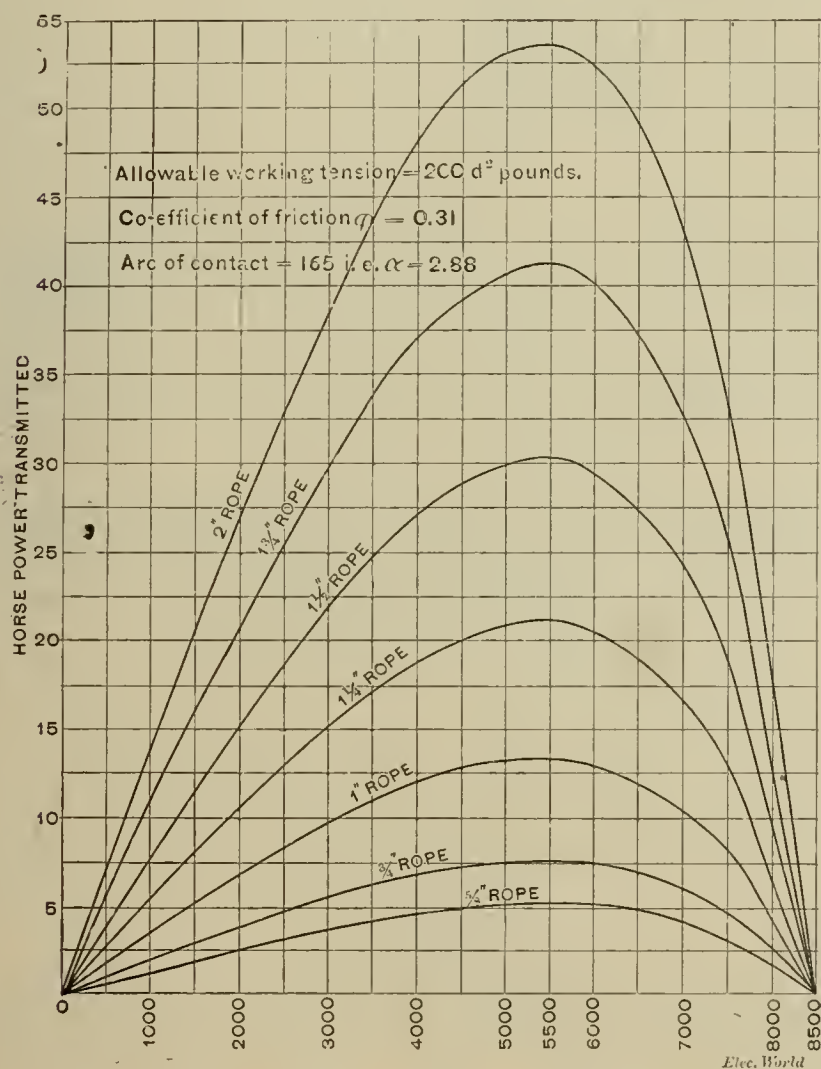


FIG. 31.—EFFECT OF CENTRIFUGAL FORCE.

minute, the whole of the allowable tension is absorbed. Assuming that the maximum power is transmitted by a rope at a velocity of about 5,500 feet per minute, it is evident that the first cost of the rope will be a minimum for a given power when running at this speed. The ratio of the first cost of the rope running at any other speed may be obtained by dividing the horse power at 5,500 feet per minute by the horse power at the required speed.*

Thus, if the first cost of an inch and quarter rope which will transmit 21.14 h. p. at 5,500 feet per minute be represented by unity, the cost at 3,000 feet per minute will be

$$\frac{21.14}{15.39} = 1.38,$$

*C. N. Hunt, in Trans. A. S. M. E., vol. XII.

since an inch and quarter rope running at 3,000 feet per minute will transmit 15.39 h. p.

The relative first cost for a given diameter of rope to transmit the same horse power at varying speeds is shown in the accompanying table:

TABLE VIII.—RELATIVE FIRST COST OF ROPE DRIVING.

Velocity of rope in feet per minute.	Relative first cost per horse power.	Velocity of rope in feet per minute.	Relative first cost per horse power.
1,000	3.78	4,500	1.05
2,000	1.89	5,000	1.02
2,500	1.62	5,500	1.00
3,000	1.38	6,000	1.03
3,500	1.22	6,500	1.12
4,000	1.10	7,000	1.28

Although the first cost of a rope to transmit a given horse power is a minimum for a speed of about 5,500 per minute, yet the economy is not as great as would appear from the foregoing table, for the effect of wear must be considered. The causes of wear, internal and external, have been previously discussed; it will be sufficient to note here that the internal destructive effect produced by bending and distorting the fibres and the wear due to external contact, slipping, or wedging in the grooves of the pulleys may within the limits of ordinary practice be considered as directly proportional to the velocity of the rope. What this wear is in terms of the velocity there is not sufficient data to determine, but if the coefficient be represented by c , the relative wear may be determined from $c v$, in which the wear increases directly with the velocity, but not, however, directly with the horse power transmitted.

If we assume the coefficient to be such that the wear on a rope at 1,000 feet per minute is equal to unity, then the wear on the same rope at any other speed will be:

$$\text{Relative wear} = \frac{\text{Required speed}}{1,000}.$$

To determine the relative wear per horse power transmitted by a given rope at varying speeds, it will be necessary to determine the wear per horse power for the rope running at any required speed, and then divide this value by the wear per horse power when running at 1,000 feet per minute. Let it be required to determine the wear of a rope transmitting a given horse power at 5,500 feet per minute, as compared to what it would be at 1,000 feet per minute.

The horse power transmitted at 1,000 feet per minute is found to be 3.57 for a one-inch rope, at which speed we have assumed that the wear is equal to unity, hence the wear per horse power may be considered equal to

$$\frac{1}{3.57} = .28.$$

At a speed of 5,500 feet per minute the horse power transmitted by the same rope is 13.53, but the wear at this speed is assumed to be five and a half times greater than at 1,000 feet, other conditions being the same, therefore the wear per horse

power = $\frac{5.5}{13.53} = .406$; that is, the wear of any rope trans-

mitting 1 h. p. at 5,500 feet per minute is $\frac{.406}{.28} = 1.45$ times the wear which would occur at 1,000 feet per minute.

From this it will be seen that although the first cost of a rope is cheaper at the higher speeds, the rope lasts longer while running at the slower speeds—conditions remaining constant.

Taking the case we have been considering, it is found that the relative first cost of the rope is inversely as the horse power transmitted or

$$\frac{\text{Cost of rope at 1,000 feet}}{\text{Cost of rope at 5,500 feet}} = \frac{13.53}{3.57} = 3.78,$$

that is, the first cost is 3.78 times greater for the slower speed, but it is shown above that the rope will wear out nearly 50

noted will be $\frac{3.78}{1.45} = 2.6$ times greater for the slower speed.

This can be determined more conveniently by assuming H = horse power transmitted at V feet per minute. H_1 = horse power transmitted at V_1 feet per minute where $H_1 > H$ and $V_1 > V$. The wear per horse power in each case will then be $\frac{V}{H}$ and $\frac{V_1}{H_1}$; the relative first cost of the rope per horse power running at the lesser speed, compared to that when running at the greater, will be as H_1 is to H ; hence the ratio of relative cost, taking wear into account, is

$$\frac{H_1}{H} \times \frac{V}{V_1} = \left(\frac{H_1}{H} \right)^2 \times \frac{V}{V_1}$$

TABLE IX.—RELATIVE WEAR AND COST OF ROPE PER HORSE POWER TRANSMITTED.

Velocity in feet per minute.	Relative wear per horse power transmitted.	Relative cost of rope per H. P. transmitted considering wear.
1,000	1.	1
2,000	1.03	.54
2,500	1.06	.45
3,000	1.10	.40
3,500	1.13	.36
4,000	1.18	.347
4,500	1.25	.345
5,000	1.34	.36
5,500	1.45	.38
6,000	1.61	.44
6,500	1.93	.52
7,000	2.40	.80
7,500	3.22	1.36

Table IX. has been calculated upon the above basis of comparison, namely, that the wear in a rope at 1,000 feet per minute is equal to unity and increases directly as the speed; and also that the cost of ropes for a permanent installation is proportional to the square of the ratio of the power trans-

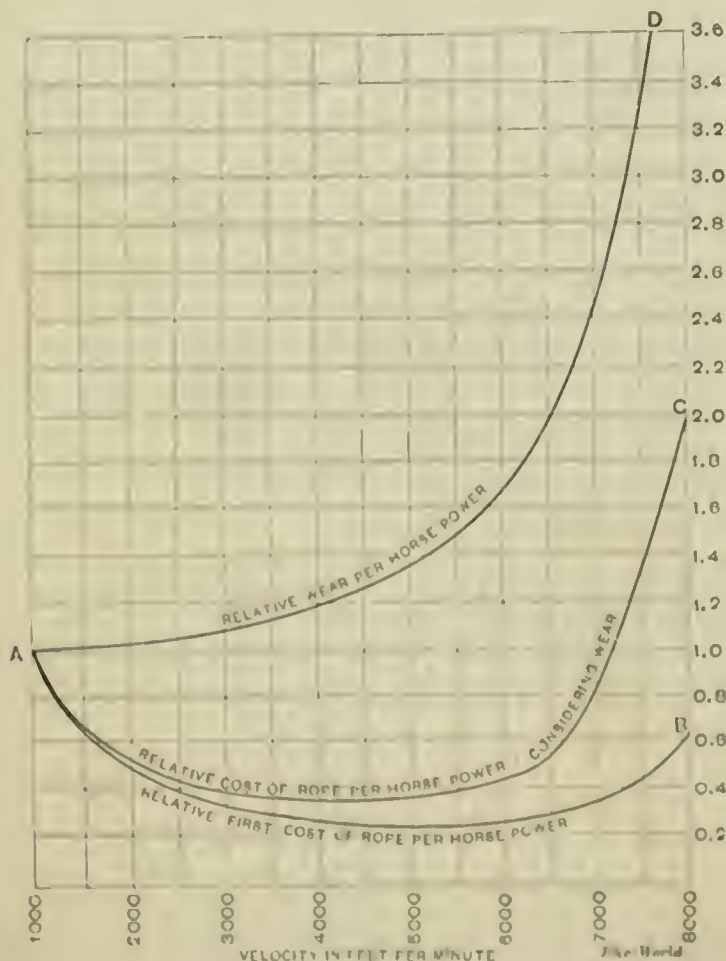


FIG. 32.—RELATIVE WEAR AND COST OF ROPE PER H. P.

mitted at different speeds multiplied by the inverse ratio of the corresponding speeds. To ascertain the relative wear per horse power of a rope running at any given speeds, it will only be necessary to form a ratio between the values in the table corresponding to the given speeds. Thus, the wear per horse power at 5,000 feet per minute, as compared to that at 2,500 feet, will be $\frac{1.34}{1.06} = 1.26$.

In the same way the relative cost per horse power of a rope running at these speeds will be $\frac{.36}{.45} = 0.8$; or 20 per cent. less for the greater speed. The accompanying diagram, Fig. 32, represents these relative values graphically, to which is added the curve of relative first cost. It will be noticed that although the first cost of a rope is a minimum for a speed of 5,500 feet per minute, when wear is considered the minimum cost occurs at a speed of 4,500 feet per minute. (To be continued.)

The Calculation of Alternating Current Motors.—VII.

BY E. ARNOLD.

THE BEHAVIOR OF A MULTIPHASE MOTOR WHEN THE ARMATURE IS IN MOTION.



HE armature is supposed to turn with an angular velocity p_2 , when the difference between the angular velocities of the primary field and the armature (or the amount of slip) is

$$= p_1 - p_2.$$

We now refer again to Fig. 9 and the general equation (49) applicable to a rotary field, which reads

$$E_1^2 = \left[R_1 I_1 + \frac{s_2}{2} p_1 M I_2 \cos \phi_2 \right]^2 + \left[\frac{m}{2} p_1 L_1 I_1 - \frac{s_2}{2} p_1 M I_2 \sin \phi_2 \right]^2.$$

The E. M. F. induced in one phase of the armature is now

$$E_2 = \frac{m}{2} (p_1 - p_2) M I_1.$$

This induced E. M. F. is balanced by two E. M. Fs.:

(1) The E. M. F. expended in overcoming the resistance R_2 being equal to $R_2 I_2$. (2) The E. M. F. induced by the secondary rotary field. The angular velocity of this rotary field relative to the armature is $= p_1 - p_2$; therefore

$$E_k = \frac{s_2}{2} (p_1 - p_2) L_2 I_2.$$

If we form a triangle of these three E. M. Fs., and remember that E_k is perpendicular to $R_2 I_2$, and that the angle opposite $E_k = \phi_2$, and abbreviate by letting

$$r = \sqrt{R_2^2 + \frac{s_2^2}{4} (p_1 - p_2)^2 L_2^2},$$

it follows from the figure that

$$\left. \begin{aligned} \cos \phi_2 &= \frac{R_2}{r} \\ \sin \phi_2 &= \frac{s_2 (p_1 - p_2) L_2}{2 r} \\ I_2 &= \frac{m (p_1 - p_2) M I_1}{2 r} \end{aligned} \right\} \quad (71)$$

Putting these values in equation (49), and for the sake of brevity letting

$$\begin{aligned} N &= \frac{m^2}{4} p_1^2 R_2^2 L_1^2 + \frac{s_2^2}{4} (p_1 - p_2)^2 R_2^2 L_1^2 \\ &\quad + \frac{m s_2}{2} p_1 (p_1 - p_2) M^2 R_2 L_1 \\ &\quad + \frac{m^2 s_2^2}{16} p_1^2 (p_1 - p_2)^2 (M^2 - L_1 L_2)^2, \end{aligned} \quad (72)$$

then

$$I_1^2 = \frac{E_1^2 r^2}{N}. \quad (73)$$

The torque is equal to the work done on the armature divided by the difference between the angular velocities p_1 and p_2 .

$$D = \frac{s_2 R_2 I_2^2}{2 (p_1 - p_2)} = \frac{m^2 s_2 (p_1 - p_2) M^2 I_1^2 R_2}{8} \quad (74)$$

* For last section of this article see The Electrical World of Feb. 10.

or

$$D = \frac{m^2 s_2 (p_1 - p_2) M^2 E_1^2 R_2}{8 \Lambda} \quad (75)$$

Substituting the value of Λ , gives

$$D = \frac{m}{2} \frac{l^2 (p_1 - p_2) E_1^2 R_2}{p_1^2 R_2^2 \frac{L_1 m}{L_2 s_2} + (p_1 - p_2)^2 R_1^2 \frac{L_2 s_2}{L_1 m} + 2 l^2 p_1 (p_1 - p_2) R_1 R_2 + \frac{m s_2}{4} l^2 L_1 L_2 p_1^2 (p_1 - p_2)^2 (1 - l^2)^2} \quad (76)$$

When $p_2 = 0$, this equation agrees with equation (51).

If we put the leakage = 0, or $b = 1$, and divide numerator and denominator by $(p_1 - p_2) R_2$, the denominator will have the following value:

$$\frac{p_1^2}{p_1 - p_2} R_2 \frac{L_1 m}{L_2 s_2} + (p_1 - p_2) \frac{R_1^2}{R_2} \frac{L_2 s_2}{L_1 m} + 2 p_1 R_1.$$

This expression becomes a minimum, or the torque a

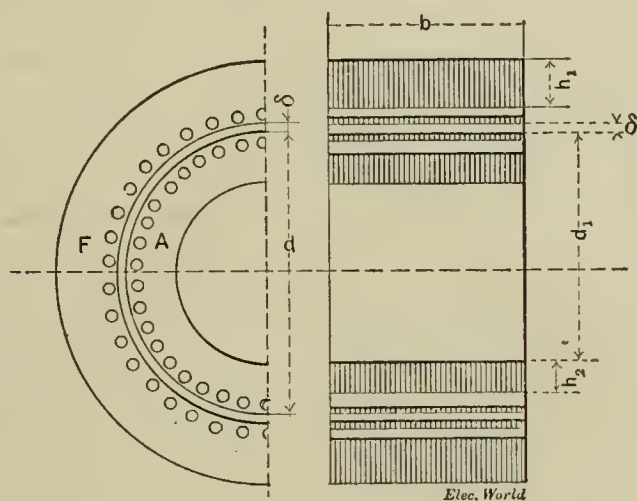


FIG. 16.

maximum, for a certain ratio of $L_1 : L_2$, or for a transforming ratio

$$\frac{s_1}{z} = \sqrt{\frac{p_1 - p_2}{p_1} \frac{s_2}{m} \frac{R_1}{R_2}} \quad (77)$$

The E. M. F. induced in the secondary winding is

$$E_2 = (p_1 - p_2) M I_1 \frac{m}{2} \quad (80)$$

This value substituted in equation (74) gives, when K represents half the number of poles,

$$D = \frac{s_2}{2} \frac{K E_2^2 R_2}{(p_1 - p_2) [R_2^2 + \frac{s_2^2}{4} (p_1 - p_2)^2 L_2^2]} \quad (81)$$

The term $\frac{s_2^2}{4} (p_1 - p_2)^2 L_2^2$ can be neglected in practical cases, as the self-induction L_2 of the armature, and the slip, $p_1 - p_2$, are small. Representing the mean secondary E. M. F., $E_2 : \sqrt{2}$, by $\bar{E}_2$, we have

$$D = \frac{K s_2 \bar{E}_2^2}{(p_1 - p_2) R_2} \quad (82)$$

The output of the motor in watts, which we represent by W , is

$$W = \frac{p_2}{K} D,$$

or

$$W = \frac{s_2 \bar{E}_2^2}{R_2} \frac{p_2}{p_1 - p_2} \quad (83)$$

Letting v represent the slip, so that, for instance, for two per cent. slip $v = 0.02$, we shall have

$$p_2 = p_1 (1 - v), \quad (84)$$

and

$$W = \frac{s_2 \bar{E}_2^2}{R_2} \left(\frac{1}{v} - 1 \right). \quad (85)$$

The secondary E. M. F., $\bar{E}_2$, can be easily found from the dimensions and winding of the motor when the primary E. M. F. is given.

In Fig. 16 F represents the iron core of the field and A that of the armature.

Furthermore, let

 $\bar{E}_1 (= E_1 : \sqrt{2})$ be the mean primary E. M. F. per phase.
 B , the intensity of the rotary field per square centimetre in the air space δ (Fig. 16).

 b , the width in centimetres of the iron of the inductor and the field.

 d , the diameter in centimetres of the inductor.

 n_2 , the number of revolutions per minute of the motor.

 K , the number of pairs of poles.

 Λ_1 , the number of wires per phase on the inner circumference of the field.

 Λ_2 , the number of wires per phase on the circumference of the inductor.

For ring winding,

$$\Lambda_1 = s_1; \Lambda_2 = z.$$

For drum winding,

$$\Lambda_1 = 2 s_1; \Lambda_2 = 2 z.$$

The circumferential velocity of the rotary field per second is

$$\frac{p_1 d}{2 K} = \frac{\pi n_1 d}{K}.$$

Then

$$B = \frac{b_1 K \bar{E}_1 10^3}{2.22 n_1 d v \Lambda_1} \quad (85)$$

and

$$\bar{E}_2 = b_2 \frac{2.22 n_1 d}{10^3 K} b B \Lambda_2 v; \quad (86)$$

or

$$\bar{E}_2 = b_1 b_2 \frac{\Lambda_2}{\Lambda_1} \bar{E}_1 v. \quad (87)$$

(To be continued.)

Flying Machines.

Although electric power was thought to be of advantage in solving the problem of flying machines, yet it seems that the apparatus of Mr. Lilienthal, of which some interesting instantaneous photographs are reproduced in "Cosmos," Feb. 4, enables a man to fly without the use of any power but that of the wind. He has successfully flown down from the top of a hill and has during his flight even risen higher than the starting point, using the wind for power. From his description, it looks as if the coming sport for young men will soon be the use of such machines, quite a little dexterity being required to keep up the proper balance. They consist simply of a pair of large fixed wings and a large tail, there being apparently no power used but that of the wind and the balancing of the body. His experiments seem to disprove some of the theories formerly held. Some time ago we reported that an electrically driven trolley balloon is to be used to convey visitors to and from the coming Antwerp exhibition.

Very Long Distance Telephony

In a somewhat speculative conclusion of a recent paper, Mr. Preece mentioned the effects of an aurora on telephone circuits and stated that it was not a wild dream to say that we may hear on this earth a thunderstorm in the sun.

Gas vs. Steam Engines.

The reports of the installations in Germany show that the number of private installations driven by steam engines were reduced by more than 50 per cent. during one year, while those run by gas engines increased at about the same rate, and there are now more than twice as many of the latter as there are of the former.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE
PRINCIPAL FOREIGN
ELECTRICAL JOURNALS.
BY CARL HERING.

NOTE.—Owing to the crowded condition of this department the following changes will be made, the object being to enable more space and attention to be given to abstracts of articles and papers of a more important nature. Almost every issue of each of the foreign journals contains descriptions and data, often with illustrations and tables, of local central stations and isolated plants; unless they appear to be of special interest they will not be noticed hereafter. References to descriptions of steam and gas engines, boilers, fuels, etc., and all other subjects not belonging under the heading of electricity and magnetism, will in general be omitted. The *Siemens* monthly "Journal Telegraphique" (in the French language) contains probably the best telegraph and telephone statistics of the world, and as this journal is doubtless accessible to those specially interested in this subject, references to such statistics and descriptions in that Journal will hereafter be omitted. Serials in the nature of a treatise on a subject will be noticed only once; this will apply also to papers which are continued in several issues and which are merely referred to in these columns as distinguished from being abstracted. When the same paper or article is reprinted or abstracted in several journals, only the first appearance will be noticed, except if the original is in a foreign language and the reprint is an English translation, in which case the references to the translation will also be given, as usual. Very good abstracts, generally longer than can be given here, are published in the monthly journal of the Institution of Electrical Engineers (London), and in the Proceedings of the Institution of Civil Engineers (London), which abstracts will be noticed only in case the original article has not been mentioned in these columns.—C. H.

ELECTRO-PHYSICS.

High Frequency.—In referring to a recent article by Lieut. Patten for obtaining high frequencies by means of generators, the Lond. "Elec. Rev.," March 9, states editorially that if an electromagnetic frequency equal to that of the vibrations of light could be set up by a generator the waves would then be light waves, but that at frequencies considerably less than these all conductors of electricity become perfectly opaque and electricity at such frequencies could not pass through copper wire; although such frequencies could probably be obtained, the currents could not be distributed by any known means; it is therefore concluded that in such a system the high frequency must be produced at the point where the light is required, and it is therefore not a generator which is wanted, but a converter of frequencies; it should be remembered that electromagnetic waves of any frequency can pass freely over space or through insulators.

Propagation of Electricity in Conductors.—*La Lum. Elec.*, March 3, publishes at some length a mathematical article by Mr. Blondin.

Parallelogram of Forces.—The "Elek. Anz.," March 4, contains another article by Mr. Schwartze, in which he attempts to prove that the usual conception of the parallelogram of forces is entirely wrong.

Transformation of Electric Currents.—Prof. Thomson's recent lecture is abstracted and criticised in "Ind. and Iron," March 9, where some interesting analogies are illustrated by simple diagrams.

MAGNETISM.

Density and Magnetomotive Force.—Under this heading the "Elek. Zeit.," March 1, abstracts briefly the article on page 146 in *The Electrical World*, Feb. 3; the editor believes to have found an error and claims that the formula for the magnetomotive force is wrong, as the value should have been multiplied by the length of the coil, from which corrected formula he deduces the dimensions of the quantities, showing that the dimensions of the magnetomotive force are the same as those of the electric current. (The author of the

original article discussed the formulas as they are often given, and they are doubtless correct; the editor's mistake lies in deducing dimensions of a quantity from a formula which does not contain all the quantities found in its dimensions, owing to the fact that they are equal to unity; the original formula for the magnetomotive force, for instance, is for that which is generated in one centimetre of length, which factor, length, therefore, does not appear in the formula, although it belongs in the expression of the dimensions. That the author did not commit an error is shown in the original article, in which he also introduces the factor length, in his proof. It might be said, without committing any error, that magnetizing force is magnetomotive force per unit of length, in which case there is no ambiguity between the two formulas, provided the proper distinction is made between the total number of ampere turns and the number per unit of length.)

Earth's Magnetism.—In the "Elek. Echo," Feb. 17, Mr. Kutschera endeavors to explain the earth's magnetism by assuming currents in the earth's crust running from east to west; he gives a chart showing the calculated and observed directions along an earth's meridian; he assumes that these earth currents are generated as they would be in a dynamo, assuming the sun to be the source of the field magnetism; the results are somewhat elaborately worked out.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Electro-Dynamometers Used as Wattmeters.—*"L. Elec."*, March 3, contains the conclusion of Mr. Meylan's article, the first part of which was abstracted in the Digest March 10. He discusses the errors due to the self-induction of the fine wire coil; the results only of his deductions can be given here. In such a wattmeter it is the impedance and not the ohmic resistance on which the shunt current depends; he gives the usual formula for the impedance, in which the quantity representing the self-induction is constant only for torsion wattmeters (that is, those in which the two coils are always at right angles); in those in which there is a deflection, the self-induction varies with the position of the coil. If the shunt must be negligible compared with the resistance; he deduces current is to represent the voltage, the reactance ($2\pi f \div T$) a formula, giving the value of the coefficient of self-induction, which must not be exceeded in order that the error in the measurement does not exceed a given amount; for instance, for 300 ohms resistance, a frequency of 125 and an error of 1-2 per cent., the coefficient of self-induction, as found from his formula, will be 0.383 henry; there are no great difficulties in making an apparatus to satisfy these conditions for 100 volts, but below 50 volts it is difficult and even impossible. He then discusses the case where the apparatus consuming the energy produces a difference in phase; in this case if there is absolutely no reactance, the shunt current will have the same phase as the voltage, and the mechanical couple will then be proportional to the true watts; he discusses the case in which the shunt coil produces a lag and shows that when there is no lag in the external circuit the wattmeter measurements are too small, as in a voltmeter; if the lag in

the external circuit is positive and less than half that in the coil, the error is negative, if they are equal it is zero, and if the former is greater it is positive; no matter how small the lag in the shunt coil, therefore, the error may become very great if the lag in the external circuit is very great; a given apparatus can therefore be used only between certain limits, for the calculation of which he gives the formula; he shows that in certain cases, as, for instance, with condensers, choking coils, etc., such a wattmeter cannot be used; with his formula the limits of any wattmeter can be determined; he reduces this formula to the form of curves which facilitate its application; in conclusion he states that good wattmeters may be made of electro-dynamometers for measurements in which the voltage lags behind the current, when this lag is not too great, but that under these conditions the apparatus must be constructed strictly to meet the requirements.

Photometers.—An Institution paper read some time ago by Messrs. Barr and Phillips is reprinted in the Lond. "Elec.," March 9. A number of papers are discussed, and it is shown that the eye is the only suitable method of measurement. A diagram is given for selenium grids showing the inconstancy of their resistance ratio, which falls very appreciably and in an erratic manner, in the course of a number of weeks after they are prepared. A number of substances are mentioned by which light may be measured by its actinic effect, among which are the formation of hydrochloric acid by the action of light on a mixture of its constituents, a method by which curves have been plotted which are used in photography; the most promising effect, they claim, is the mechanical expansion of chlorine gas upon exposure to light, an effect which is entirely independent of heating, and the gas recovers its volume upon darkening; this they think is the only known direct mechanical effect of light. In discussing photometers they give a diagram of the percentage errors of the most generally used photometers, from a large number of experiments made under the direction of Prof. Ayrton; the small star spot screen is shown to be the most efficient of all, the percentage error being about 0.35, while for a large grease spot the error is nearly 1 per cent.; the star screen is made by cutting a star out of the centre of two sheets of stiff white paper and pasting the papers from which they are cut together, with a semi-translucent paper between them. In conclusion, they suggest two principles for photometers; in one a cylinder is filled with carbon monoxide and chlorine, which upon exposure to white light is changed into carbonyl chloride, during which process the volume is reduced to one-half; a manometer gives a magnified indication of the pressure, the heat effects being compensated. In the second method two selenium screens are used, the object being to eliminate any variations of the selenium; they are arranged in differential circuit with a differential galvanometer, both being exposed to the standard in succession, the deflections being made equal by adjustable resistances; when both are exposed to the same light there will be no deflection; two lights may then be compared by moving one or the other until no deflection is obtained, a galvanometer deflection indicating simply a difference between the two illuminations; this requires that the grids remain constant only for a moment at a time. In an editorial attention is called to the recent researches of Abney and Festing, showing that when two surfaces are illuminated to an equal brightness with red and green light respectively, and if the light is then diminished in the same ratio, the two surfaces no longer have the same brightness as judged by the eye.

Photometry of Projectors.—"L'Ind. Elec.," Feb. 25, contains an article giving in detail the principal parts of a recent paper by Mr. Fery, abstracted in the Digest Jan. 20; in it he shows that for a perfect projector the illumination remains constant up to a certain distance, after which the law

of the inverse squares applies; a diagram of the intensities at different distances is given (it resembles roughly a steam engine indicator diagram for a cut-off at one-third stroke); a table is given of the calculated and observed results, showing an approximate agreement (although the error in some cases is over 50 per cent. of the observed value); simple formulas and an example are given, no account being taken of reflection and absorption; it concludes that the figures given regarding the Chicago searchlight are not wrong; it is believed that all confusion could have been avoided if strictly scientific language had been used. In "La Lum. Elec.," Feb. 24, Mr. Fery replies to a recent article by Mr. Guilbert, abstracted in the Digest Feb. 24, correcting some statements made therein; he states that the cross-section of the beam passes through a minimum, the illumination at that point passing through a maximum; this maximum point is at about 100 times the true focal distance from the apparatus.

Locating Faults in Street Mains.—In the Lond. "Elec.," March 9, Mr. Collis illustrates and describes a simple method in which a bare wire is laid in the street above the faulty main, insulated from the earth and connected at the ends to the faulty section; a current is passed through the main, and therefore a shunt current will pass through this wire; by grounding one end of a galvanometer and moving the other end over this wire, the fault will lie below the point at which a balance is obtained; the arrangement is an ingenious adaptation of the Wheatstone bridge principle, no calculations being required.

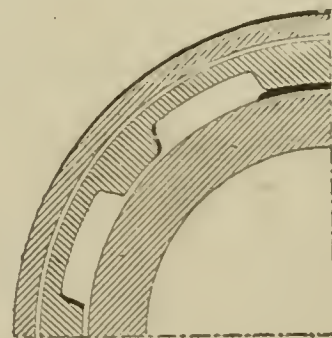
Liquid Rheostat.—"La Lum. Elec.," March 3, describes and illustrates the Hirschmann rheostat, consisting of a liquid in a rubber tube, which may be compressed more or less by means of a screw.

Humphrey & Green's Meter.—"La Lum. Elec.," March 3, publishes a well illustrated description; a movable and a fixed piece of iron in a series coil measure the currents, which are registered periodically by another solenoid operated by clockwork.

Theory of Units.—The paper mentioned in the Digest, March 17, is reprinted in "La Lum. Elec.," March 3.

DYNAMOS AND MOTORS.

A New Alternator.—An alternator of novel construction made by a Swiss firm is illustrated in the Lond. "Elec.," March 9. The field, which is stationary, is made of a cast steel ring, having a U-shaped cross-section containing a single coil; between the two annular poles revolves a cast steel ring (apparently not laminated), having a number of projections, which nearly fill the space between the polar surfaces, as shown in the adjoining figure; the armature coils are fixed on the stationary part, there being twice as many as there are projections; the only movable parts are the shaft



A NEW ALTERNATOR.

and the cast steel notched ring; a very high peripheral speed is obtained and the mechanical strains on the coils are obviated; it is said to suppress completely all magnetic leakage and that the excitation requires about one-sixth of the energy that other alternators do; a 275-kilowatt alternator absorbs but three-tenths of 1 per cent. and the variation between no load and full load is less than 20 per cent.; the in-

ternal resistance is very low, owing to the high magnetic densities used, the armature self-induction is weak and the machines are very easily worked in parallel.

Alternators in Parallel.—In a correspondence to the Lond. "Elec. Eng.," March 9, Mr. Metzger discusses the practicality as distinguished from the possibility of running alternators in parallel; he finds that the system of having many circuits any of which can be switched on to any machine is much more reliable than coupling alternators in parallel; he believes that the engineers in charge of stations in which alternators can only be run in parallel would prefer either of the other systems; such engineers do not design their own stations and the designers do not have the responsibility of a heavy winter's run.

Starting Shunt Motors.—Mr. Baumgardt in the "Elek. Zeit.," March 1, refers to a previous article abstracted in the Digest Jan. 6, in which he stated that in order to make the starting resistance as small and cheap as possible, the starting current should be taken as large and as constant as possible; he states that if the starting current is approximately constant, a shunt motor will start with a nearly constant acceleration: he discusses at some length all the factors involved in the starting of a motor and in conclusion gives a calculated curve for the relation between the starting time and the accelerated speed.

Theory of Non-Synchronous Motors.—A serial of a mathematical nature by Mr. Arnold is being continued in the numbers of the "Zeit. fuer Elek.," it appears to contain somewhat more than his recent article in The Electrical World on the same subject.

Electric Motors in Factories.—The Lond. "Elec. Rev.," March 9, describes the installation of motors at the Henley telegraph works, giving a full-page illustration of the switch-board and its connections, the illustration being given also in the Lond. "Elec. Eng."

Application of Motors.—In Mr. Richard's well-illustrated serial in "La Lum. Elec.," March 3, are given descriptions of traveling cranes, elevators, fans and other devices.

Patin & Levasseur Dynamo.—An illustrated translation of the description of this machine, mentioned in the Digest March 17, is given in the Lond. "Elec. Eng.," March 9.

ARC AND INCANDESCENT LIGHTS.

Illumination.—Dr. Cohn's article, mentioned in the Digest last week, is abstracted more fully in "La Lum. Elec.," March 3; besides what was given in the former abstract, the following may be of interest: The Hrabowski reflector is described for an overhead arc lamp; it resembles an inverted dishpan with a slightly concave bottom; the upper part is a simple diffuser painted white, while the sides, which are slightly convex inward, are made of wire, coated with a white substance; a small concave opal glass shade is placed below the lamp and a glass ring with a prismatic cross-section is placed around the lamp just below the level of the arc; a sectional diagram, which is not very clear, is given; the disposition of the parts is such that 30 per cent. of the light is reflected directly from the upper part, 42 per cent. passes through the glass prism and is refracted and reflected from the white wires, and the 10 per cent. falling on the hemispherical globe below is partially transmitted and partially reflected on to the upper reflector; 10 per cent. is lost in the glass prism. Measurements showed that in a lecture hall 12 gas lamps over the table gave 17 metre candles, 10 incandescent lamps at 50 volts and 25 amperes gave 18 metre candles, from a mean of 20 measurements an arc lamp with this reflector gave 37 metre candles and a simple arc lamp 16 metre candles; directly below a bare arc lamp he found 17 metre candles, while with this reflector it was 42 metre candles. In another measurement he showed that there was practically no loss by using a reflector (which signifies that the gain of

the rays usually lost is equal to the loss in the reflection); the reflector costs as much as the arc lamp. A reflector for side arc lamps in the upper corner of a room is also described, and consists of two reflectors with straight sides shaped like the frustum of a cone open at the large end; the large one is placed in back of the lamp and has a diffusing reflector, while the smaller one is placed in front of the lamp and acts both as a partial transmitter and a partial reflector; the former is placed eccentrically with the lamp; one-half of the light is reflected once and the other half is partially transmitted and partially reflected twice; the whole apparatus resembles a large luminous body illuminated nearly equally; at 1.7 metres from the lamp he found 11.6 metre candles, at 4.1 metres he obtained 7.8 metre candles, and at 10 metres 1.3 metre candles.

An Early Incandescent Lamp.—The "Zeit. fuer Elek.," March 1, reprints an article by Mr. Jona from the Italian, in which he quotes from a sort of patent granted to Brusotti Ferdinando di Rosasco, dated Nov. 30, 1877; it describes a lamp in which a refractory material is heated to white heat by being in contact with a conductor; he speaks of the conductor having a small cross-section and great length; for the conductors he suggests metals and for the refractory material calcium, magnesium, etc.; he recommends enclosing it in a glass bulb from which the air has been exhausted as much as possible; he recommends running the lamps in parallel; one of his lamps is still preserved by a society in Milan.

Lamp for Lantern.—The Borland arc lamp is illustrated in the Lond. "Elec.," March 9; it consists of two inclined carbons at the end of two levers, which are moved by two solenoids at the other ends of the levers; the cost is said to be considerably less than that of the usual limelight.

ELECTRIC RAILWAYS.

Heilmann Locomotive.—"L'Elec.," March 3, gives a diagram of the connection, which, besides what has already been stated in these columns, shows that the exciter current can be passed through the armature of the main generator, making it a motor, in case the steam engine stops at its dead point; there is no resistance between the generator and the motors; it appears that it takes four men to run the locomotive; the steam admission is constant, the variable quantities being governed by the speed of the machine; there is a hand governor. Diagrams are given of the profile and the speeds, which latter are also given in two full-page tables. In the data about the train it is stated that the locomotive is supposed to start and draw on a level 450 tons and over a curve of 125 metres radius; the maximum horse power of the engine is 800; the weight of the locomotive is 113 tons and the weight of the train 70 tons, making the weight of the train two-fifths of the total; at a speed of 45 kilometres per hour, the drawbar pull was 1,980 pounds and the horse power 150.

In an editorial in the Lond. "Elec. Rev.," March 9, the system is again discussed unfavorably; it is claimed that there is absolutely no value in the contention that such a portable engine will prove more economical than an ordinary locomotive, which can be compounded as well as the Heilmann engines; it is claimed that the principal point is whether it can be shown that with an electrical efficiency of 70 per cent. any engine can be designed for a traveling platform which will be as economical in fuel as a locomotive burning about 17 pounds of coal per mile; it is claimed that the steam locomotive is an economical running engine, and it is feared that the present attempt will tend to bring the advocates of electrical traction into contempt.

Liverpool Railway.—In the discussion of the two recent papers mentioned in the Digest last week, reprinted in abstract in "Ind. and Iron," March 9, Mr. Greathead called attention to the fact that the weight of the motor was only 20 per cent. of that of the train, while the steam locomotive of the London underground railway was 40 per cent.; the

tractive effort of the latter per ton of train was 71 pounds, as against 120 pounds of the former; the adhesion was 115 pounds of the electric motor, as against 61 pounds of the steam locomotive per ton of train; the pull was 738 pounds at Liverpool, 367 pounds on the City and South London line, and 234 pounds on the underground steam railway per ton of train, all of which are greatly in favor of having motor cars as against motor engines. The Liverpool overhead railway cost about \$450,000 per mile (presumably for the road alone).

Electric Vehicles.—An illustration of the Clubbe electric omnibuses, mentioned in the Digest last week, is given in "Ind. and Iron," March 9; it shows an ordinary parcel wagon with the batteries on a suspended train below the rear wheel axle and switches near the driver's seat.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Parallel Working of Long Lines.—The Lond. "Elec. Eng.," March 9, reprints in full an Institution paper by Mr. Mordey. The first portion is devoted to a reply to a recent statement by Prof. Forbes in his Niagara Falls paper, regarding the Mordey alternators; this is reprinted in full in another column. Regarding the "hunting" or regular pulsation of the current, he states that while it may have been caused by self-induction, he thinks the cause must be looked for elsewhere, as the effect of self-induction in his experiments would have been inconsiderable; he thinks the true explanation lies in the character of the resistance and in the governors of the engines; the change in the resistance of the filaments of incandescent lamps accounts largely for the pulsation; an indicator diagram supports the view that the governors of the engine must also be considered; such a diagram is given and consists of a very heavy black line for the descending curve, showing that the steam varied widely during the taking of the card. He described some tests made three years ago with a 25-kw. alternator used as a motor, which tests prove his assumptions in his reply to Prof. Forbes to be justified; other tests are described with a 50-kw. alternator as a motor, the object of which was to ascertain the effect of inserting resistance between two alternators, in one of which the motor ran without a load; the results are given in a table showing that as the resistance increased the current became unsteady, but there was no hunting; the results support the explanation as given, showing that a resistance of about thirty times a reasonable working amount had to be inserted before synchronism was interfered with; if the excitation of the motor had been raised above that required for the minimum armature current, it would be found that it would go out of step with a smaller external resistance than before. Other tests are described with a 25-kw. alternator used as a motor, which was loaded with a constant load, resistance being placed in the circuit between the alternators; even with a very large resistance steady running was obtained if there is sufficient difference between the volts of the generator and the motor; when the motor was loaded the steadiness improved with the addition of the line resistance; the idle current was very small; the relative lowering of the E. M. F. of a synchronous motor, he says, is a necessity in order to obtain good results in power transmission for long distances; the excitation of the motor must be lowered in such a case to give the right E. M. F. He describes some tests of two 100-kw. alternators to find whether they could be paralleled with a considerable resistance between them and their load; with a half load, a voltmeter across the load kept perfectly steady; with full load and 8 ohms in the circuit, there was a very noticeable but not violent pulsation in the synchronizing lamp, but at the load the pulsation was very slight; in another test the two machines were run in parallel with a load close to one of them, but separated from the other by 16 ohms, corresponding to a line loss of about 40

per cent.; there was a pulsation, but they showed no inclination to get out of step. In conclusion he gives some interesting analogies of alternators in parallel by comparing them with two steam engines which drive a common shaft by spur gearing, the teeth representing the successive waves of current; after referring to the operation of coupling when in step, he carries the analogy to the synchronizing abilities of various alternators, comparing alternators with unyielding fields to teeth with great stiffness and small armature reaction, while those with yielding fields to teeth of yielding elastic material, such as soft rubber; in conclusion he shows how unnecessary it ought to be to reduce the number of magnetic teeth or periods in order to get satisfactory and smooth driving, either singly or in parallel, saying that it was only in cases where the electrical spur wheels are so designed that the teeth cannot get in that a small number of periods can be of any service. The discussion is given briefly, but was apparently not revised, and will therefore not be abstracted until the revised report is published.

Fusible Cut-Outs.—In the first part of an article by Mr. Anney in "L'Ind. Elec.," Feb. 25, on the present conditions of electric wiring of houses, he proposes to criticise the apparatus used, in which he says very little progress has been made (presumably referring to French apparatus). The present section is on fusible cut-outs; after examining a number of the commercial forms, he states that they do not fulfill the requirements; he discusses the effect of the length of the fusible wire on the fusing current, for which he gives some experimental data; no rule seems to have been followed regarding the lengths nor the maximum voltage at the terminals; fuses should be constructed for a different length for each current; he proposes to use one length for 1 to 15 amperes and another for 15 to 30; the lengths of those examined were insufficient even for 100 volts, none of them being able to stand a short circuit without causing a persisting arc, the force of which was sufficient to explode the case; he discusses the effect of the terminal plates, claiming that to fasten the wire under a screw is very bad practice; round wires of more than about 120 mils in diameter should not be used; only bands should be used for high currents; to proportion wires for a constant amperage per square mil is wrong; for bands of a constant thickness, however, it is correct to increase the width in proportion to the current, which he proves by an experimental investigation; it should not be possible to place a large fuse in a holder for a small one; an important improvement is to arrange the fuses so that no metallic tools are required for their insertion; another improvement in three-wire systems is to have an insulating partition to prevent inserting the fuse between the wrong terminals; metallic covers should never be used.

Balancing a Three-Wire Station with One Machine.—In the Lond. "Elec. Rev.," March 9, Mr. Gibson replies to the criticism of Mr. Thursfield, which he claims is incorrect, as any current in the balancing wire could easily be dealt with in that battery by moving the discharge switches, only half the balancing current being required to be passed through the cells; the E. M. F., he claims, can be kept exactly equal, or, if necessary, slightly higher on the proper side.

Automatic Interrupter.—The Leconte interrupter is illustrated in "La Lum. Elec.," March 3; the contact is made by mercury in a retaining vessel, the bottom of which is held on by springs; a solenoid operated by a battery and a clock opens the bottom at a predetermined time allowing the mercury to run out and open the circuit.

Policy of Electric Supply Companies.—An editorial in "Ind. and Iron," March 9, calls attention to the importance of filling out the load diagram, but gives nothing new; it advocates special rates for work of such a nature as to preclude the possibility of any clashing with existing full load periods;

it believes that companies are not devoting as much attention to this as they ought to.

Train Lighting.—A translation of the article by Mr. Grawinkel on the lighting of the German postal cars is given in abstract in the Lond. "Elec. Eng.," March 9, with an illustration of the switchboard.

Rules and Regulations.—The rules adopted in the city of Rouen are given in "L'Elec.," March 3, and in abstract in the Lond. "Elec. Eng.," March 9.

Traveling Crane.—The Lond. "Elec. Eng.," March 9, publishes a working drawing of a 10-cwt. crane constructed in France.

Electricity on the Stage.—Lond. "Lightning," March 8, begins an illustrated article by Mr. Niblett on "Electricity in Stageland."

WIRES, WIRING AND CONDUITS.

Weight of Copper in Lines.—In the "Elek. Rund.," No. 11, Prof. Krebs discusses mathematically the relation of the weight of copper to the energy transmitted with continuous, and with one, two or three phase alternating currents, on the basis that in all of them there shall be the same amount of heating; the results are not given conveniently for abstracting; comparing one of them with that of Mr. Weaver in his article recently published in these columns, he obtains 5.83 for two-phase currents, for which Mr. Weaver, on the basis of equal losses, obtained 6.

Ferranti Cables.—"La Lum. Elec.," March 3, publishes some good illustrations; each wire is contained in a tube of an insulating material made of a longitudinal piece, which is wrapped spirally with another, leaving considerable air space between the wire and the tube, so that the wires may lie loosely therein; these tubes are then bunched together, being compressed into suitable shapes to make a cable of circular cross-section.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telegraph Cable in the St. Gothard Tunnel.—The Lond. "Elec.," Feb. 23, describes the cable and the laying of it, which was added a few months ago to those already in the tunnel; a cross-section of the cable is given; the conditions were unusually severe, the chief among them being the chemical influences, the uncommonly high temperature in the tunnel, and the danger of mechanical injury. The cable was made by Felten & Guilleaume and consists of 7 cables each of 7 strands, taped and tarred and enclosed in a double lead covering, which is again served with insulating material, over which are 25 peculiarly shaped wires, which interlock and form an extremely close and firm sheathing, which, though strong mechanically, is nevertheless flexible; this is covered with asphaltum, the outside diameter being 2 inches; the chief difficulty in the laying was in the making of the joints, owing to the moist state of the atmosphere in the tunnel.

Multiple Switchboards for Telephony.—The Lond. "Elec. Eng.," March 9, calls attention to a recently published pamphlet in German by Mr. Sack, the late director of the German telephone service, in which the three systems, Scribner, Kellogg & Mix, and Genest, are compared, the latter being considered the best; the illustrations are said to be sufficiently clear for those who cannot read the German language.

Duplex Telegraphy.—An illustrated report of the legal proceedings of Muirhead vs. the Commercial Cable Company is given in the Lond. "Elec.," March 9; also a brief editorial discussion; the report is published in the Lond. "Elec. Rev."

ELECTRO-CHEMISTRY.

Electrolysis of Alkaline Salts.—The Lond. "Elec. Rev.," March 9, discusses the electrolysis of the mixed electrolyte, stating that secondary actions of great importance and some quite unexpected ones are often observed in mixtures under

various voltages. In a note in the same issue on the electrolysis of alkali salts, it states that when secondary reactions take place preventing the continuous accumulation of these products of electrolysis, the E. M. F. required is determined almost solely by these secondary reactions, and if the result of the latter is the same as with alkali salts, the E. M. F. required for decomposition will practically be the same also, which has been shown by recent experiments, which, if confirmed, will obviate the necessity of assuming the primary decomposition of the water.

Theryc-Oblasser Accumulator.—The Lond. "Elec. Rev.," March 9, discusses unfavorably the recent favorable report of Dr. Fleming on this battery (see reference in the Digest Feb. 10; a perforated envelope of celluloid encloses the plates); the report is given, in which it is shown that 7.14 and 6.44 ampere hours per pound of plates was obtained when the discharge was 200 and 180 ampere hours respectively. The criticism claims that the tests are too few and too short to allow of any conclusion being drawn, the question of durability being the most important one; that the battery has a greater capacity than others is claimed to be incorrect; it is not believed that this battery is an advance over some existing and well established types; electricians and users have agreed for some time that the best type of battery in existence is based on the Plante process, and that the use of paste, whether compressed or not, must be considered as a retrograde step.

Rubber.—According to "La Lum. Elec.," Feb. 24, it has been discovered that cells containing caoutchouc are contained in plants in which it has not before been found; among them are the Wimmeria, Salacia and Plagioptron; large quantities of rubber trees have also recently been discovered in Madagascar.

Electricity of the Skin.—According to the "Elek. Echo," Feb. 24, Prof. Yarchanoff has shown that any irritation of the skin generates quite a perceptible current; the opening and closing of the eyelid also generates a noticeable current.

Thermo-Hydrometer for Accumulators.—The Lond. "Elec. Rev.," Feb. 23, mentions an instrument recently brought out by a London firm which consists of a combination of a thermometer with a hydrometer and intended to overcome the objection to the use of the latter alone, as it gives no accurate values of the strengths of solutions unless the temperatures are also determined. It mentions the rules which Mr. Preece has adopted in measuring the cells in his private installation, in which he uses a hydrometer in each cell and states that it is possible and easy to indicate with absolute accuracy to 1 ampere hour (apparently of a 330 ampere hour cell) the quantity of charge which has been taken out of a cell and the quantity which remains in it.

Electric Galvanizing.—"Ind. and Iron," March 2, contains a plan and elevation of a plant on the Cowper-Coles system; the diagrams simply show the four tanks with a revolving crane placed in the centre between them. In hot galvanizing the thickness of the zinc can be varied only within very narrow limits, while in the cold process it can be varied from a few grains per square foot to 1 1-2 ounces; another advantage is that the surface is much smoother, rendering iron plates more suitable for the hulls of fast vessels. A table is given for the various deposits, from which it appears that for the extremes of 1-2 ounce and 2 ounces of zinc per square foot, the thickness is 0.861 and 3.444 mils and the time of immersion 5 and 20 minutes respectively.

Improvements in Leclanche Cells.—Mr. Wolff in the "Elek. Zeit.," March 1, describes an improved form, in which the carbon electrode is made of a porous carbon cell, in which the inner filling may be replaced; it is much wider at the bottom, making a sort of shelf half-way up, on which is a porcelain ring supporting the zinc, which is made in the form of a cylinder of sheet metal. For the solution he gives

the formula 84 grams salammmoniac, 24 grams kitchen salt and 42 grams of a 50 per cent. solution of zinc chloride, the latter being made by dissolving an excess of zinc in hydrochloric acid and diluting the resulting solution until it has a specific gravity of 1.52, representing a 50 per cent. solution; the object of this is to prevent the crystals from adhering to the zinc; the object of the kitchen salt is to prevent creeping salts from forming; in place of the zinc chloride a little hydrochloric acid may be added to the cell when it is first set up.

Purification of Sewage.—The tests at Worthing are described in "Ind. and Iron," March 2; the unfavorable report recently published is not confirmed by these experiments, which bear out the favorable view; the apparatus consists of revolving zinc discs as negative electrodes and rods of brass wrapped with platinum gauze as the positive terminals; 300 amperes at 6 volts are used; the circulation continues until there is 0.5 grain of free chlorine per litre; galvanized iron is employed for tanks and pipes, in which a coating soon forms which protects the metal; great uncertainty seems to exist in regard to the cost of connecting the dwelling houses with the supply pipes. According to an abstract in the Lond. "Elec. Eng.," March 2, Mr. Hermite said that the solution could be brought to the houses for 25 cents per head per annum, allowing 9 gallons per head (per day?), sufficing not only for flushing purposes but also for washing floors.

Galvanoplastic Bath.—The Thofehn bath is illustrated in "La Lum. Elec.," March 3; the liquid is kept in circulation by a pump and an elevated tank.

MISCELLANEOUS.

Electricity in Plants.—"La Lum. Elec.," March 3, calls attention to the fact that in all fruits an electric current can be noticed between the eye and the stem, also between other parts of plants, and it suggests that besides using the electric light in plant culture it might be possible to decompose the chemical products in the soil by an electric current, thereby producing fruits and flowers of greatly increased size.

Reproduction of Diamonds.—In an Academy paper by Mr. Moissan, reprinted in "L'Elec.," March 3, he reports that he obtained better results by utilizing bismuth instead of iron and immersing it in liquid lead, but even then the crystals were very small; some of the diamonds were striated like some natural diamonds.

Lightning.—In the "Zeit. fuer Elek.," March 1, Mr. Larden describes a peculiar freak of lightning during an ascension of the Matterhorn, a prominent mountain of the Alps.

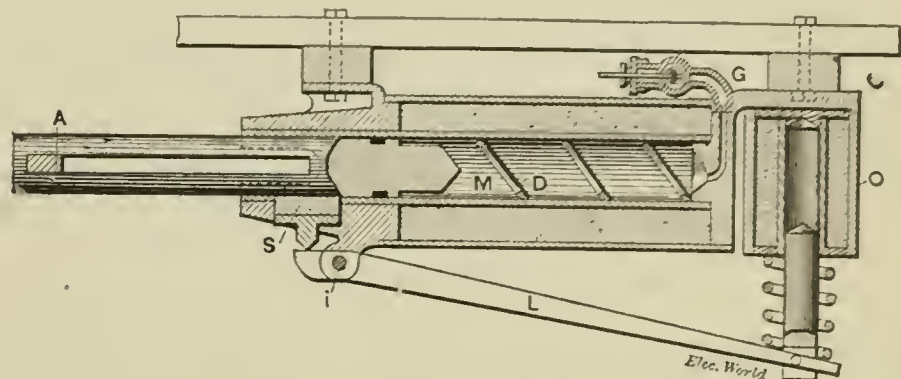
Aluminium.—According to "La Lum. Elec.," March 3, the Neuhausen factory has reduced the price to 5 francs per kilogram (equal to 44 cents per pound), which, it is said, brings the price down to that of an equal volume of the usual metals.

An Electric Brake.

The electric brake we illustrate, the invention of E. B. Skinner, Ogden, Utah, is intended by its inventor for general railroad and street railway work. Special features claimed for it are that an arrangement is provided whereby the brake shoes are held pressed against the wheels after the brake is set, thereby dispensing with the continuous application of the electric current; for street railway work where the trolley system is used the hand brake can be promptly applied in case the current from the trolley should fail from any cause, both the electric and hand brakes being adapted to operate the same set of shoes.

Referring to the figure, the brake is shown released. To set the brake, a current through the solenoid *O* raises the lever *L*, releasing the pressure of the shoe *S*; a current in

the solenoid *MD* then draws in the plunger and brake arm *A*, when the current is discontinued and the brake held by the pressure of the shoe *S* through the lever arm *L* by means of the spring *R*. To release the brake a current is sent through the solenoid *O*, which through the lever *L* releases

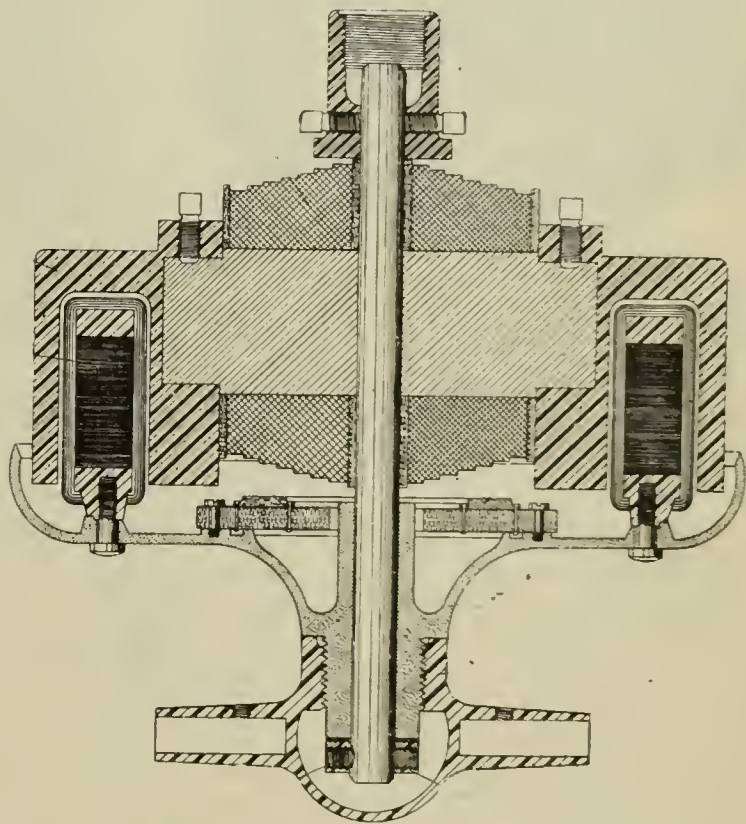


ELECTRIC BRAKE.

the shoe *S*, and the brake plunger is forced out by the spring *D*. *G* is an air valve. A special switch is used to govern these various operations.

A New Electric Fan.

A new electric fan, manufactured by the Dayton Fan and Motor Company, Dayton, Ohio, has a powerful field, and at the same time is so well proportioned and peculiarly arranged as to be very compact and unobtrusive. The small field coils are made possible by almost completely enclosing



IMPROVED ELECTRIC FAN.

the armature in the pole pieces, thus utilizing every possible square inch of air gap and reducing the magnetic reluctance to a very small amount. The pole pieces which thus enclose the armature serve another important purpose in forming a shell which completely covers the motor and which—finished in black enamel or cream and gold line—makes the motor of highly artistic and ornamental appearance. The stationary shaft is kept bathed in oil from the chamber, as shown in the cut. The results of this excellent designing will be shown in the following figures:

Voltage.	Speed.	Sweep of blade.	Width of blade.	Angle of blade.	Current
110	140	60 inches	8 inches	30 degrees	.9
220	148	60 "	8 "	30 "	.5
250	148	60 "	8 "	30 "	.45
500	172	60 "	8 "	25 "	.3

These fans are built regularly in windings to suit 110 or

220 volts direct, or 6 1-2—9 1-2 amperes arc, and of 250 volts, two to be used in series on a 500-volt circuit. A 500-volt fan which has been running in a street railway 500-volt power house for six months, only stopping when the plant was shut down, and in which the pressure varied from 450 to 650 volts, showed no traces of wear except for 1-4-inch of carbon dust and soot, and was as good as when started. The manufacturers state that they will not put their 500-volt fan regularly on the market until after a season's experience with lightning storms in various parts of the country to demonstrate the capacity of its necessarily delicate wires, should the lines be struck.

New Quick Break Switches.

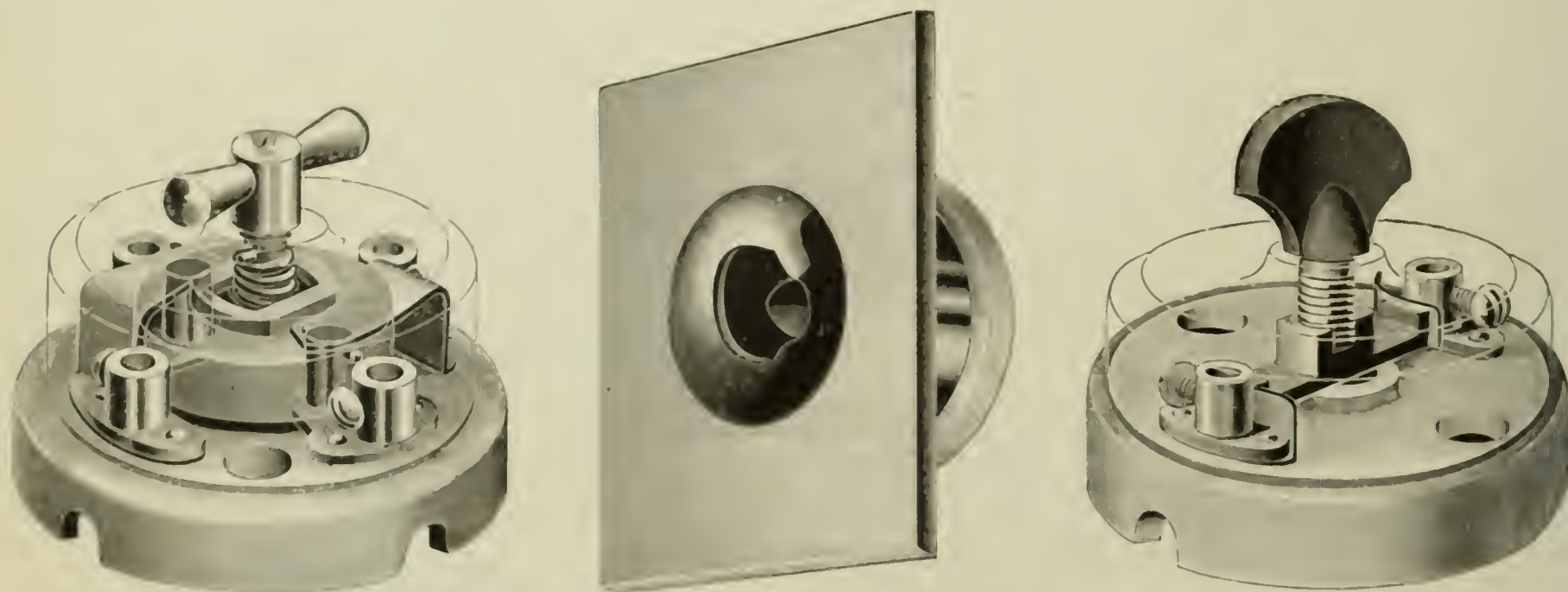
We illustrate several forms of the Gibbs switch, manufactured by the Perkins Electric and Manufacturing Company, Hartford, Conn., which is based upon an interesting

principle. Referring to Fig. 1 the stem of the handle has a screw thread and is connected by a spiral spring to the insulating block, in the centre of which a nut fits loosely. When the handle is turned the spring is put in tension and at the same time the nut is raised until it clears its lock in the base, when the insulating block revolves with great rapidity for a quarter turn; the nut then drops in its seat, where it is firmly held until the switch is again operated. The parts revolve in one direction only. The insulating block is fitted with two compact pins, passing entirely through the insulation and these are fitted loosely in their positions, so as to allow of automatic adjustment between the upper and lower spring copper brushes. When in contact the insulating block is free to move slightly in any direction, and cannot possibly bind the contact pins. All the parts are strong and not liable to give out, but to protect against any trouble, they are made absolutely interchangeable, and can be replaced in a moment should any breakage occur.

Fig. 2 represents the Gibbs flush switch for residence and office installations, which can be made to be operated only by keys, so that no one except duly authorized persons can have access to them. These latter are fitted with a spring lock, which fastens the flush plate to the cast iron box so that no one unprovided with a specially designed key can remove the plate to operate the switch, a provision peculiarly acceptable in insane asylums and other institutions. Another form of the Gibbs switch, the outside of which is made entirely of porcelain, is designed for specially fine or ornamental work, and in which the cover screws to the base. The working parts are the same as in the other types of Gibbs switches, and plain white porcelain is usually furnished ex-

The Burnley Cartridge Battery.

The battery we illustrate, manufactured by the Miamisburg Electric Company, Miamisburg, Ohio, is a modified form of Leclanche cell, having the containing jar and zinc rod, with a special form of porous cup. The porous cup or cartridge is



FIGS. 1, 2 AND 3.—QUICK BREAK SWITCHES.

made of specially prepared paperboard, with sufficient rigidity to withstand the necessary compression. The top of the cartridge is specially paraffined to resist the action of creeping salts. By this construction choking by the deposition of reduced salts within the pores of the cartridge, as is often the case with earthen cups, is avoided. The reduced salts as formed adhere to the extremely fine shreds always present on paper, and having a flimsy support soon drop by their increased weight to the bottom of the jar. Extended practical experience has proved that the paper composing the cartridge will not slough off, but remains as firm in texture after two years' use as it was after the first two hours.



CARTRIDGE BATTERY

The internal arrangement of the depolarizing compound of carbon and manganese surrounding the negative electrode is such as to utilize all the oxygen present in the manganese, and thus a smaller bulk of this material can be used, thereby reducing the size of the cell, while maintaining its efficiency as compared with other forms of cells. It is claimed that by this arrangement of the depolarizing material the cell is enabled to keep up a more constant E. M. F. than with other forms of Leclanche cells, while its life is equal to the best of the latter.

The novel construction of the cartridges is such that they are only one-half the size of the ordinary porous cup, being 5 3-8 inches high and only 2 inches in diameter, permitting

the use of a small containing jar. The weight of the cartridge, filled and ready for use, is between 14 and 15 ounces, which is only one-third the weight of other porous cups. Being composed of a tough and fibrous paper, they cannot be accidentally broken, an important consideration and much in their favor, which, also, in connection with their small size and light weight, reduces transportation charges.

A New Telephone.

The telephone which was recently placed upon the market by the Western Telephone Construction Company, of Chicago, and which was illustrated in *The Electrical World* of March 10, is here shown more in detail. Reference to the accompanying illustrations will give an adequate idea of its construction and operation. The magneto generator is of

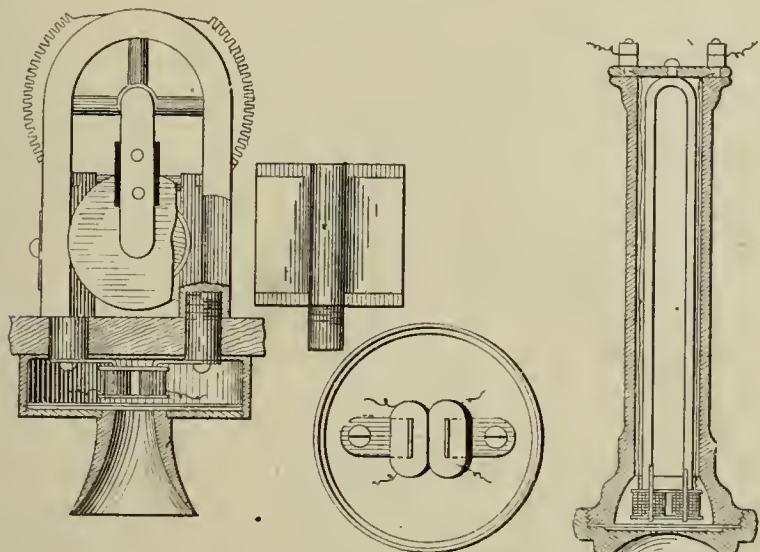


FIG. 1.—A NEW TELEPHONE.

the well-known type ordinarily used for signalling bells and telephone lines. The permanent magnets of the magneto generator are placed with the poles against the door or front of the enclosing case. The armature of the generator is surrounded, as is usual, with soft iron pole pieces which form the cylinder in which the armatures rotate. The disc, preferably of non-magnetic material, is adapted to cover the armature and support the axis upon which the armature rotates. Connected with the soft iron pole pieces are soft iron extensions projecting through the cover of the case and to

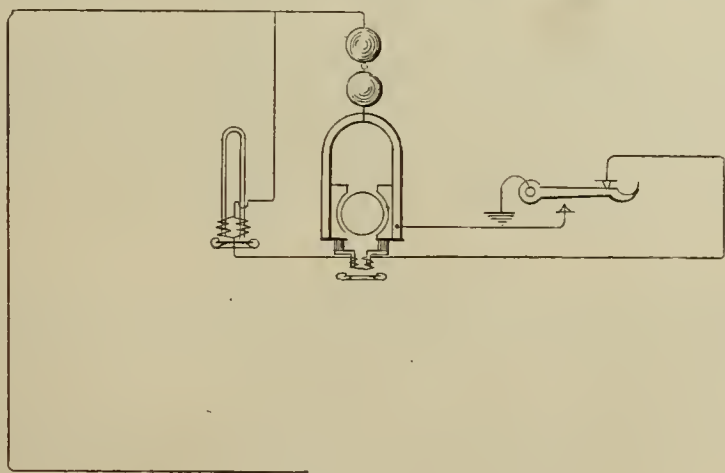


FIG. 2.—A NEW TELEPHONE.

these extensions are attached the angular soft iron pieces, upon the ends of which are wound the coils. The angular pieces are thus in magnetic connection with the permanent magnets of the magneto ringer. The ends of the angular pieces project through the coils and in close proximity with the diaphragm, which is rigidly supported at its periphery in the case, which is provided with a mouthpiece. The diaphragm is of the usual construction of soft iron.

The receiver is of ordinary construction, but instead of using a straight bar magnet, one of horseshoe form is employed. To the ends of this horseshoe magnet are secured

and riveted soft iron extensions, around which are wound coils of fine wire. The ends of these soft iron pieces are brought into close proximity with the diaphragm.

As will be seen from the diagram, Fig. 2, the line from the subscriber's outfit, or from one station of a private line, starting from the ground, passes through the contact point when the switch is down, thence through the ringer and out to the line to ground at the exchange or the other station, or back again to the starting point, in case of a metallic circuit. When the telephone is taken off the hook contact is made with the point, as shown, when the circuit is through the two coils of the transmitter, thence through the coils of the receiver, thence by line to the exchange or through station and back again, as before.

It has been found that the connection of the two coils of the receiver in multiple arc produces the best results and the construction of the telephone is such that it not only utilizes the permanent magnets of the ringer, which are usually powerful, but accomplishes the same results as an ordinary battery transmitter in a much more compact and convenient form.

The coils of the transmitter are connected in circuit in series so that double the voltage is secured that would be obtained were but a single coil used, or were the coils connected in multiple.

Many advantages are claimed for this form of construction, and the tests over both long and short distance lines have proved most satisfactory.

New Books.

DIE ELEKTRICITAETSWERKE, ZU KOELN UND AMSTERDAM. (Central Stations of Cologne and Amsterdam.) By Carl Coeper. Price, \$25.

This volume is by far the largest and most elaborately prepared work of the kind which has ever come to our notice. Its size is 15 by 22 inches, and the greater part of it consists of well executed, double-page plates on cardboard. As the title indicates, the volume describes the alternating current stations in the cities of Cologne and Amsterdam and the apparatus of the Helios Company, of Cologne, which erected these stations; this company represents in Germany the well known Austrian firm of Ganz & Co., whose apparatus is that devised by their engineers, Zipernowsky, Deri and Blathy, who were among the earliest workers in the alternating current field.

A full description of the stations is given in the text, together with a large number of illustrations. Besides the description and data of the stations, including tabulated information, load diagrams, etc., there is a chapter on the details, such as the transformers, meters, lamps, motors, switchboards, etc.; among the double-page plates are colored plans of the cities, showing the distribution; also external and internal photographic views of the stations, colored switchboard diagrams, a large number of views of the engines and direct driven alternators, etc.

A description of the Cologne station was published in our columns some time ago, and a number of these cuts, diagrams and tables were there given, further references having been given in our Digest, but those who are specially interested in central station work will find much new matter to interest them in this volume. These stations doubtless form two of the best of those on the Continent using the alternating current system. We have just been informed by the publishers that the English edition of this work has recently gone to press.

The author of the work, Mr. Carl Coeper, is the director of the Helios Company, who, although representatives of the firm of Ganz & Co., of Budapest, have made many important improvements entitling them to be included among the independent companies.

ELEMENTARY MANUAL OF MAGNETISM AND ELECTRICITY. Specially Arranged for the Use of First Year Science and Art Department and Other Electrical Students. By Andrew Jamieson, M. I. C. E. Third edition. London: Charles Griffin & Co., Ltd. 1894. 297 pages, profusely illustrated. Price, \$1.25.

This manual, we learn from the preface, has been written expressly for elementary and first year students, and while covering the elementary stage of the Science and Art Department examination, is yet intended to be sufficiently general for students who have not these examinations in view.

It seems to be an unfortunate necessity that compels British writers to conform to a government programme in writing their text books. From an author with the well-known practical accomplishments of Prof. Jamieson, we naturally expect a treatment far removed from the time honored academic methods which do not consider the object of the knowledge taught nor the relative weight of its different parts, and were he free from the handicap referred to, there is every evidence in the present work that we would not be disappointed. To illustrate what disadvantages an author has to labor under, and how students suffer from this system of official requirements for text books, it may be said that even after finishing the study of this book, the student would probably be unable to understand scarcely one of the important commercial applications of electricity. It may be said that such books are intended to merely teach the principles of electrical science and thus prepare the student to understand their applications, but a sufficient reply is that these principles should be taught as far as possible in connection with their practical applications, and not uniformly with reference to laboratory models and apparatus.

The practical bent of Prof. Jamieson is visible in many places, as where he illustrates an Edison-Hopkinson dynamo as an example of a short magnet; in the appendices, where practical directions are given to make numerous experimental apparatus, a compass, a detector galvanometer, an electric bell, shellac varnish, etc.; and in the fine type descriptions of commercial apparatus which he interpolates.

Most of the illustrations seem to be original, and in their suggestiveness are far superior to those usually seen in text books. The text is clear and to the point, and, as far as the limitations of the book seem to permit, makes use of practical illustrations to impress principles.

THE PRACTICAL ELECTROPLATER. A Comprehensive Treatise on Electroplating, with Notes on Ancient and Modern Gilding and Formulas for New Solutions. 298 pages, illustrated. New York: Emile Brunor. Price, \$1.00.

The external appearance of this volume is somewhat that of an edition de luxe of a literary work, which impression might be further borne out by the extra quality of paper upon which it is printed, the frontispiece portrait of the author, the tailpieces and wide margins were it not removed when we come to pages of advertising at the end of the volume.

Of the 298 pages of the book, 70 are given to electrotyping and perhaps as much more space to historical, personal and miscellaneous matters. The remainder of the work is devoted to the practical operations of electroplating, gilding, dipping and oxidizing, much more space being given to the latter subjects, however, than to electroplating proper. The directions of the author are explicit, and the information being the result of long and successful personal experience is necessarily more reliable and practical than that found in most other publications on the subject. A cut of a familiar looking dynamo is given twice in the book over the caption "Brunor's Perfected Dynamo," although the name plate on the machine plainly reads "Crocker & Wheeler." In view of the acknowledgment of the author in the preface to Prof. Crocker and Dr. Wheeler for aid in compiling the book, we are rather surprised at some of the electrical matter, as, for example, the discussion of the electrical word "intensity."

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS. By Francis E. Crocker and Schuyler S. Wheeler, D. Sc. With a Special Chapter by H. A. Foster. Second edition, revised and enlarged. New York: D. Van Nostrand Company. 295 pages, 99 illustrations. Price, \$1.

That the first edition of this very useful little book was exhausted within a year is evidence that its undoubted value has been appreciated, and we predict that its popularity will steadily increase in the future. For those who have to do with the practical operation of dynamos and motors this work has a practical value which few books possess, and there is none other with the same object that approaches it in completeness and reliability, nor in clearness and conciseness of expression.

The second edition is considerably enlarged, many additions having been made to the section on examination and testing. Part IV. has been added, giving special instructions for handling Thomson-Houston, Brush, Fort Wayne, Sperry and Excelsior dynamos on account of the special character of these machines; the section on the Thomson-Houston machine, contributed by Horatio A. Foster, is particularly full, the most minute directions being given for its operation and repair and the remedy of the various troubles to which it is subject.

The mechanical execution of the book is not in keeping with its contents. The cuts are unusually poor, the paper is of inferior quality and the margins are cut down to a minimum.

ENGINEERING EDUCATION; Being the Proceedings of Section E of the World's Engineering Congress, Held in Chicago, Ill., July 31 to Aug. 5, 1893. Edited by De Volson Wood, Ira O. Baker and J. B. Johnson. Published by the Society for the Promotion of Engineering Education. 342 pages. Price, \$2.50.

We referred at the time of the Congress to the important character of the papers read before section E of the World's Engineering Congress and of the formation of the Society for the Promotion of Engineering Education as an outcome of the meeting, and a closer examination in this volume of the proceedings of the Congress and of the plans of the new society confirms our opinion of the value of the former and the prospects of good results from the latter. Sixteen papers are printed, whose value and that of the discussions appended become more apparent from the following list of some of the authors and those who took part in the discussions: Profs. Burr, Bull, Johnson, De Volson Wood, Thurston, Jacobus, Spangler, Carpenter, Hele-Shaw, Jamieson, Merriam and Lanza. Some thirty professors of engineering participated in the proceedings, and the live interest shown by all of them augurs well for the future of the society then founded. To those interested in education, whether directly or indirectly, this work will be of more than usual interest.

PARLIAMENTARY TACTICS AND RULES FOR DEBATE FOR THE USE OF THE PRESIDING OFFICER AND PUBLIC SPEAKERS. Arranged by Harry W. Hoot. New York: The Scientific Publishing Company. 52 pages. Price, 50 cents.

This little book has been prepared to meet a demand for something that would settle all questions of parliamentary law immediately, without referring to text-books, which in themselves are not only voluminous, but tend to confuse and embarrass. The author has used great care in preserving the substance of each question, yet abbreviating to the greatest possible extent, and whatever may be found in any manual now in use will be found in this in a very few words, yet sufficient to be quickly and thoroughly understood.

The index is found upon the margin, where each question is placed in its relative order. The question having the highest order of precedence is placed at the top, and descending in regular order to those in the next order of precedence, to the lowest. Thus can be seen at a glance, and without turning a page, whether a motion is "in order," and on each page are all the rules concerned.

INDUCTION COILS AND COIL-MAKING. A Treatise on the Construction and Working of Shock, Medical and Spark Coils. By F. C. Allsop. London: E. & F. N. Spon. 162 pages, 118 illustrations. Price, \$1.25.

The author in his preface states that in compiling this book it has been his aim to produce a practical manual that will prove of service not only to those engaged professionally in the construction and repairing of coils, but also to the medical man and amateur coil makers. Dimensions and full details are given for constructing different kinds of coils, accompanied by practical hints and suggestions as to their working and derangements.

In addition to instructions how to make shock, medical and spark coils, there is a chapter on induction, and others on accessory appliances for, and the application of, medical coils, on experiments with spark coils, batteries for coil working, faults in medical and spark coils, and on figures produced by electric discharges on photographic plates.

The author, in addition to his own contributions, has collected together much information from other sources, and the work can be recommended as probably the best that has yet appeared on the subjects treated.

ELECTRICITY AND MAGNETISM. An Elementary Course. By C. G. Knott (Edin.), F. R. S. E. Philadelphia: J. B. Lippincott Company. 1894. 239 pages, 175 illustrations. Price, 75 cents.

This is a work written on typical academic lines and, were it not for one or two of the numerous cuts, would give little evidence that it was not written in 1853 instead of 1893. From the preface we learn that the book is designed primarily to suit the needs of students entering the first stage of the English Science and Art Department, and that the exercises at the end of most of the chapters are in part compiled from the examination papers of the same department. The work is thus written for a special English audience, and the writer is therefore not wholly responsible for the entirely academic character of the book. If used merely as part of a course of mental training, in which the practical bearing of the knowledge taught has no weight whatever, as, for instance, in schools for girls, the book may serve a useful purpose, but otherwise it has little value as a first book in electricity and magnetism in comparison with other text books in which there is a more practical perspective.

NOTES.

The Smithsonian Report for 1891, which has just been issued, contains a translation by William Hallock from the German of an address delivered before the Royal Bavarian Academy of Sciences by Eugene Lommel on "The Scientific Work of George Simon Ohm." (Washington, D. C.)

"Electricity Up to Date," by John B. Verity, has again appeared in a new edition, the fourth; 15,000 copies have already been sold, which is evidence of a due appreciation of a work by the popular audience for which it has been written. The present edition has been largely rewritten, and a new chapter added on electric heating and cooking. (London: Frederick Warne & Co. Price, 75 cents.)

The National Electric Light Association has issued its report of the sixteenth convention, held at St. Louis, Feb. 28—March 2, 1893, which forms a handsome volume of 430 large octavo pages, and contains a frontispiece photogravure of Mr. James I. Ayer, the president of the St. Louis meeting. The character of papers read gives this volume a permanent value not possessed by some of the other reports of the Association. Nikola Tesla, Prof. Forbes, Dr. Bell, L. B. Stillwell and C. S. Bradley are some of those who read papers of especial value, while most of the other papers and parts of the discussion contain much information of practical importance. (New York.)

We have received from the Oerlikon Company, of Zurich, Switzerland, an interesting set of photographic views of their traveling beam electric cranes, showing a number of details of construction; also of a crane, traveling on a surface track taking its current from the trolley wire; also illustrated price catalogues of cranes and elevators, hanging boring machines and a very useful tool for a workshop in the form of a boring machine carried on a light truck and operating the drill through the medium of a flexible shaft; all of these are driven electrically, and the constructions are characteristic of the good workmanship for which this company is noted.

"Telephone Lines and Their Properties," by Prof. William J. Hopkins, has passed into another edition, which, the title page states, is revised and enlarged. No indication is given as to the extent of the revision or the character of the additions in the preface or elsewhere, though we find that the pages have been increased from 258 to 272. The success of this work, which we predicted in our review, follows not only from its intrinsic value, but also because it is the only work, aside from Preece and Stubbs' treatise (to which it furnishes an admirable complement and extension) that deals with the modern aspects of telephony. (New York: Longmans, Green & Co. Price, \$1.50.)

"The Book of the Fair," now being issued in parts of 40 pages (\$1.00 each), will, when completed, form a magnificent volume of 1,000 pages, twelve by sixteen inches in size. The paper, typography, engraving and letter press are all in keeping with the high aims of the publishers, which are doubtless to produce a memento of the World's Fair that will be as much superior to publications relating to previous expositions as the Chicago Exposition was superior to all of its predecessors. Part XI., which is devoted mainly to the electrical features of the fair, treats this portion very satisfactorily. The subjects for illustration have been well chosen and the engravings are fine specimens of photographic reproduction, the Franklin statue being particularly well executed in a fine full-page engraving. The list of subjects is necessarily somewhat brief, but the descriptions are technically correct, which is not always the case in works of this character. (The Bancroft Company: Chicago and San Francisco.)

The "Physical Review" for March-April, 1894, contains a frontispiece portrait of Heinrich Hertz and a biographical sketch by Prof. E. L. Nichols. Prof. Carhart gives the result of some experiments as to the effect of the surrounding medium on the electrical conductivity of copper, and concludes, contrary to the opinion of Prof. Sanford, that surrounding medium has no effect. John Daniel continues his paper on "A Study of the Polarization Upon a Thin Metal Partition in a Voltmeter," discussing in this section the passage of ions through a gold leaf partition in a voltmeter, and the minimum or critical current at which ions are deposited visibly upon the partition for various electrolytes. He finds that in such a voltmeter as was used in his experiments, there is no passage of copper ions through a gold leaf partition, and gives tables of the critical current for a number of electrolytes. Knut Angstrom gives a quantitative determination of radiant heat by the method of electrical compensation, Profs. Nichols and Moler describe an apparatus for generating oxygen and hydrogen by electrolysis, and Louis W. Austin has a note on the effect of extreme cold on magnetism. Prof. Macfarlane reviews McAulay's "Utility of Quaternions in Physics," and J. J. Thomson's "Notes on Recent Researches in Electricity and Magnetism" is reviewed by H. B. Loomis. The electrical contributions, as will be seen from the above enumeration, form a goodly proportion of the contents. (Macmillan & Co.)

Colorado Springs, Col., capital stock \$150,000, has been formed to produce electricity and gas. T. H. Edsall, J. A. Hayes and I. Howbert, Colorado Springs, Col., are interested parties.

THE AMERICAN ELECTRIC COMPANY, Toledo, Ohio, capital stock \$10,000, has been formed to buy and sell electrical apparatus and patents incident thereto. O. S. Brumback, F. H. Hurd, C. F. Wall, C. A. Thatcher and S. C. Schenck are interested parties.

THE READING AND WOMELSDORF ELECTRIC RAILWAY COMPANY, Reading, Pa., capital stock \$30,000, has been formed to construct and operate an electric railway in Berks County, Pa. M. C. Aulenbach, A. B. Hawk and S. E. Rigg are the promoters.

THE BREESE AND MANSFIELD COMPANY, Jersey City, N. J., capital stock \$100,000, has been formed to buy and deal in machinery pertaining to electricity, etc. C. P. Breese, New York; E. J. Emerson and F. Mansfield, of Jersey City, N. J., are the promoters.

THE EATON ELECTRIC LIGHT, POWER AND ICE MANUFACTURING COMPANY, Eaton, Ohio, capital stock \$50,000, has been formed to produce electricity, ice, etc. The incorporators are H. C. Aydelott, J. S. Banner, D. W. Cooper, W. C. Dove and C. C. Aydelott.

THE LYCOMING IMPROVEMENT COMPANY, Jersey City, N. J., capital stock \$1,000,000, has been formed to build, purchase and sell plants for producing and furnishing light, heat and power. J. R. T. Davis, G. G. Davis, Philadelphia, Pa., and C. N. King, Jersey City, N. J., are the promoters.

THE BLUEFIELD ELECTRIC RAILWAY COMPANY, Bluefield, W. Va., capital stock \$20,000, has been formed to construct and operate a railway between Bluefield, W. Va., and Graham, Va. The organizers are J. M. Wiryman, W. H. Triol, J. W. White and F. W. Halsey, Philadelphia, Pa.

THE NORTH BALTIMORE WATER AND ELECTRIC COMPANY, Baltimore, Md., capital stock \$80,000, has been formed to operate and maintain a system of waterworks, electric light and power plants, etc. G. E. Downing, L. Wooster, C. W. Jones, A. G. Henry and J. Richank are the promoters.

THE KINSMAN AND FARMDALE RAILWAY COMPANY, Kinsman, Ohio, capital stock \$10,000, has been formed to construct and maintain, by electrical or other means, a standard gauge railway. D. M. Yeomans, J. A. Russell, F. W. Forbes, E. R. Brackin and Allen Jones are the promoters.

THE HOUSTON AND SUBURBAN STREET RAILWAY COMPANY, Houston, Tex., capital stock \$100,000, has been formed to construct and operate a street railway in Houston to be operated by electrical or other means. A. Christeson, W. A. Wilson, Jr., and E. W. Cove, Houston, are the incorporators.

THE OHIO AND INDIANA PIPE LINE COMPANY, Jersey City, N. J., capital stock \$1,000,000, has been formed to construct and operate electric light plants, etc. E. R. Chapman, S. M. Brice, T. W. Scarborough, New York; S. Shortridge, Brooklyn, N. Y., and A. Williams, Paterson, N. J., are the promoters.

THE EASTERN AUTOMATIC TELEPHONE COMPANY, Jersey City, N. J., capital stock \$500,000, has been formed to manufacture and construct, etc., electrical and other apparatus. The promoters are C. H. Scrymser, Brooklyn; C. L. Tappan, Babylon, L. I., N. Y., and C. E. Renshaw, East Orange, N. J.

THE CLARKSBURG TELEPHONE COMPANY, Clarksburg, W. Va., maximum capital stock \$1,000,000, has been formed to purchase, manufacture and sell telephone apparatus, and to operate telephone and telegraph lines, etc. The organizers are D. P. Morgan, N. J. Coplin and T. M. Hickman, all of that town.

THE EUREKA LIGHTING COMPANY, San Francisco, Cal., capital stock \$250,000, has been formed to manufacture and deal in electricity for all purposes. J. H. Livingston, William Clift, W. D. Clark, Hy. Williams, H. M. A. Miller, San Francisco; O. G. Miller, Oakland, and Joseph Hutchinson, Palo Alto, Cal., are the organizers.

THE COLLEGE HILLS AND PARK LINE, Sherman, Tex., capital stock \$100,000, has been formed to maintain a street railway to be operated by electricity or other power in and through that town. J. P. Harrison, W. M. Scott, L. C. Chapman, R. S. Dorchester, D. A. Simmons, H. N. Tuck, J. R. Cole, J. M. Cullers and Geo. F. Henry, all of Sherman, are interested.

MR. CHAS. E. CHAPIN, 136 Liberty street, New York, Eastern agent for the sale of the Packard incandescent lamp, reports having recently received several large orders for this well-known lamp.

THE BALL & WOOD COMPANY, Elizabethport, N. J., has sent an invitation to its friends in the vicinity of New York to visit its works on March 31, to inspect a new type of vertical engine of 600 h. p., previous to its shipment to the Chicago Edison Company.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, 50 Broadway, New York, and Equitable Building, Baltimore, has been appointed by the Buckeye Electric Company, of Cleveland, Ohio, as its sole agents for New York and Baltimore and their vicinities.

THE SWITCHBOARD of the United Electric Light and Power Company's station on West 29th street, and part of the building were destroyed by fire on Monday morning. In pulling the switches when the flames were observed, the engineer, Samuel Hicks, was burned about the face. The fire is reported to have been caused by a short circuit.

MR. THOMAS L. SCOVILL, who during the past seven years has been the New York agent of Holmes, Booth & Haydens, will on April 1 sever his connection with the above-named firm. Mr. Scovill has accepted the presidency of the Mechanical Boiler Cleaner Company (working under the Stewart patent), and will be located at 32 Park place. His company will also deal in brass and insulated wire, together with articles manufactured in brass and aluminium.

BROOKLYN, N. Y.—The Atlantic Avenue Railway Company, owned by the Brooklyn Traction Company, has the following officers: President, Benjamin Norton; secretary-treasurer, W. J. Richardson; auditor, Charles Colne; superintendent, H. R. Newkirk; purchasing agent, W. M. Tobias. There are 44 miles of road, and 440 cars, of which 233 are Westinghouse motor cars. The Brooklyn Traction Company's offices are in the Bartlett Building, Philadelphia. C. F. Stevens is secretary and treasurer.

PRIMARY BATTERY SUIT.—On March 13, Judge Aldrich, of the United States Circuit Court, of the District of Massachusetts, handed down a decision sustaining the patent on the agglomerate cup of the well-known Holtzer cylinder battery, manufactured by the New York Carbon Works, New York City. The Judge decided that the complainant's invention "must be accepted as a valuable improvement upon the means previously employed in this kind of battery," and ordered a decree for an injunction and an accounting.

MR. CYRUS ROBINSON has severed his connection with the General Electric Company and has accepted one as designing engineer with the Jeffrey Manufacturing Company, of Columbus, Ohio. Mr. Robinson has been with the General Electric Company as designing engineer for the power and mining department. The Jeffrey company has been in the mining business for a number of years, and it is its intention to increase its business and commence the building of electrical mining plants, including generators, mining machines, haulage plants, pumping and hoisting apparatus, etc., for coal and ore mines. Mr. Robinson's past experience well fits him for his new position.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., March 24, 1894.

PRESIDENT M. J. FRANCISCO, of the National Electric Light Association, and his son, were in Boston this week.

THE SHAWMUT FUSE WIRE COMPANY, of Boston, has a new manager in Mr. M. Metcalf, a young gentleman of business ability, succeeding Mr. McFerriday, who is absent in Colorado for his health.

THE WESTINGHOUSE ELECTRIC COMPANY has secured its first order from the West End Street Railway Company, of Boston, and it is a pretty good one, as it is for 150 car equipments positively and 50 additional, if needed.

THE PHILLIPS INSULATED WIRE COMPANY, of Pawtucket, R. I., with its new and handsome building, is quite the attraction electrically in that city just at present, and Mr. H. O. Phillips and Secretary Smith are never happier than when expatiating upon their delightful home and surroundings.

THE DWIGHT SLATE MACHINE COMPANY, of Hartford, Conn., a corporation enjoying an excellent reputation as manufacturers and dealers in machinery, tools and supplies, makes a splendid display in its new warerooms at 13 Central Row, opposite the post office. Its popular and capable manager, H. N. Hinckley, complains a little of the dull times, but says he is kept busy.

MR. JOHN M. FOX, electrical engineer and contractor and dealer in electrical supplies, Portland, Me., has removed to larger and more commodious quarters at No. 66 Union street, that city. The change was necessitated by his rapidly increasing business. In addition to a complete and large line of electrical goods, Mr. Fox now carries an excellent supply of gas and electric fixtures, shades, etc.

MR. CHAS. W. HOLTZER, of the Holtzer-Cabot Electric Company, Boston, has obtained a favorable verdict from Judge Aldrich,

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
41 Park Row New York, March 26, 1894.

THE PECKHAM MOTOR TRUCK AND WHEEL COMPANY, 26 Cortlandt street, New York, has opened a Boston office, of which Vice President A. W. Field will have charge.

of the United States Circuit Court, District of Massachusetts, in his suit against the Consolidated Electric Manufacturing Company for infringement of his patent on the construction of galvanic batteries, under Letters Patent No. 327,875 and known as the "Holtzer Cylinder Battery."

MR. FRANK S. DE RONDE, general sales agent for the Standard Paint Company, of New York, was in Boston this week and favored this office with a call in company with Mr. Chas. B. Price, of Pettingell-Andrews company, its representative in New England. The presentation of Mr. De Ronde's card was accompanied with one of the "P. & B." Perfectos, the choice fragrance of which must still linger in the memory of all who were fortunate enough to get one at the recent Washington convention.

MR. J. F. BUBERT has succeeded to the construction and engineering departments of Claflin & Kimball, formerly general agents of the Mather Electric Company, and has opened an office in Room 71, Hathaway Building, 629 Atlantic avenue, Boston. Mr. Bubert identified himself with the Mather company in 1884, and in 1887 assumed charge of the construction and engineering departments for Claflin & Kimball, general agents. He possesses exceptional ability and valuable experience in these particular branches of electrical work, and will unquestionably meet with the success he justly deserves.

ELECTRICITY AND PROPOSED LEGISLATION thereon have been quite prominent in Boston this week. The daily papers are devoting considerable space, sensationally of course, to the "breezy tilts" between ex-Congressman Geo. Fred Williams and Attorney Hyde, of the West End road, in connection with the aldermanic hearing on the burying of overhead wires. The street railway transfer question has also cut quite a figure in state legislative committee meetings, and the struggle between the electric railways and steam roads has been made decidedly manifest owing to proposed amendments relative to grade crossings.

THE WEST END STREET RAILWAY COMPANY has perfected plans for the extension of the electrical service the coming season, and the following are the districts that are to be thus equipped: All of East Boston, the incomplete portion of Brookline, Mt. Auburn street and Huron avenue in Cambridge, Malden and Medford and minor extensions in Somerville and other suburbs. The electric track welding machine, whose work was seen last season in Cambridge and on Shawmut avenue, has been improved to meet certain deficiencies that were demonstrated by experience, and is expected to be put at work again here soon after April 1.

ALMON & SARGENT, electrical engineers and contractors, is the title of a new firm, with offices just opened in the Hathaway Building, 629 Atlantic avenue, Boston. The members of the firm, however, are not new to the electrical public, both of them having been connected with the construction departments of the Thomson-Houston and General Electric companies, of the former of which Mr. Almon was superintendent for a long time. Their abilities are as well known and recognized as they themselves are. The firm will also act as general agents for the Belknap Motor Company and L. P. & D. Transmitter Company, with offices in Boston and New York. Mr. Almon has for some time been doing some very successful work in New York for these companies.

THE LONG AND BITTER CONTEST, on the one side, at least, between the town of Wakefield, Mass., and the Citizen's Gas and Electric Light Company, is about at an end, as the award of Commissioners E. B. Hale, S. L. Powers and I. T. Drew has been filed in court, and is to the effect that the town must pay \$151,600 for the plant. This litigation was one of the first in the interest of municipal lighting and the Citizen's company, through its well and favorably known vice president, H. C. Buck, has from the commencement occupied simply a defensive position. The decision of the commissioners is in accord with the statute compelling a town to take the existing plant if it votes twice to establish a lighting plant. The plant of the Citizen's company is a model one in every respect.

Canadian Notes.

LONDON, March 2, 1894.

THE PROPRIETORS of Winona Park have decided to refuse to allow the Hamilton, Grimsby and Beamsville Electric Railway to use the park for excursions, as they desire it for the use of lot owners only.

THE BOARD OF MANAGERS of the Galt and Preston Electric Railway met on Saturday last, and opened tenders received for the construction of the electrical part of the road. The contract was given to Ahearn & Soper, of Ottawa.

THERE IS CONSIDERABLE TALK of again submitting the question of Sunday cars to the vote of the people in Toronto. It has now been twice defeated, but Sunday car advocates are determined to keep at the matter until cars are permitted to run on Sunday.

A BILL HAS BEEN BROUGHT up in the Local House to incorporate the Toronto and Richmond Hill Electric Railway. It is proposed to extend the present line of the Metropolitan Railway

right up Yonge street to Richmond Hill, a distance of about 20 miles.

AT A GENERAL MEETING of the shareholders of the Montreal Street Railway, held on the 19th inst., it was resolved to increase the capital stock of the company from \$2,000,000 to \$4,000,000, and the directors were empowered to issue new bonds to the extent of the increase at such times and in such amounts as they might see fit.

A VERDICT has been given by the Privy Council in the case of the Winnipeg Street Railway versus the new Winnipeg Electric Railway favorable to the electric company on all the points involved. The old horse car line claimed to have been granted a monopoly of Winnipeg streets, but the decision sets this claim aside, and the electric railway will now proceed with numerous extensions to its system.

THE RELATIONS between the Niagara Falls Electric Railway, the Queen Victoria Park Company and the town of Niagara Falls were discussed thoroughly the other day in this city by representatives of the three respective interests mentioned. The chief points under discussion were the double tracking of the railway line, the condition of the roadbed between the rails, and the nature and maintenance of the road alongside the line at certain points. The ground was fully gone over and a substantial agreement reached on several points.

CONSIDERABLE DISCUSSION is going on at present in Toronto as to the possibility of establishing a direct street car service between the city and the island, and various schemes have been proposed with that object in view. The City Council has been giving the matter a good deal of attention, and several conferences have been held with the street railway company, but nothing very definite has as yet been done. A bridge from the Queen's wharf was suggested, but as the estimated cost of such a structure would be in the neighborhood of \$150,000, the proposition has been dropped.

English Notes.

(From our own Correspondent.)

LONDON, March 14, 1894.

AN ELECTRICAL PARCEL VAN.—The daily newspapers contain an announcement that an electrically driven van for the conveyance of parcels has been perambulating the streets of London with much ease, and attracting considerable attention from those interested in the matter. As a van of this kind must contain a heavy load of accumulators, motors, etc., and must be capable of steering amongst the crowded and narrow streets of the city, and of being pulled up sharply, even on the down gradient, it does not seem as if there was any probability of such vans becoming common. If they do, however, it is to be hoped that arrangements will be made to mitigate the anxiety generally depicted on the faces of those responsible for the driving of these cumbersome contrivances.

BRIGHTON. This town, which was one of the first in the country to be lit by electric light, is now supplied with electric current for public and domestic lighting from the Corporation Electric Light Station. This is one of the most successful municipal stations in this country. During the last twelve months it has doubled the number of domestic consumers, and the rate of increase of the demand for current is still very great. One of the most interesting features of the Brighton system is the plan of differential charges which has been devised by Mr. Arthur Wright, the corporation electrical engineer. The object of this system is to encourage steady consumption of current. Up to a certain point, depending upon the maximum of current taken by the consumer, each consumer is charged at a maximum rate; but beyond that point he is charged at only half this rate. The maximum current taken by each consumer is indicated by a "demand meter," the invention of Mr. Wright. This meter registers the maximum amperes taken by the consumer during the month, as well as indicating to the consumer by means of a scale the number of units he must consume before he can get the benefit of the lower price. This system has been found greatly to encourage the use of electricity in the private rooms in shopkeepers' houses.

DUPLEX SUBMARINE TELEGRAPHY.—An important case involving both a patent covering a system of duplex submarine telegraphy and an interesting point of patent law, came before the courts on Wednesday last. The action is brought by Messrs. Mulrhead against the Commercial Cable Company, and has already occupied the attention of Queen's Bench Court III. for seven days, the best counsel of the bar being engaged on one side or the other. The Commercial Cable Company became licensees of Messrs. Mulrhead under the United States patent of 1880, the agreement between the parties reciting the various patents taken out by these gentlemen, among them being the English patent No. 2564 of 1876 and an United States patent 234,490 of 1880; it being further agreed that any differences of opinion arising should be tried before an English court. The Commercial Cable Company allege that the American patent of 1880 contains nothing

more than one of the many methods of duplex working specified in the English patent of 1876, now expired. They therefore argue, that they are no longer under an obligation to pay royalty under the United States patent of 1880, since this, under the American patent law, must have expired contemporaneously with the English patent, of which it is, they argue, nothing more than a later edition. If the contention of the Commercial Cable Company is correct, they will relieve themselves from annual payments amounting in all to something like £45,000, their payments to the patentees running on under the American patent to 1897. It is somewhat curious that the question of the simultaneous expiring of an American with the earliest similar foreign patent, which has been the source of so much argument with you, should give rise to costly litigation in this country also, and that the action Bate Refrigerating Company v. Hammond, which has cropped up so frequently in electrical litigation in the United States, should be quoted in our own law courts.

News of the Week.

Telegraph and Telephone.

ATLANTA, GA.—A large delegation of telephone men connected with the Southern Bell Telephone and Telegraph Company held a meeting in Atlanta last week. The visiting delegation came to inspect the handsome new building, switchboard and underground system of the Atlanta Telephone Company, recently completed.

TOLEDO, OHIO.—Within the next week a patent suit involving \$5,000,000 will be filed in the United States Court by the American Electric Company, of Toledo, against the Central Union Telephone Company, the Bell Telephone Company, and the Western Electric Company, of Chicago, for appropriating a multiplex switchboard invented by M. J. Carney, of this city.

LAGRANGE, IND.—The Lagrange and Rome City Telephone Company has been organized here by the election of D. A. Fawcett as president and J. E. Franks secretary. The line, twelve miles long, will be in operation within ten days, and President Fawcett says extensions will be made to Kendallville, Fort Wayne and Goshen. The stock in the company is held at Lagrange, Kendallville and Fort Wayne.

Electric Light and Power.

ASHEBORO, N. C.—An electric plant, boilers, etc., will be bought by B. J. Fisher.

BEAUMONT, TEX.—The Beaumont Ice, Light and Refrigeration Company is in the market for electrical machinery.

WEYMOUTH, MASS.—Residents are complaining of the quality and quantity of electric light now being furnished.

NEWTON, N. J.—A petition is now being circulated asking the authorities to issue bonds for an electric lighting plant, to cost about \$4,000.

LOGANSFORD, IND.—The special electric light committee has made plans for a municipal electric light plant. William Dolan, of the committee, will give details.

MILWAUKEE, WIS.—Jacob Cloos, manager and electrician of the Manitowoc Electric Light Company for nearly five years, has resigned to accept the appointment of electrical engineer to the Pabst Heat, Light and Power plant.

ROODHOUSE, ILL.—The city of Roodhouse, Ill., is ready to receive bids for lighting the city, as per plans and specifications which have been adopted. The city will grant a franchise for from five to ten years. W. G. Armstrong is mayor.

BUFFALO, N. Y.—Architect Fred Mohr, of East Utica street, is making plans for important improvements for the property of the Elmwood Beach Improvement Company, on Grand Island, to include an electric lighting plant. William Ziegler, the Buffalo brewer, is interested and Charles Wagner, of Buffalo, will be manager.

The Electric Railway.

HARTFORD, CONN.—Both Boards of Council have given the Hartford Street Railway permission to equip with the trolley system.

POTTSTOWN, PA.—Contractor Crilly has begun work on the trolley railway to connect Pottstown and Ringing Rocks, a distance of five miles.

McKEESPORT, PA.—The Citizen's Passenger Railway Company proposes to extend its lines this coming summer, but no details have been made public.

PHILADELPHIA, PA.—Jones & Wallace, of Wissahickon, Pa., have been awarded the contract for the proposed extension of the Wissahickon Electric Railway.

HENDERSON, KY.—The Henderson Electric Street Railway Company has decided to build three and one-half miles of electric road. E. G. Seabee, Jr., is manager.

WARREN, N. H.—An item is going the rounds of the press that a scheme is being pushed to build an electric railway from Warren, N. H., to the summit of Mount Moosilake.

CENTRAL FALLS, R. I.—The Town Council is considering the petition of the Pawtucket Electric Street Railway Company to lay a double track and operate cars on Broad street.

KANSAS CITY, MO.—Surveys have been completed for eight miles of the Westport and Waldo electric road. No contracts have yet been let. W. E. Winner, 415 American Bank Building, Kansas City.

STILLWATER, ILL.—The Stillwater Electric Railway Company will soon be sold at Sheriff's sale. It is reported that a stock company will be organized amongst the residents of Stillwater for the purchase of the road.

MEDINA, N. Y.—About the 1st of April work will be begun upon the proposed Batavia and Lake Ontario Railroad, of which Captain Beecher is president and J. W. Holmes, of Batavia, is chief engineer. It will be a one-track elevated road.

BALTIMORE, MD.—Daniel Keller and others of the Twelfth District have asked the Baltimore county commissioners for a renewal of the charter granted them for an electric railway from O'Donnell street, in Canton, to Keller's Pavilion, by way of Mount Carmel.

RALEIGH, N. C.—On the 14th of April, at the court house, will be sold at the instance of the Mercantile Trust and Deposit Company, of Baltimore, the property, rights of every kind and franchise of the Raleigh Street Railway Company. R. T. Gray, commissioner, Raleigh, N. C., will give details.

LITHIA SPRINGS.—An electric railway will be constructed to Lithia Springs from Atlanta, Ga. The eight miles of line to the Chattahoochee River will be constructed at once, and the remaining seven miles from the river to Lithia Springs later. The Chattahoochee River is to be crossed by electric launches like those in use at the World's Fair.

LAWRENCE, MASS.—The Lowell, Lawrence and Haverhill Street Railway Company has begun to relay its double tracks on Essex street, a work which was stopped last fall owing to the stringency in the money market. The double track extension to Barker's Grove, Methuen, will be started soon. Messrs. Soule & Dillingham, Boston, are the contractors.

BROOKLYN, N. Y.—W. A. Boland, of Boston, has secured the contract to construct 100 miles of street railroad through Brooklyn and suburban towns for the new Nassau electric railroad of this city. The contract calls for the completion of half of the system by July 15, and the remainder before the end of the year. Several other Boston capitalists are interested in the concern.

AUBURN, ME.—General Manager E. W. Gross has applied for right to erect poles and string wires for change of motive power to electricity for the Lewiston and Auburn Railway, and the matter has been referred to a special committee of three. Mr. Gross states that contracts for rails, etc., will be placed as soon as permission is granted.

DETROIT, MICH.—The Township Board of Springwells has granted to a Detroit syndicate, headed by Elmer T. Hance, postmaster of Detroit, a franchise to run an electric street railway on Michigan avenue from the city limits to the Dearborn line, to be completed within six months. The name of the new company will be the City and Suburban Traction Company.

LOCKHAVEN, PA.—The McDonough Construction Company, of New York, has offered to build a railway on the bond plan, Lockhaven to raise \$10,000 on bond issue, and 60 per cent. of the stock to remain with the local company, which would control the road. L. M. Patterson, R. D. Peck and T. H. Harmon have been appointed a committee of Lockhaven citizens to raise \$10,000 on issue of bonds by the road. It is proposed to bond the road for \$100,000.

Personal Notes.

PROF. E. L. NICHOLS will go to Europe in June on a year's vacation.

MR. J. J. CARTY delivered a lecture at Cooper Union on March 12 on "The Telephone," being one of the course of University Extension lectures.

MR. ALBERT L. CLOUGH read an able paper on electric rapid transit before the Manchester (N. H.) Board of Trade, on March 13, and urged the grant of an electric franchise for Manchester.

WILLIAM MAVER, JR., delivered a lecture at Cooper Union on March 19, on "Electric Alarms and Signals," being one of the University Extension Course lectures. Fire and burglar alarms, police patrol signals and railway electric block signalling were considered among others, and the complicated details of some of these little known systems were clearly and thoroughly explained.

MR. FREDERICK BATHURST is making a tour of the principal industrial countries of Europe in order to note the state of

electrical development in each as compared with the United States and England. He finds that Switzerland at the present moment is much ahead in the application of electricity to power and lighting, and has brought to practical perfection the simple and two and three-phased alternating systems.

MR. MAX LUHN, chief engineer of the Helios Company, of Cologne, Germany, and also manager of the company's branch office in Berlin, arrived March 25, on the American Line "New York," for a tour of inspection of the electrical features of the principal American cities. Mr. Luhn visited this country about eighteen months ago and made many friends, who will be glad of an opportunity of seeing him again, and learning more regarding the work his company is doing in Germany. His permanent address while in America will be in care of C. S. Chamberlain, Times Building, New York.

MR. H. F. PARSHALL, it was recently rumored, contemplated leaving the employ of the General Electric Company and connecting himself with a well-known manufacturing firm. We are informed, however, that arrangements have been made by which Mr. Parshall is to continue with the General Electric Company in the capacity of consulting engineer. He is to sail for Paris the last of March and will spend several months in Europe in the interests of the company. Mr. Parshall, both by education and experience is well fitted for the line of work he has been following. He received his technical education in the universities of Cornell and Lehigh. His practical experience began with the Sprague Electric Railway and Motor Company, where



he spent considerable time designing stationary and street car motors. For a brief period he was connected with the Westinghouse Dynamo and Motor Company, of Baltimore, and during that time designed what is claimed to be the first multipolar single reduction motor that was successfully operated in this country. The armature was of the ironclad type and drum wound and differed little from the best street car motors of to-day. He was engaged by the Edison General Electric Company as an engineer at the Schenectady works until the consolidation of the two great companies, since which time he has been at Lynn in charge of the calculating department, in which all the calculating and much of the designing work is done. Mr. Parshall is a member of the American Institute of Electrical Engineers and the American Institute of Mechanical Engineers and a lecturer at the Massachusetts Institute of Technology on Dynamo Design.

Miscellaneous Notes.

THE ELECTRIC CLUB, of St. Louis, Mo., held its regular meeting on Saturday evening, the 24th inst., at 8:15. Mr. H. H. Humphrey read a paper on "Electrolysis," and a general discussion will follow. Some business matters of importance to the club will be presented.

THE UNIVERSITY OF WISCONSIN has announced the following special lectures and subjects in electrical engineering: Gilbert Wilkes, dynamo designing; A. V. Abbott, telephone switchboards; L. A. Ferguson, modern electric light stations; A. J. Rogers, electrolysis; Elisha Gray, the telegraph.

A FARM PLANT. Mr. B. W. Philbrick, the electrical engineer of ex-Vice-President Morton's Ellerslie farm, has just finished installing the largest country installation in the world. Besides an immense lighting plant there are motors for all purposes, and 300 electro-thermostats in the barn, which building requires no less than 300 lights.

PRINCE BISMARCK is introducing the electric light in his palace at Friedrichsruhe, and has entrusted the work to the firm of Schuckert & Co., of Nurnberg, Germany. The power for the plant is to be obtained from a sawmill belonging to the Prince and located within a very short distance of the buildings in which the light is to be introduced.

THE ELECTRICAL SOCIETY, recently organized at Cornell University, has been very successful, and great interest has been taken in its work, both by the students and the professors. It has now been decided that the papers read before the society will be published in book form. The volume will also contain the discussions. The publication will be issued towards the close of the college year—probably in May.

THE AMERICAN STREET RAILWAY CONVENTION, which is to meet in Atlanta in October next, will be most hospitably received by that city. Preparations are being made, and the place for the convention has been selected. It will be at Machinery Hall, in Piedmont Park, where, in addition to the rooms for the convention's session, there is ample building room for the numer-

ous railway exhibits. Everything points to a successful meeting. The executive committee have met in Atlanta, and have adjourned after arranging preliminaries.

ELECTRIC BUOYS.—Captain W. S. Schley, and Lieutenant-Commander C. H. West, U. S. Navy, accompanied by Mr. Ira W. Henry, electrical engineer of the Bishop G. P. Co., started for Mobile, Ala., on March 25, to make a topographical survey of Mobile Bay and the adjacent shores to ascertain the practicability of lighting the thirty-mile channel with electric buoys and provide for the erection of the necessary generating plant. The successful operation of electric buoys for the last six years in New York Bay and the fine showing in Lake Michigan during the Fair have proven the adaptability of this work for harbor lighting, and opens up a new branch of lighthouse engineering.

Trade and Industrial Notes

THE NOVELTY ELECTRICAL SUPPLY COMPANY, of Williamsport, Pa., has moved into new quarters on the ground floor of 35 West Fourth street.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., will furnish the iron roof for the new car barn for the Colonial Street Railway Company, of Kingston, N. Y.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY, 572 First avenue, N. Y., has issued circular No. 8, an illustrated price-list of blade switches of capacities from 35 to 1750 amperes.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, of Pittsburgh, Pa., has issued a circular describing and illustrating the Wurts non-arcing railway lightning arrester, recently placed on the market.

THE CHARLES PLUMB ELECTRICAL WORKS, 89 Erie street, Buffalo, N. Y., will, in addition to a regular supply business, manufacture and repair static electrical apparatus, frictional machines, physicians' electro-medical apparatus and electro-mechanical devices.

WELLS GOODHUE, 1564 Monadnock Block, Chicago, has succeeded to the business of the firm of Goodhue & Lincoln, dealers in high grade electrical material, Wagner slow speed motors and dynamos for direct and alternating currents, Sunbeam incandescent lamps, etc.

THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 DeKalb street, St. Louis, Mo., recently organized, is meeting with flattering success, if substantial orders for batteries and cells can be considered as a criterion. This company is now fully equipped and in a position to execute orders of any size.

THE GREAT WESTERN MANUFACTURING COMPANY, of Chicago, is preparing for the market a new one-eighth horse power fan motor for 110-volt circuits with a 12-inch fan and wire guard.

THE WHEELER REFLECTOR COMPANY, 18 Washington street, Boston, Mass., has issued a 32-page catalogue of electric reflectors based upon the Wheeler system of special shapes for special uses. Many forms of reflectors are shown, including a new silver-plated mirror reflector for show rooms and windows.

FRANK H. STEWART, 1208 Green street, Philadelphia, is placing on the market a neat and efficient type of electric fan. The fans will be made with two and four blades for six and one-half and nine and one-half amperes and 110, 220 and 250 volt direct current circuits, and will be furnished nickel-plated or of polished brass.

THE WESTERN BUILDING AND LOAN ASSOCIATION, 227 South Clinton street, Chicago, Ill., has submitted its first annual report. All the officers of the association are, or have been, connected with the Western Electric Company for a number of years. It is claimed that the association has met with great success during the past year.

THE GERSON ELECTRICAL COMPANY, 4203 Walnut street, Philadelphia, Pa., has issued a "Telephone Catalogue" in which various styles of receivers and transmitters are described. Their standard instruments consist of the "Bell" main line magneto telephone with a Blake or carbon transmitter, and "warehouse" telephone, with the same kind of transmitter and receiver, but signaling by means of a switch and electric bell.

THE STANDARD PAINT COMPANY, 2 Liberty street, New York, is sending to its many friends samples of its ruberoid roofing. Ruberoid, combining as it does the good qualities of P. & B. Compound, is claimed to be "the thing" for the roofs of power houses and sheds. It is absolutely waterproof, is odorless, will resist fire, acids, and alkalis, and is not affected by contact with either steam, oil or gases. In fact, it is what has been for many years sought, a light, easily laid waterproof roofing.

H. B. COHO & CO., of the "Mail and Express" Building, 202 Broadway, New York, are now contractors for the apparatus manufactured by the Mather Electric Company, of Manchester, Conn., for New York City, Brooklyn and vicinity and New Jersey. Mr. Coho is well known through his connection with the Waddell-Entz company, as its sales agent, and proposes to make a strong fight for Mather business in his territory. Mr. Thomas C. Perkins,

vice president of the Mather Electric Company, who is in New York City much of the time, will also make his headquarters at 203 Broadway.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, is just placing upon the market the Allen soldering stick—a soldering flux in solid stick form to take the place of resin, acids and soldering salts. It is put up in candles one inch in diameter and six inches long, and is applied by simply rubbing on the joint when heated.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY'S new telephone was recently tried between Newark and other points in New Jersey. It is claimed that during one conversation, carried on over an eight-mile line, the receiver at the Newark end was held at arm's length by one of the visitors and every one in the large room heard distinctly everything that was said over the line, some of those present being more than ten feet distant from the receiver. The tests included trials with several microphone carbon telephones, but the results with the Western instrument are claimed to be much more satisfactory.

FISHER & PORTER, 1025 Monadnock Block, Chicago, Ill., are equipping with machinery, for W. H. Roessle, of Pittsburgh, a gold mine at Tellico Plains, Tenn., and have supplied Kotine, a new material for painting iron structures, for the new Lincoln Park bridge, recently erected by the Pittsburgh Bridge Company. They have the contract to supply two 75-h. p. M. A. Green engines for the Leland Hotel, Chicago, and have several contracts of a similar nature, ready to be closed. They have advices from the home office of the Altoona Manufacturing Company, that the

works are running full time with a complete complement of men, and are turning out engines as fast as their equipment will allow. One 150-h. p. engine for the Farmington Light and Power Company, Farmington, Ill., and one 125-h. p. engine for the Western Glass Company, of Colorado City, Col., are among the plants recently installed in the West. From the Providence Steam Engine Company they say word comes that the works are running day and night with a double turn of men in the construction of the improved Greene engine, of which they are the sole builders. There is evidently a demand abroad for engines and orders are being placed where they will receive the best attention.

Business Notices.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient and at prices lower than ever. THE HAYDEN-BOOKER MFG. CO., 2140 DeKalb St., St. Louis, Mo.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED MARCH 13, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

516,188. ELECTRIC RAILWAY; M. W. Dewey, Syracuse, N. Y.

Application filed July 6, 1889. This comprises a conduit having a movable coil therein in electrical connection with a source of electricity, a vehicle, means to cause the movable coil to follow the vehicle, a secondary circuit on the vehicle in inductionable relation to the coil, and a motor to move the vehicle in the secondary circuit.

516,198. AUTOMATIC HEAT REGULATING APPARATUS; C. F. Goodhue, Boston, Mass. Application filed May 11, 1893. This comprises a circuit adapted to render operative damper controlling mechanism, and embracing a thermostatic circuit closing device, a polarized relay having a vibratory armature, and a current reverser, and means for establishing the circuit independently of the thermostatic device.

516,204. MAGNETIZING COIL; J. D. Ihlder, Yonkers, N. Y. Application filed Nov. 18, 1893. As a means of producing a low rate of change of magnetic lines of force, a double magnetizing circuit in shunt relations to each other, and wound in opposite directions with terminals in permanent connection.

516,205. CABLE HANGER; A. E. Johnson, Wakefield, Mass. Application filed July 6, 1893. This comprises a metallic strip having tongue slots and provided at one end with a tongue having one or more finger openings, the strap having one or more locking fingers, one of the fingers being adapted to enter one of the finger openings after the tongue has been inserted through the tongue slots.

516,213. ALTERNATING CURRENT MOTOR; R. Lundell, Brooklyn, N. Y. Application filed July 30, 1892. An alternating current motor having a pair of current collecting brushes, one fixed and the other immovable, with a conductor connecting said brushes, the movable brush lying in a different plane from and adapted to be rotated past, the fixed brush. (See illustration.)

516,217. RHEOSTAT; H. McNulta, Bloomington, Ill. Application filed May 1, 1893. This consists of a pile of plates, each of which contacts with an adjacent plate by contact projections.

516,239. ELECTRICAL PROTECTION FOR SAFES; C. F. A. Sturts, San Francisco, Cal. Application filed April 11, 1893. This comprises an inclosing casing having a movable front, a lining for the casing composed of metallic sheets having interposed insulating material, one or more automatic circuit closers connected to both of the sheets and adapted to be closed by removing the removable front, and electrical connections to an alarm.

516,240. ELECTRICAL PROTECTION FOR WINDOWS; C. F. A. Sturts, San Francisco, Cal. Application filed April 11, 1893. The combination of a window and an alarm mechanism, of a molding connected to the window frame, parallel wires in the molding, and one or more spring contacts normally open, but adapted to make contact with both of the wires.

516,253. SECONDARY BATTERY; E. R. Whitney, Manchester, N. H. Application filed Feb. 4, 1893. This comprises a number of pans of insulating material, the bottom portion of each of which enters and closes the top portion of the one below, the pans having positive and negative plates supported on the inner and outer surfaces thereof, and connected therewith by

electrical conductors passing through the bottom of the tray.

516,263. ELECTRIC MOTOR; O. F. Conklin, Dayton, Ohio. Application filed Jan. 9, 1893. The combination of a spider supported by the armature and having a space in the central vertical extension thereof; a switch attached to the extension within the space, the switch having two contact points; a field magnet having two sets of coils inclosed by the armature; a vertical rod and a cam loosely mounted thereon, whereby connection may be effected with one or both sets of field magnet coils.

516,298. DYNAMO-ELECTRIC MACHINE; F. J. Crouch, Portland, Ore. Application filed Feb. 27, 1893. The combination with a base frame of separable fields having flanged ends removably connected together, and means for vertically adjusting the connected fields within the base frame.

516,312. PROCESS OF ELECTRIC METAL WELDING; H. Lemp, and W. S. Moody, Chelsea, Mass. Application filed Oct. 20, 1890. This comprises a transformer having a secondary bar or conductor provided with an intermediate pole or electrode whereby it may constitute a divided source of energy.

516,336. CAR LIGHTING; W. M. Miner, Plainfield, N. J. Application filed Nov. 7, 1893. The combination of a branch from a main line exterior to the car, electric lamps in series in the branch, a storage battery in series with the lamps, and means controlled by the current flowing in the branch for closing and breaking the connection between the battery and one or more substitute lamps.

516,341. SAFETY DEVICE FOR ELECTROSTATIC MEASURING INSTRUMENTS; W. E. Ayrton and T. Mather, London, England. Application filed Sept. 7, 1893. The combination of a "safety terminal" having the metal parts inclosed in insulating material, safety fuse holder and an insulating and short-circuiting device.

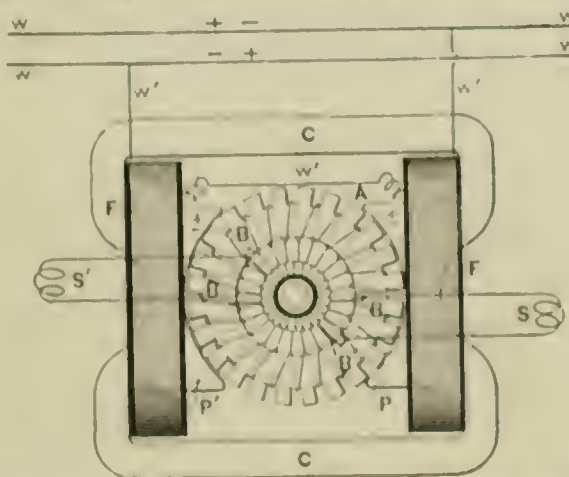
516,374. CLOSED CONDUIT ELECTRIC RAILWAY; F. L. King, Chicago, Ill. Application filed May 5, 1893. The combination of an insulated conductor, a chamber inclosing the same, a cover for the chamber provided with armatures with a vehicle carrying magnets having their magnetic fields overlap and succeed each other.

516,379. SWITCH FOR SECONDARY BATTERIES; H. Muller, Nuremberg, Germany. Application filed Dec. 27, 1892. The combination with main sliding contacts and guideways for the battery, of auxiliary sliding contacts and guideways connected to the main contacts, and a voltmeter connected with the last named guideways so that the voltage of a single cell is indicated.

516,447. COMMUTATOR FOR ELECTRIC MACHINES; C. Olivetti, Ivrea, Italy. Application filed April 29, 1893. This comprises a commutator divided into a plurality of electrically separated parts, each part consisting of a series of commutator segments provided with intervening insulating spaces, brushes being provided for each electrically separated part of the commutator, the arrangement being such that the brushes of the same polarity shall have successive and continuous action.

516,478. ELECTRIC LOCK; J. R. Donnelly, Fairfield, Me. Application filed March 30, 1893. A combination keyboard having bars or poles connected with the wires of an electric circuit and push buttons, the poles of which are connected with movable arms adapted to be connected at will with the bars.

- 516,484. REGULATING SOCKET FOR INCANDESCENT LAMPS; M. D. Greengard, St. Louis, Mo. Application filed May 18, 1893. A socket having a resistance and connections, a revoluble shaft connected thereto, a friction disc carried by the shaft and a spring having its body in engagement therewith with sufficient force to hold the same and the shaft at different points in their movement.
- 516,487. ELECTRIC CURRENT REGULATOR; C. D. Haskins, Brooklyn, N. Y. Application filed April 1, 1889. The combination with a shifting brush carrier, of a frictional device to operate the brush carrier, and an electric motor in circuit with the dynamo to rotate the frictional device.
- 516,492. ELECTRIC TROLLEY DEVICE; C. Knapp, St. Louis, Mo. Application filed Nov. 20, 1893. This comprises a pole the terminal of which forms suitable bearing surfaces, suitable lugs on each side of the upper of the surfaces, and guards adjacent to each bearing surface for guiding the wire. (See illustration.)
- 516,495. SYSTEM OF CAR LIGHTING, HEATING, ETC.; I. N. Lewis, Fort Wadsworth, N. Y. Application filed July 15, 1893. In a railway car carried by a swiveling truck, the combination with a dynamo, power driven from the axle of the truck, of a transmitting shaft geared to the axle, and a bearing for the shaft carried by an arm or bracket mounted on the equalizing bars of the truck.
- 516,496. CAR LIGHTING; I. N. Lewis, Fort Wadsworth, N. Y. Application filed Sept. 6, 1893. The combination with a dynamo machine, of a reversible driving power, a compensating coil connected to the armature and adapted to oppose the rise of electromotive force from increase of speed, and a pole changer between the pole and armature.
- 516,497. SELF-REGULATING DYNAMO; I. N. Lewis, Fort Wadsworth, N. Y. Application filed Sept. 8, 1893. The combination with a dynamo, driven by variable speed, of a magnet coil in the circuit of the armature wound or applied to tend to cut down the voltage of the armature when the current in the coil, due to increase of speed rises.
- 516,498. ELECTRIC SWITCH; I. N. Lewis, Fort Wadsworth, N. Y. Application filed Oct. 12, 1893. The combination of a separately excited dynamo and an electromagnetic pole changer controlling the connection thereof, with a working circuit and responsive to changes in the direction of the current supplied by the armature of the machine.
- 516,500. ELECTROMECHANICAL GONG; M. Martin, Malden, Mass. Application filed Aug. 8, 1893. This comprises a vibrating striking lever and controlling mechanism to engage and retain the lever stationary at the end of each vibration, combined with electromagnetically releasing mechanism for the controlling mechanism.
- 516,506. INTERIOR TELEPHONE SYSTEM; T. McCoubrey, New York, N. Y. Application filed Dec. 4, 1893. A telephone pivotally secured to a portable base, in combination with switching contacts between the base and the telephone, whereby, when the latter is tilted to one side, the circuit connections are changed.
- 516,508. ELECTRIC HEATER; J. O'Meara, New York, N. Y. Application filed Dec. 22, 1892. This comprises a core supplied with a surrounding conductor insulated from the core and from



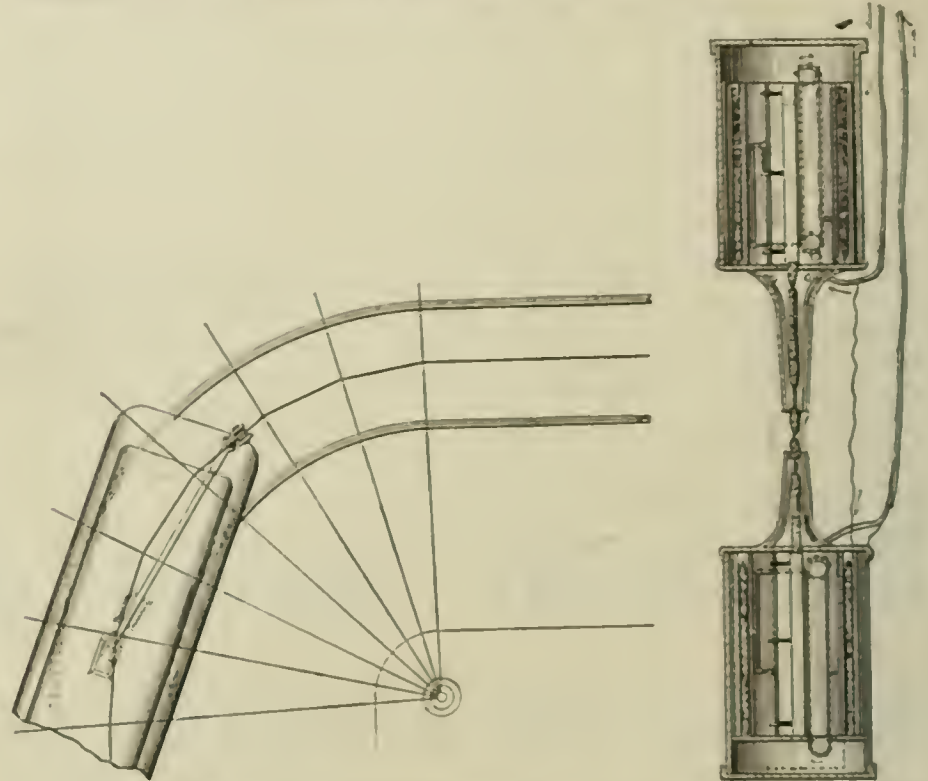
NO. 516,213. - ALTERNATING CURRENT MOTOR

external objects, and its coils, insulated from each other, combined with a casing having laterally projecting flanges and a series of change tops applicable to such flanges, at pleasure, to increase or diminish the top surface.

- 516,516. ELECTRIC MOTOR FOR STREET CARS; W. Baxter, Jr., Baltimore, Md. Application filed April 4, 1891. In combination with an electric motor having its field distorted and the wire space formed between its poles; of face plates on the sides of the poles to increase the cross section.
- 516,524. SUSPENDED ELECTRIC FAN MOTOR; J. F. Denison, New Haven, Conn. Application filed Jan. 9, 1893. An armature core comprising two castings, each consisting of a half rim and an arm extending inward from the center of the half rim and provided with an eye, through which the shaft passes.
- 516,552. TELEGRAPH APPARATUS; J. A. Parker, St. Louis, Mo., and J. L. Summers, Chicago, Ill. Application filed Feb. 23,

1893. In an electric telegraph, a revolving contact drum, fixed stops at one end thereof, a space key and a lever connecting thereto and normally in contact with one of the stops.

- 516,553. ARMATURE FOR DYNAMO ELECTRIC MACHINES OR MOTORS; W. B. Sayers, Glenwood, Scotland. Application filed April 26, 1892. This comprises an armature having the sections of its winding connected to the commutator strips by commutator coils so wound upon the core that the current generated in each of them and in the adjacent armature section will be in the same direction.
- 516,558. AUTOMATIC BLOCK SIGNAL; J. D. Taylor, Chillicothe, Ohio. Application filed May 29, 1893. The combination



NO. 516,492. - TROLLEY DEVICE.

NO. 516,574. - ARC LAMP.

with a revoluble signal, of a source of light yielding to two light beams, the revoluble signal being arranged to eclipse the light beams in alternation.

- 516,565. ELECTRIC RAILWAY SUPPLY SYSTEM; J. D. Cummings, Detroit, Mich. Application filed Sept. 22, 1892. This comprises a contact device suspended from the car consisting of a supporting frame located in the conduit and a plurality of independently vertically and laterally movable travelers loosely mounted in the frame and arranged horizontally.
- 516,574. ELECTRIC ARC LAMP; F. L. McGahan, Indianapolis, Ind. Application filed Jan. 2, 1892. The combination of a casing, a spiral carbon magazine with springs therein for forcing the carbons to the center of the same, an opening in line with the centre through which the carbons are adapted to pass, spring arms for holding the carbons, means for feeding the same and circuit wires connected to the springs. (See illustration.)
- 516,597. SEMAPHORE SIGNAL; I. L. Green, Kittanning, Pa. Application filed July 22, 1893. The combination of a semaphore arm fulcrumed near one of its ends, a sleeve, a link pivotally connecting and end of said arm with the sleeve, and means for moving the sleeve rearward and thereby raising the arm to horizontal position.
- 516,596. ELECTRICAL RAILWAY SIGNAL; I. L. Green, Kittanning, Pa. Application filed July 22, 1893. The combination with a longitudinally movable arm, a means for locking the same in its rearward position and contacts brought into engagement with each other by the rearward movement of the arm, of a relay, and an electromagnet, the magnet serving to release the locking mechanism for the arm.
- 516,598. ELECTRICAL RAILWAY SIGNAL; I. L. Green, Kittanning, Pa. Application filed July 28, 1893. The combination with an arm, a shaft, a segment on said shaft, a rack bar engaged by the segment and connected with the arm, and a supplemental shaft adjacent to the first mentioned shaft, and a speed multiplier connecting the shafts together.
- 516,626. CLOSED CONDUIT ELECTRIC RAILWAY; E. H. Brown, Salem, Mass. Application filed April 22, 1893. Closed independent and separate sections, each forming a surface conductor, a section of a continual central rail, and an insulating inclosure, in combination with independent longitudinal switch contacts, each lying loosely within the inclosure.
- 516,631. CLOSED CONDUIT FOR ELECTRIC RAILWAYS; W. Lawrence, New York, N. Y. Application filed May 2, 1893. This comprises a main conductor, a contact, a connection from the main conductor to the fixed part of the contact, a weighted lever carrying the movable part of the contact, a sectional working conductor, a rod connecting the moving conductor to the weighted lever, and a water tight casing inclosing the contacts and lever.

The Electrical World.

Vol. XXIII.

NEW YORK, APRIL 7, 1894.

No. 14.

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THE W. J. JOHNSTON COMPANY, Limited,

41 PARK ROW (TIMES BUILDING), NEW YORK.

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New England Office, 620 Atlantic Ave., Boston.

Western Office, 936 Monadnock Block, Chicago.

Philadelphia Office, 927 Chestnut Street.

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In the growth of the paper in circulation, size and general improvement, the value of its columns for reaching those engaged in electrical pursuits has not failed to be appreciated by advertisers. The following table shows its steady onward march in this department of business. The first issue of

1880 contained 25 different adv'ts.	1887 contained 154 different adv'ts.
1881 " 28 " "	1888 " 175 " "
1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 289 " "
1884 " 82 " "	1891 " 325 " "
1885 " 100 " "	1892 " 316 " "
1886 " 138 " "	1893 " 317 " "

The first issue of 1894 contained 320 different Advertisements.

No announcements of the Publisher are included in this list.

"WANT" AND "FOR SALE" ADVERTISEMENTS

are a special feature of THE ELECTRICAL WORLD. Position Wanted small advertisements cost but \$1 an insertion; Help Wanted and For Sale small advertisements cost but \$1.50 an insertion. Remit in advance for the number of insertions desired.

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41 Park Row, New York.

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THE ELECTRIC RAILWAY IN EUROPE AND AMERICA.

In a recent issue, an esteemed French electrical contemporary, whose editor is an exceptionally fairminded one, ventures to remark that "old Europe was the cradle and America the school" of the electric railway. To this poetical effusion it might have been added for completeness' sake, that the birthplace and parents of the infant were also American. This will doubtless lead many of us to stop and consider what proportion of a successful man's abilities he owes to his parentage and schooling and how much or how little to his cradle. The little story might have been related more completely though less poetically, and with less modesty, about as follows: After being born here of American parents, the baby was taken to Europe where he was rocked and exhibited in his cradle; finding the natives there very thorough but a little too slow for him, he left them and returned to this country to get his schooling; after becoming a man he again went to Europe to teach his former admirers and child nurses what he had learned at school.

A COMPARISON.

Our esteemed contemporary, the "Western Electrician," in its issue of last week takes pleasure in patting itself on the back for what to it was a phenomenal Convention issue, both in size and number of copies printed—the number dated March 3. While we doubt the effect of lengthy calculations of the acreage, etc., of paper used when based upon a sporadic issue of a journal, yet we congratulate our Western contemporary upon the enterprise intended by it, and trust that it will not allow the next seven years of its existence to pass by without marking its end by another heroic effort. This number furnishes an opportunity to determine how an extraordinary Convention issue of our contemporary compares with a usual Convention issue of The Electrical World, and for this purpose we will take our number of the same date, first basing the comparison upon material:

	Number of copies.	Number of pages.	Reams of paper.
The Western Electrician.....	16,630	56	128
The Electrical World.....	15,500	124	240

While we must acknowledge that in quantity of material our contemporary exceeds in its extraordinary issue that of its usual edition several times over, and that in advertising it has also there reached a high-water mark, the comparison in the latter respect is not quite so favorable as the above, as will appear from the following figures:

	Pages of advertising.	Number of advertisements.	Inches of advertising.
The Western Electrician.....	40	157	1,838
The Electrical World.....	76	386	3,215

In reading matter we fear that a comparison based on quality would be still less favorable to our esteemed Western contemporary, but as we are not aware that it makes any claim of excellence for this part of its Convention or any other issue, we will, therefore, spare it a comparison in that respect.

THE AMERICAN BELL TELEPHONE COMPANY.

The report of the American Bell Telephone Company, which we print elsewhere, has an interest not usually found in business statements. As marking how component a part of business life the telephone has become are the statistics showing how the recent business depression was reflected in that industry. A significant statement is

the amount of money invested during the past nine years upon betterments and extensions of plant, a great part of which was no doubt expended in pursuance of the policy to place the systems in a perfect condition, in order to be prepared to ward off competition upon the expiration of the fundamental telephone patents. The report refers to the probability of a system of tariff rates being substituted for the present flat rate. That this will eventually be done there is no doubt, as there is neither rhyme nor reason in the present method of fixed charges through which the small user is overcharged and the large user gets his service below cost—an absurd method that is being rapidly discarded in charging for the electric light. The statistics given in regard to the relative use of the telephone in the United States and other countries are gratifying to patriotic pride. It is shown that the United States has more telephones than all of continental Europe, with its more than 300,000,000 inhabitants, and that in commercial England, France and Germany there are 844, 1,583 and 580 inhabitants to a telephone, while in America there is a telephone to every 265 persons, or one to about every 50 voters. The reference to the excellent construction of long distance telephone lines recalls to mind the uniform lack of public recognition given by the American Bell company to the professional talent to which it owes a part of the success which has placed millions in its coffers. Owing to its policy of sinking the personality of its employees it is only within a limited circle that the value of the work of men like Lockwood, Pickernell, Carty and others has become known—a circle to which the splendid technical successes of the company is therefore not a mystery, as it is to the general public.

THE NEW PRACTICAL MAGNETIC UNITS.

In our last issue we referred to the probable application of the practical magnetic units provisionally adopted by the American Institute of Electrical Engineers at its recent meeting, and stated that since names had been given we might expect methods to follow that would cause them to be as readily and simply employed in magnetic calculations as their electric analogues are in electrical calculations. In another column Messrs. Houston and Kennelly point out how this may be done, and after reading their article, many, if not all, the doubts will be removed from the minds of those who had formed their ideas of the practicability of the new units from supposed difficulties in their direct application to practical calculations. Heretofore in magnetic formulas the reluctance has entered as a component part of the entire expression and been thus hidden; or if considered separate, it was in a form similar to that of resistance if instead of substituting its value in ohms we had instead represented it in terms of specific resistance, and length and diameter of conductor. In electrical calculations we now determine the resistance in ohms before substituting it in any practical formula; similarly in magnetic units, since we have given a concrete form to the idea of reluctances, we will now, as a matter of course, calculate its value in oersteds and apply the result in an exactly similar manner to that of resistance in ohms. Much has been said of the impracticability of a unit of magneto-motive force which is not of the same magnitude as an ampere turn, or not related to that magnitude by a power of 10. In the article to which we refer it will be seen that this objection is largely a theoretical one. In the magnetic circuit of a dynamo, for example, having found the value of the field in webers and multiplied that by the oersteds, as determined from the ferric and ferroferric circuits, it will be seen that the labor or liability of error in these passing from the resulting gilberts to ampere turns is negligible. Now that we have the units in a concrete form, it is easy to associate them with the electrical units by analogies. The oersted, for instance, corresponds to resistance, or

the ohm, the weber to the flow of current or the ampere, and the gilbert to electromotive force or the volt. There is no direct analogue to the gauss, but we consider the density of current in relation to the heating limit of conductors, as we do the density of magnetic flux with reference to a magnetic material. We say, for instance, that the density of current in an armature wire and in a field wire should not exceed, say, respectively 3,500 amperes and 1,000 amperes per square inch, and similarly we say that the flux intensity in wrought and cast iron should not exceed, say, 15 and 9 kilogausses, respectively, the possession of a unit with a name in the latter instance enabling us to avoid specifying the unit area.

POPULAR ENGINEERING LITERATURE.

Since the advent of several semi-popular professional magazines, and the growth of the demands of editors of literary magazines for popular scientific and engineering writing, there has been a vast amount of pseudo-scientific rubbish unloaded on the unsuspecting public. As the average reader of these articles is supposed to be unable to comprehend the real scientific principles at stake, it is therefore thought necessary to select the merely striking and curious points for their delectation. These are then enlarged upon to an alarming extent, and all sorts of speculations added, until the impression is left upon the minds of the readers that scientists and engineers must be a poor lot indeed to be unable to realize some of the promises thus glibly held out by these writers—who, by the way, are almost always unknown in the scientific or professional circles they purport to represent. It is this class who have made a shibboleth of the phrase "Electricity is yet in its infancy," who picture the modern ocean ship propelled by electricity crossing the ocean in a day, and who, after harping upon the use of electricity for trunk railways, have recently substituted electric air navigation as being less tame. The value of a popular article seems to be considered by these writers as in a direct ratio to the number of sensational statements that it can be made to contain, and they apparently view the public they serve as capable of being gulled to any extent, provided the stuff they write is given a semi-scientific guise. One of their favorite themes is the appalling inefficiency of the steam engine. Elaborate calculations are made to show that the steam engine is a wofully inefficient machine and the implication conveyed that steam engineers are a sorry lot not to apply a remedy. We are also told that there is no reason why heat should not be directly converted into useful energy from coal and that the manner in which we at present waste energy in producing light is little short of criminal. While it is true that from a thermodynamic standpoint the steam engine is inefficient, this follows from a law of nature and not through the neglect of man, and there does not seem to be the slightest probability that we shall ever be able to convert heat into mechanical energy with a greater efficiency than that given by heat engines. Another subject that had a great attraction for these gentlemen was the generation of electricity from water power. The energy of water, they argued, unlike that of coal, is free of cost, and the efficiency of the turbine is eight to ten times as great as that of the steam engine. With these data to start with they revelled in predictions; all domestic operations were to be carried on by electricity, and the farmer would sow, harvest, market and even assist the chemical growth of crops by electricity, and man would become a mere tender of electric buttons. That the development of water power for electric transmission purposes has not brought about the results predicted probably concerns the prophets little, as once that their object is achieved—which seems to be the desire of having their sayings liberally quoted in the newspapers as those of distinguished "scientists" or "engineers"—their energies are directed toward new fields to conquer in a similar manner.

Flywheel Regulation of Water-Power for Electrical Work.

BY WM. PIERSON JUDSON.

The Electrical World of March 17, 1894, describes the electric plant at Concord, N. H., and says "the idea of using flywheel inertia as a factor in the regulation of water power for electric work is being tried here for the first time with great success."

Flywheel regulation of water power for electrical work has been used for the past six years in one other case, at least, as will appear from the following particulars:

An isolated arc light plant, operated by water power through a large turbine wheel, was installed for New York owners at Oswego, N. Y., about 1886. In January, 1888, the writer was requested to correct some unknown defect in the plant, which caused frequent breaks in the lighting service. These breaks were attributed by the people who installed the plant to the ignorance of the dynamo man, who, like most frail humanity, had enough inherent defects of his own without also bearing those of a machine which he could not control.

Parts of the lamps and switches were burned out daily, and both of the armatures—of which there were two—were frequently absent for repairs. Finally both fields and armature were burned out, and the writer was then called in.

Examination of the conditions showed that all the breaks had been of a character likely to be caused by excessive speed in the waterwheel and consequent excessive E. M. F. in the circuit.

The large turbine wheel which furnished the power for the dynamo also operated various other machines of irregular use, and was governed by the ordinary swinging ball governor, geared to the turbine water gate.

This governor, of course, required several seconds' time in which to move the water gate whenever the wheel varied from its normal speed, and it evidently was not quick enough in its action for the electrical part of the load.

The writer decided that all the troubles had resulted from lack of regulation of speed, and a large flywheel was at once ordered and was set up between the turbine and the dynamo, with the immediate effect of stopping all the difficulties complained of.

Complete Metallic Circuits for Electric Railways.

To the Editor of The Electrical World:

The writer has been very greatly interested in the paper on the "Importance of Complete Metallic Circuit for Electric Railways," read by Mr. J. H. Vail at the Washington Convention. Mr. Vail states that "physical difficulties of operation were developed which warned the experimenters to avoid the 3-wire system in future electrical railway work." The difficulties met were in a set of trials made to effect a saving in copper in installations and the trials were made in 1890.

The writer is at the present time furnishing the power to operate the street railways in Portland, Ore., entirely by the system Mr. Vail decries, and further, has been doing so for the last two years. During this time there has not been an interruption chargeable directly or indirectly to the use of three wires. The results obtained by Mr. Vail by the use of track feeders is attained with the further advantage of a saving of more than one-half the wire needed by his plan.

In answer to a query made by the officials of the company operating the water works in Omaha, as to means used to prevent pitting by electrolysis in Portland, Mr. Smith, the engineer in charge of the Portland plant, wrote that no instance of pitting had occurred.

In view of the successful operation of this plant for two years, the writer would be glad to have Mr. Vail point out

the difficulties met that led to the statement taken from his paper.

Portland, Ore., March 26, 1894.

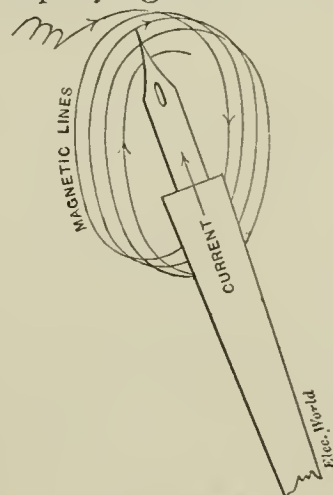
A. C. BALCH.

An Easily Remembered Rule.

BY CARL HERING.

So many rules have been published giving the relative directions of the current and the lines of force or whirls surrounding it, that it now becomes necessary to apologize for introducing a new one. The apology in this case is the same as the one usually given, that the author believes it to be simpler and more easily remembered than the others. The present rule applies only to the direction of the lines of force encircling the wire and therefore does not refer to the direction of an induced current as in dynamos, or the direction of motion as in motors, for which the writer has found Fleming's well known three finger rule to be the best.

To remember the direction of the magnetic whirls around a current, one has only to remember that if the current flows like the ink from a pen (that is, out at the point), then the direction of the magnetic whirls around this current will be the direction of the circular motion of the whole pen in drawing these whirls as one would, naturally, representing them as a close spiral encircling the pen, and beginning as though one started to write the small letter "m" (magnetic lines). The accompanying sketch will show this more



SIMPLE METHOD OF DETERMINING DIRECTION OF CURRENT.

clearly. Although it takes more than a few words to state this rule it is really simpler than it appears, the only important point to remember being that one must draw the spiral as if starting to write a small letter "m" (magnetism) and not as if starting to write the letter "C" (current); when drawn in the latter direction the current represented by the pen will be the one induced by the generation of these lines, as in transformers.

Some may prefer another rule, which is, that if the direction of the current is the same as the one in which one looks at a watch, then the magnetic lines will have the same direction as the movements of the hands of the watch. The reverse of this also applies: if the direction of looking represents the direction of the lines of force the direction of motion of the hands represents the direction of the current producing these lines.

Electricity in the Courts.

In discussing the legal proceedings regarding Muirhead's condenser, "Industries and Iron" indulges in the following bit of English wit of the "Punch" order: "All the leading electricians are to be in court and will be found on one side of the condenser or the other. The scientific witness—or expert, as he is sometimes called—displays capacity when examined by his own counsel, and resistance when the current is reversed. The judge acts as a condenser, as we have often seen him put a couple of questions so much to the point that there is no possibility of leakage."

On the Applications of the Proposed Names for the Practical Magnetic Units.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

In close analogy to Ohm's law of electric current flux, namely, $C = E/R$, or amperes = volts divided by ohms, is the law of magnetic flux $\Phi = \mathcal{F}/\mathcal{R}$; i. e., webers = gilberts divided by oersteds.

There is this difference, however, that while in a fixed voltaic circuit the resistance of the circuit at any one temperature is independent of the current strength, the reluctance of the iron in a magnetic circuit varies with the amount of flux.

The quantity of fundamental importance in all magnetic circuits is the flux, measured in C. G. S. units or webers. The range of such fluxes in the various forms of magnetic circuit, practically employed, is great. Thus, in the dynamo of largest output yet constructed (the 1,500 kw. intramural multipolar generator at the recent Chicago Exhibition) there were 12 field cores, and consequently 24 separate magnetic circuits through the armature. The flux in each circuit was about 15 megawebers, making the total flux through the armature about 360 megawebers. Again, in the case of an actual generator of 100 kw. capacity, with 8 poles and 16 circuits through the armature, there are at full load 3,538,000 C. G. S. units of flux, or 3.538 megawebers in each circuit, making a total flux usefully employed in the armature of 56.6 megawebers.

Again, the flux in each of the two magnetic circuits through the armature of a continuous current bipolar 1-12-h. p. fan motor is about 40 kilowebers, or 80 kilowebers through the armature in all.

In alternating current transformers the flux also possesses a wide range. A transformer of 100 kw. capacity might have a maximum total flux of 3 megawebers, depending, of course, on the frequency and specifications of design. On the other hand, a small 100-watt transformer operating at 130 ~ might have a total maximum of flux of 160 kilowebers.

In electromagnets there is evidently an enormous range of flux variation, owing to their different cross-sections and in regard to the character of the work they are called upon to perform. A large electromagnet of, say, 100 square centimetres cross-section might have a total flux on closed magnetic circuit of 2 megawebers, while an electric bell magnet having, say, 1 square centimetre of cross-sectional area, might not perhaps develop more than 2 kilowebers of flux.

Flux density, $\mathcal{B}$, measured in gauss, or webers per normal square centimetre, has been carried experimentally in wrought iron under special conditions by Ewing and Low to 45.35 kilogauss. Practically, however, soft iron becomes saturated in the neighborhood of 19 kilogauss.

In dynamo field frames of wrought iron or soft steel a density of 15 kilogauss is common.

In dynamo field frames of cast iron a density of 10 kilogauss is common.

In alternating transformers worked at frequencies below 100 ~ a density of 9 kilogauss is common.

In alternating transformers worked at frequencies above 100 ~ a density of 5 kilogauss is common.

In the entrefer of dynamo machines a density of 3 kilogauss is common.

In permanent magnets of hard steel a density of 2 kilogauss is common.

The earth's flux in the neighborhood of New York has a density of 0.6 gauss approximately.

The earth's horizontal component has a density of 0.18 gauss approximately.

The reluctance of a magnetic circuit is a very important

practical quantity. In closed ferric circuits the reluctance is usually determinable, from experimental data, with all the precision that is necessary for practical work, but in a composite iron and air circuit, for which the name "aeroferric" circuit is proposed, the reluctance, while not so accurately determinable, can yet be approximately computed, when allowance is made for derived leakage paths. To this category all practical motors and dynamos belong. The reluctance of non-ferric circuits is usually very difficult to predetermine, but is also usually of much lesser practical importance.

The reluctance of any homogeneous portion of a magnetic circuit can be expressed in terms of its length, cross-section, and reluctivity, just as the resistance of a voltaic circuit can be expressed in terms of its length, cross-section, and resistivity. The reluctivity of air is unity, or differs from the unity of free ether by an inappreciably small amount. The reluctivity of iron depends upon the flux density, as expressed by the relation

$$\nu = \frac{a}{1 - b\mathcal{B}}, *$$

where ν is the reluctivity, while a and b are two constants depending upon the nature of the iron, and determined experimentally from a sample of the iron. Consequently, when the flux density in the various portions of a magnetic circuit are given, the reluctances of those portions are determined, and can then be aggregated like voltaic resistances. The total reluctance in the magnetic circuit or any branch thereof is therefore calculable when due allowance is made for the derived leakage paths, and these latter have lesser influence, the smaller the reluctance of the entrefer.

For example, in the case of the 100-kw. continuous current generator before alluded to, the total reluctance at full load of each separate circuit through the armature is approximately 6 millioersteds, made up as follows:

The armature core				
reluctance at $\mathcal{B}$	= 9.5 kilogauss	= 0.20 millioersted		
The two entrefer				
reluctances . . .		= 4.28	"	"
The cast steel				
magnet semi-				
cores at $\mathcal{B}$. . .	= 14.6	"	= 0.78	"
The cast steel				
magnet yokes				
at $\mathcal{B}$	= 13.0	"	= 0.69	"
Total reluctance			= 5.95	"

The allowance for derived leakage paths has here been made in assigning the proper increase of available area, density and reluctivity at that density, to the cores and yoke.

In this instance, about 70 per cent. of the circuited reluctance is situated in the entrefer.

The flux in each armature circuit necessary to generate the full E. M. F. in the loaded generator at speed has been before mentioned to be 3.538 megawebers. Consequently, by Ohm's law, the M. M. F. necessary to produce this flux through the circuit is

$$\begin{aligned} \mathcal{F} &= \Phi \mathcal{R}, \text{ or } \mathcal{F} = 3.538 \times 10^6 \times 5.95 \times 10^{-3}, \\ &= 2.105 \times 10^4, \\ &= 21,050 \text{ gilberts;} \end{aligned}$$

and since 1 gilbert = 0.7958 ampere-turn—i. e., practically 0.8 ampere-turn, $\mathcal{F} = 16,840$ ampere-turns, or 8,420 ampere turns on each field spool. The actual number developed is 8,500 ampere turns at full load, agreeing very fairly with the computed value from reluctance.

The Saline Electric Railway.

The last section of the electric railway to the summit of the Saline, about 5,000 feet above the level of the sea, was recently opened.

*This is a consequence of the known relation $\nu = a + b\mathcal{B}$.

The Portland General Electric Power Plant.



THAT the era of electrical power transmission is fairly at hand is again attested by the magnificent plant now being equipped for the Portland General Electric Company at Oregon City, Ore., twelve miles from the city of Portland, on the Willamette River. So much has been said and written of the possibilities of electrical transmission in the last few years that it is encouraging to see a practical demonstration of this principle on such a scale as is now being executed in the

power station is one of the most important yet constructed. The present plant is of thoroughly legitimate parentage. It is the offspring of a somewhat similar plant built several years ago with the crude waterwheels and generators there in service. Notwithstanding this fact the plant has been in successful operation from the very start, and has proved to be a first class investment. Its continued success, its extreme simplicity and exceedingly profitable returns on the investment are jointly responsible for what is to be one of the most complete and interesting electrical power plants ever constructed.

Nature and the State government of Oregon have combined to furnish the Portland General Electric Company an ideal water power for its station. A good idea of its location may be obtained from the map shown in Fig. 1. At

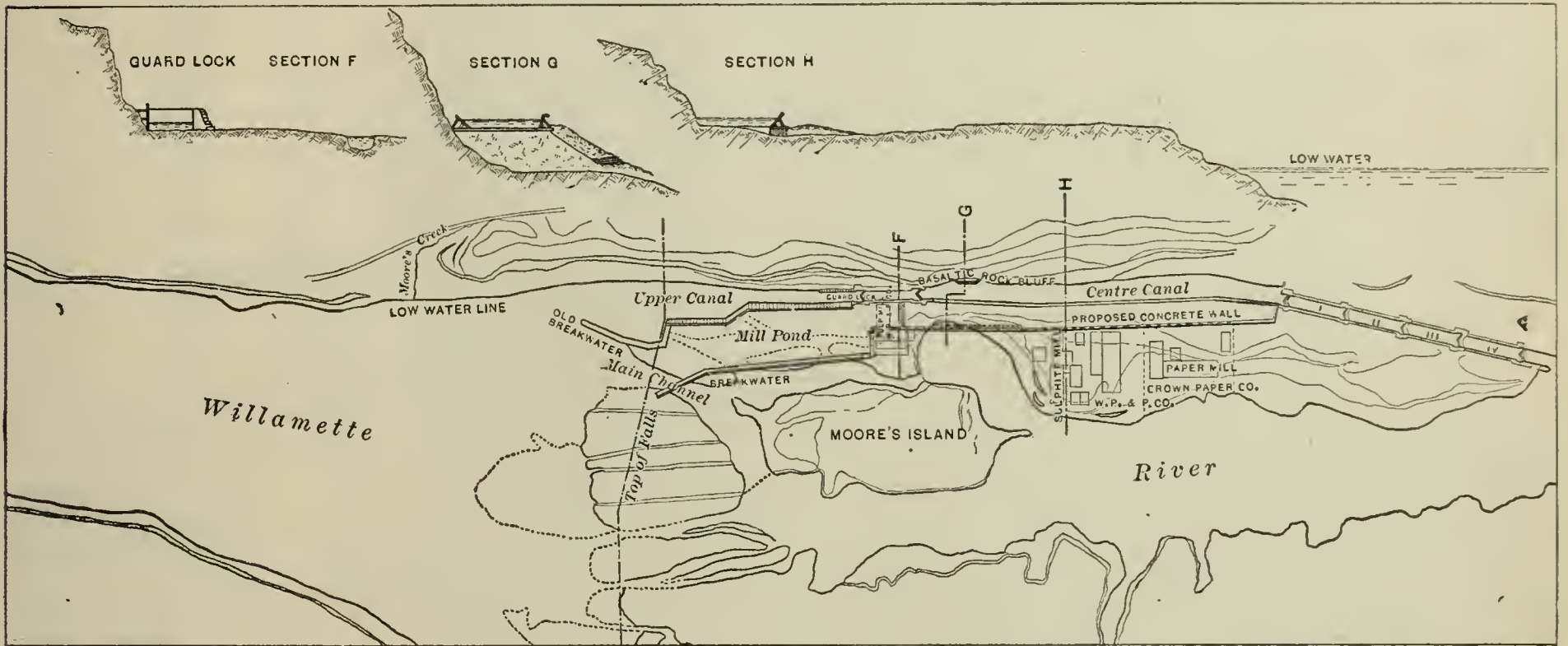


FIG. 1.—MAP OF RIVER AND CANAL, SHOWING LOCATION OF POWER STATION.

enterprising Northwest. With the Portland General Electric Company it is no longer a question as to whether a plant of this kind will successfully operate. It is now a question

this point on the Willamette River, known as Oregon City, are a series of broken falls, over which navigation is impossible. The State government consequently designed a

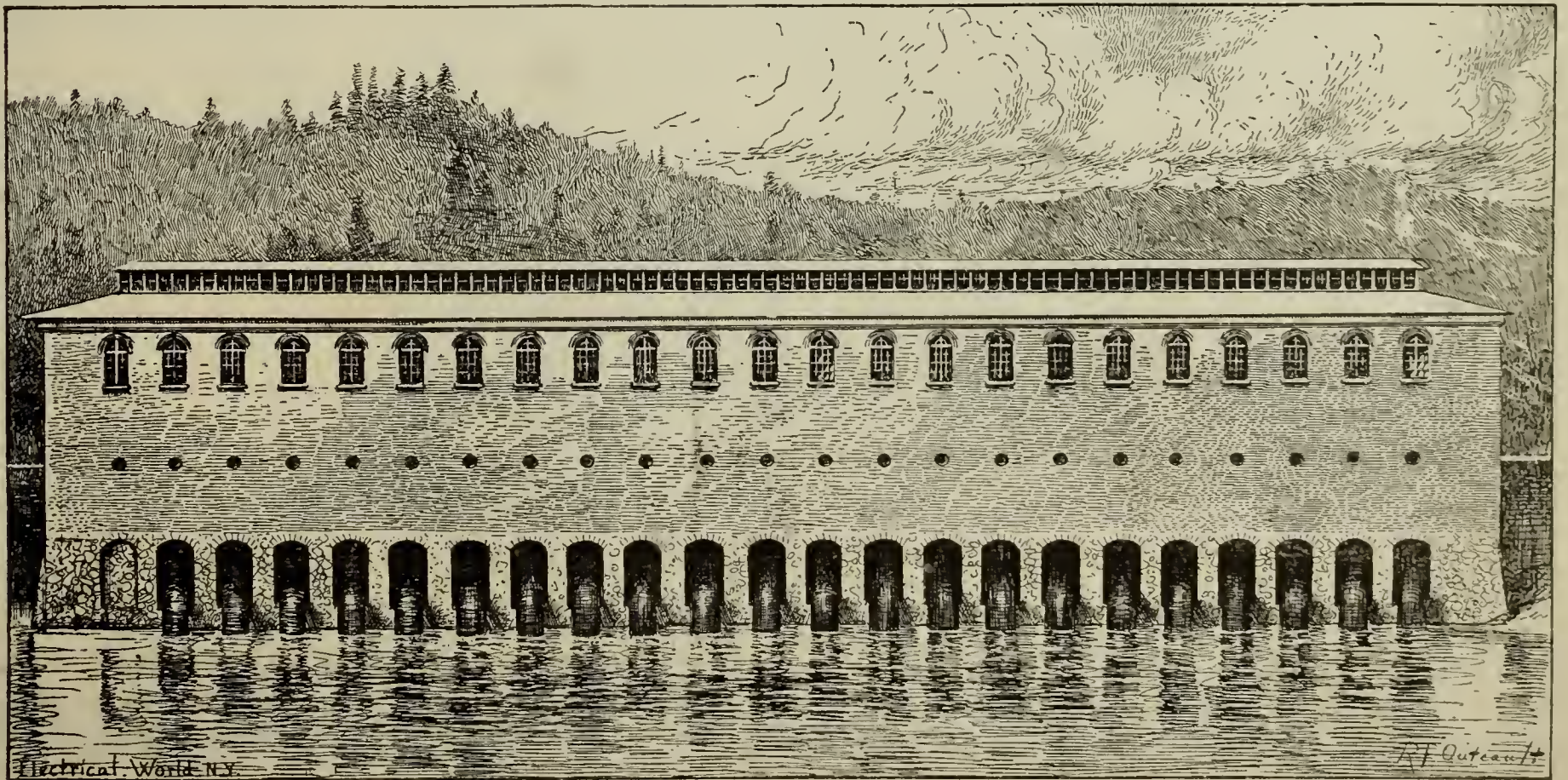


FIG. 2.—EXTERIOR VIEW OF THE POWER STATION.

of how much time will be necessary to place all the apparatus and turn on the water. As an engineering effort, both from an electrical and mechanical standpoint, this

canal along the left bank of the river, through which vessels could pass around the falls and continue their course. The Portland General Electric Company has secured con-

trol of this canal, and is erecting its new power station at the point marked G. The building will form one wall of the canal, and from the gates in this wall the water will pass through the turbines to the draft tubes to the bed of the river below, a fall of 40 feet.

At this place are several industrial plants now being operated by water power direct, so that the new electrical station will afford engineers an excellent idea of the differ-

ence between the new and the old way of utilizing water power. Under the old system the raw material had to be shipped to this point and reshipped when finished; whereas, with the electrical plant, the current is generated here and then transmitted over twelve miles of line to the city of Portland, to be utilized there for lighting the city, operating the street railways and for various other uses to which electric power has been adapted.

One section is devoted to two 48-inch turbines for driving a pair of exciters of 400 h. p. capacity each, which are directly connected to the shafts of the turbines in the same manner as the generators, making the total electrical capacity of the station 12,800 h. p. One section is devoted to two 15-inch turbines; one for operating a duplex power

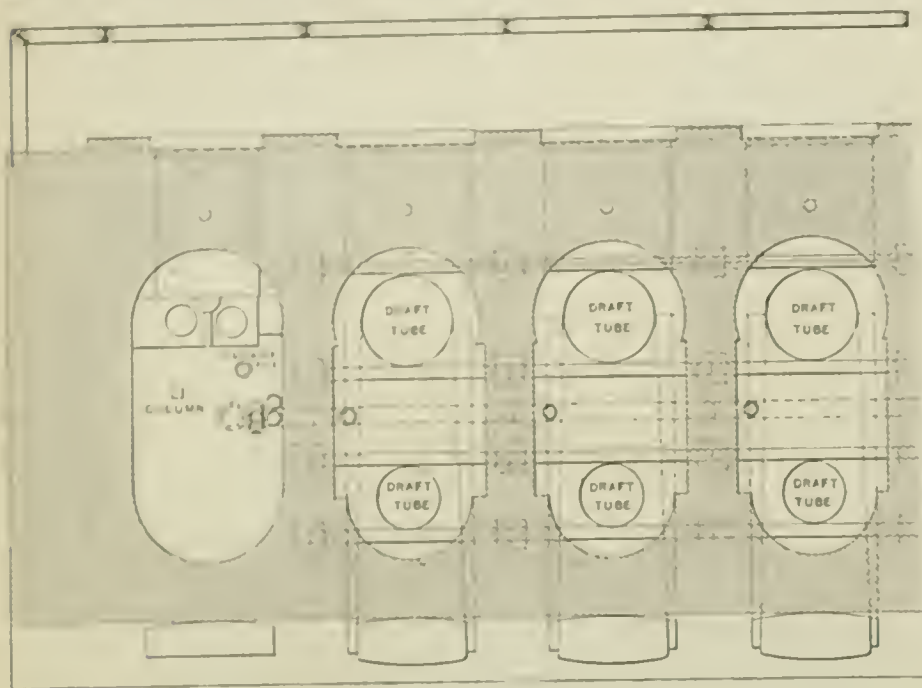


FIG. 3. SECTIONAL VIEW AT TOP OF TURBINE.

ence between the new and the old way of utilizing water power. Under the old system the raw material had to be shipped to this point and reshipped when finished; whereas, with the electrical plant, the current is generated here and then transmitted over twelve miles of line to the city of Portland, to be utilized there for lighting the city, operating the street railways and for various other uses to which electric power has been adapted.

An excellent idea of the exterior appearance of the power station may be obtained from Fig. 2.

It will be noticed that there are 22 sections to the building

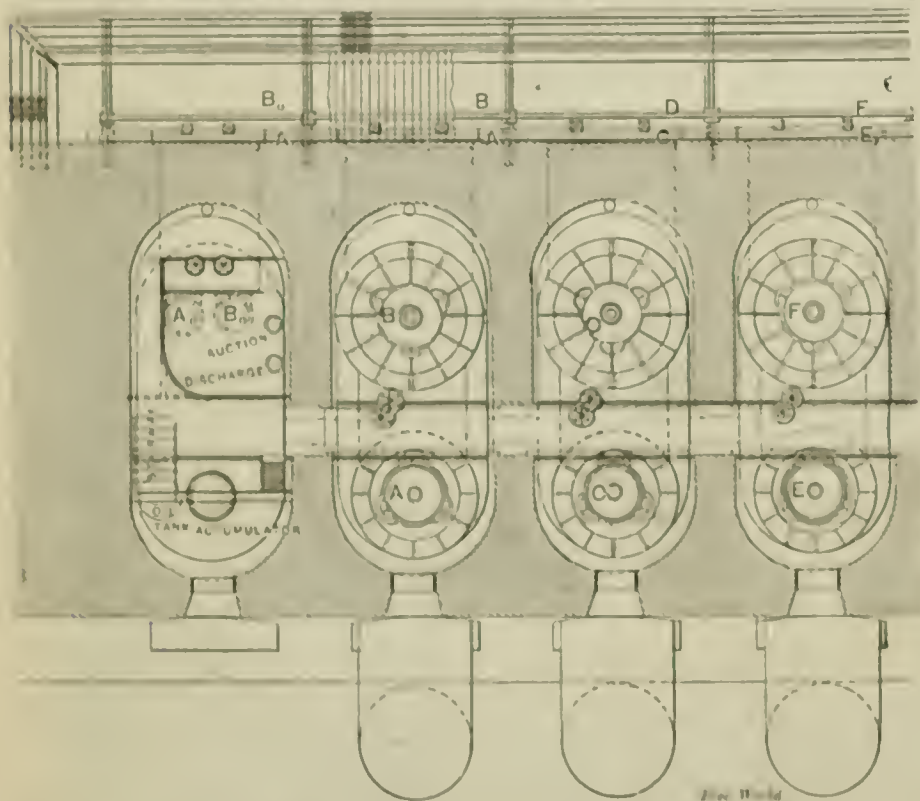


FIG. 4. SECTIONAL VIEW FROM BULL'S-EYE WINDOW.

of uniform size and style, four of which are shown more in detail in Figs. 3 and 4, which are plans of a short section of the station at an elevation of 30 feet and 48.9 feet respectively. In each of 20 sections are to be installed one 42-inch and one 60-inch cylinder gate Victor turbine, directly connected to a generator of 600 h. p. capacity, making a total electrical equipment of 12,000 h. p. The 42-inch turbines

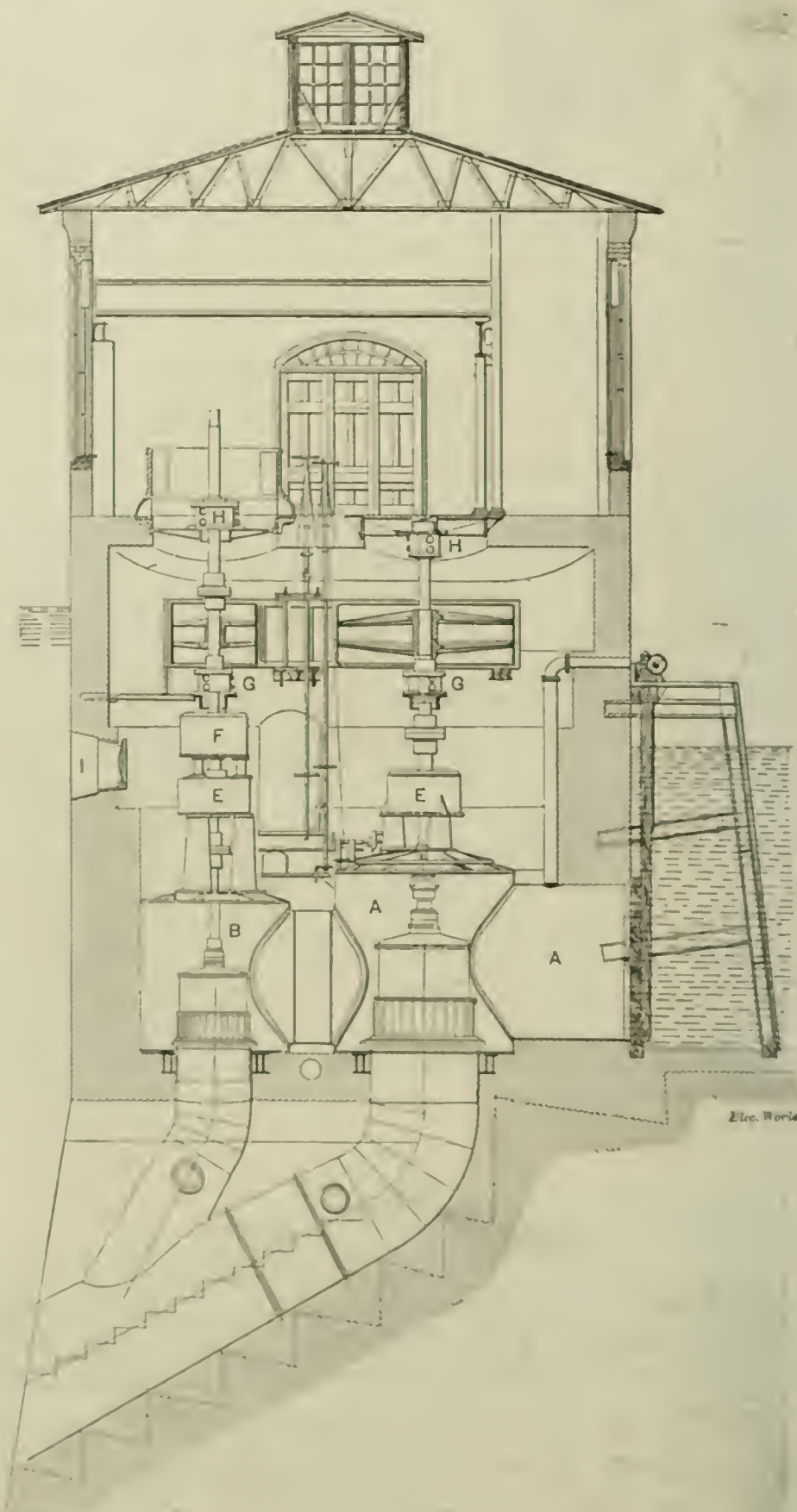
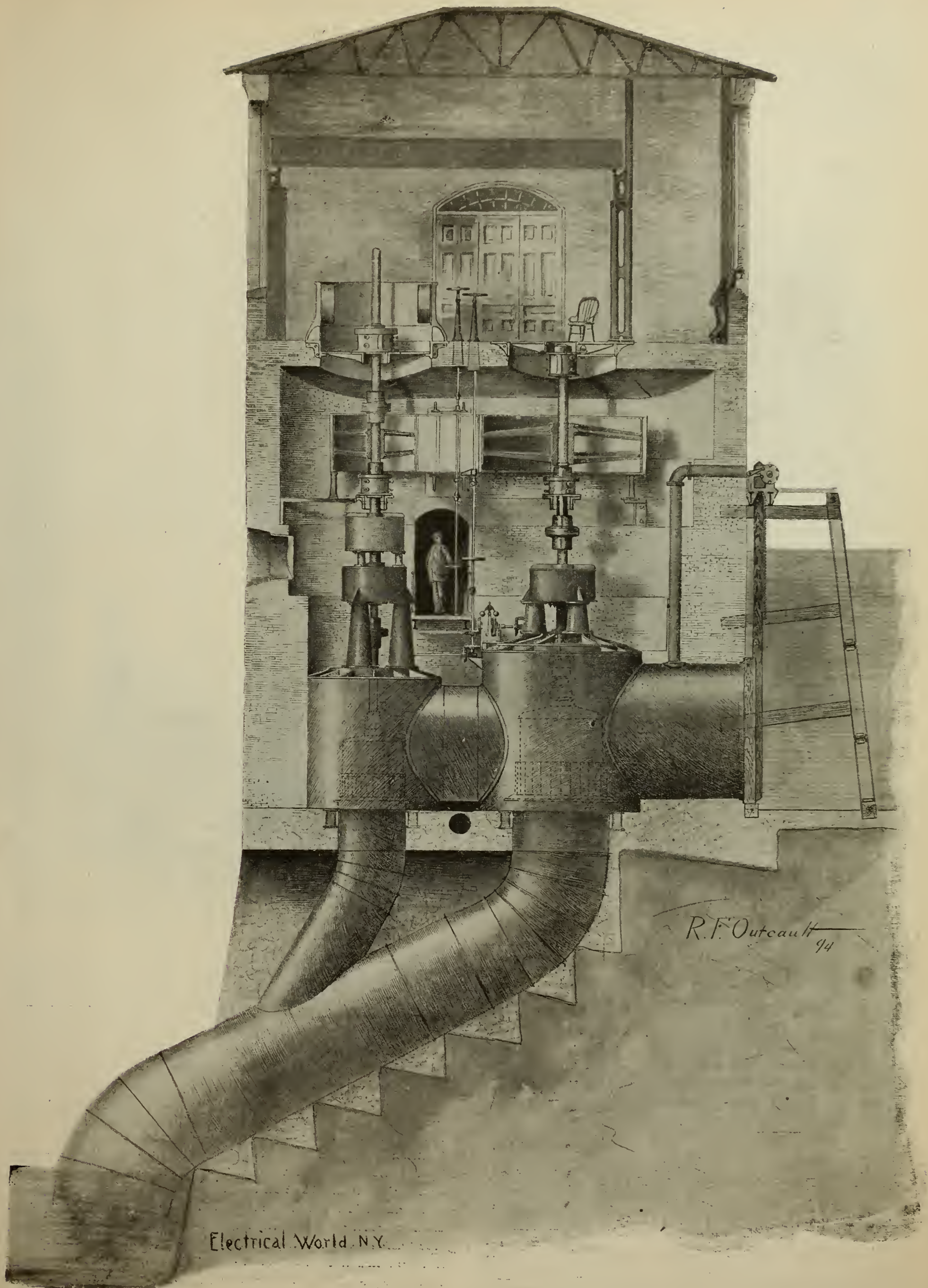


FIG. 5. SECTIONAL ELEVATION, LOOKING UP-STREAM.

will form the initial plant, while the larger turbines will form the auxiliary plant.

It will thus be seen that in one long room there will be electrical generators with a total capacity of 12,800 h. p. divided into 22 separate units, each one independent of the other.

The building itself is of the most substantial character. From the rock foundation to the generator floor it is built of solid cement laid in forms, while from the generator floor to the eaves of the structure is of brick with steel roof. A sectional view is given in Figs. 5 and 6. In this it will be no-



Electrical World N.Y.

FIG. 6.—SECTIONAL VIEW OF POWER STATION.

ticed that the draft tubes are anchored by a series of shelves to its rocky bed, so that no side pressure could affect the solidity of the structure. It could only be loosened from its foundations by being lifted up out of this anchorage.

Fig. 3 shows a section of the building at the top of flumes,

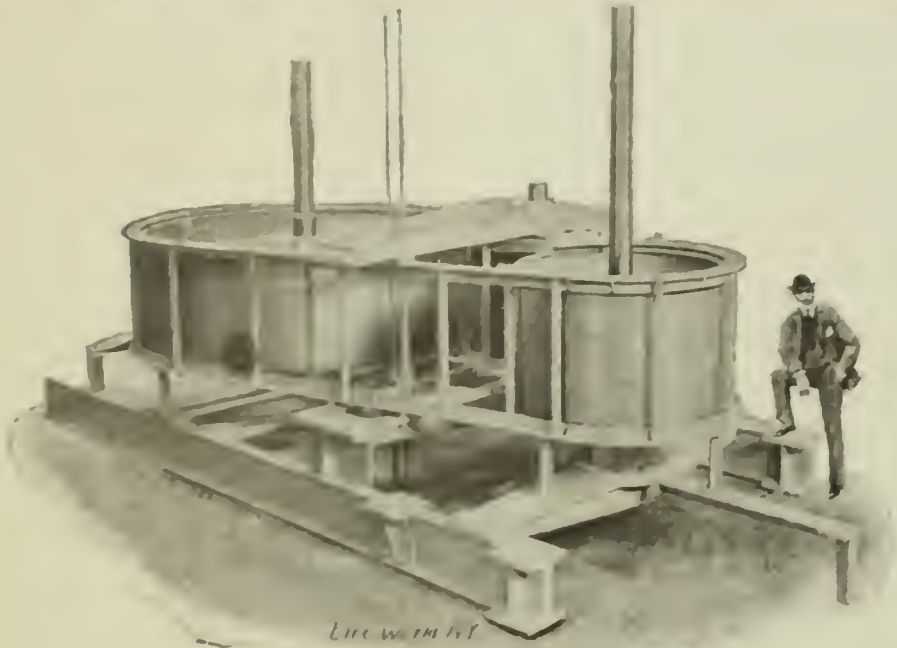


FIG. 7.—BELT TIGHTENER.

while Fig. 4 gives an idea of the structure looking through from the bull's-eye window. The building itself has a total length of 420 feet and is 77 feet from the water level of the river to the caves.

By following the letters in Fig. 5 the arrangements made

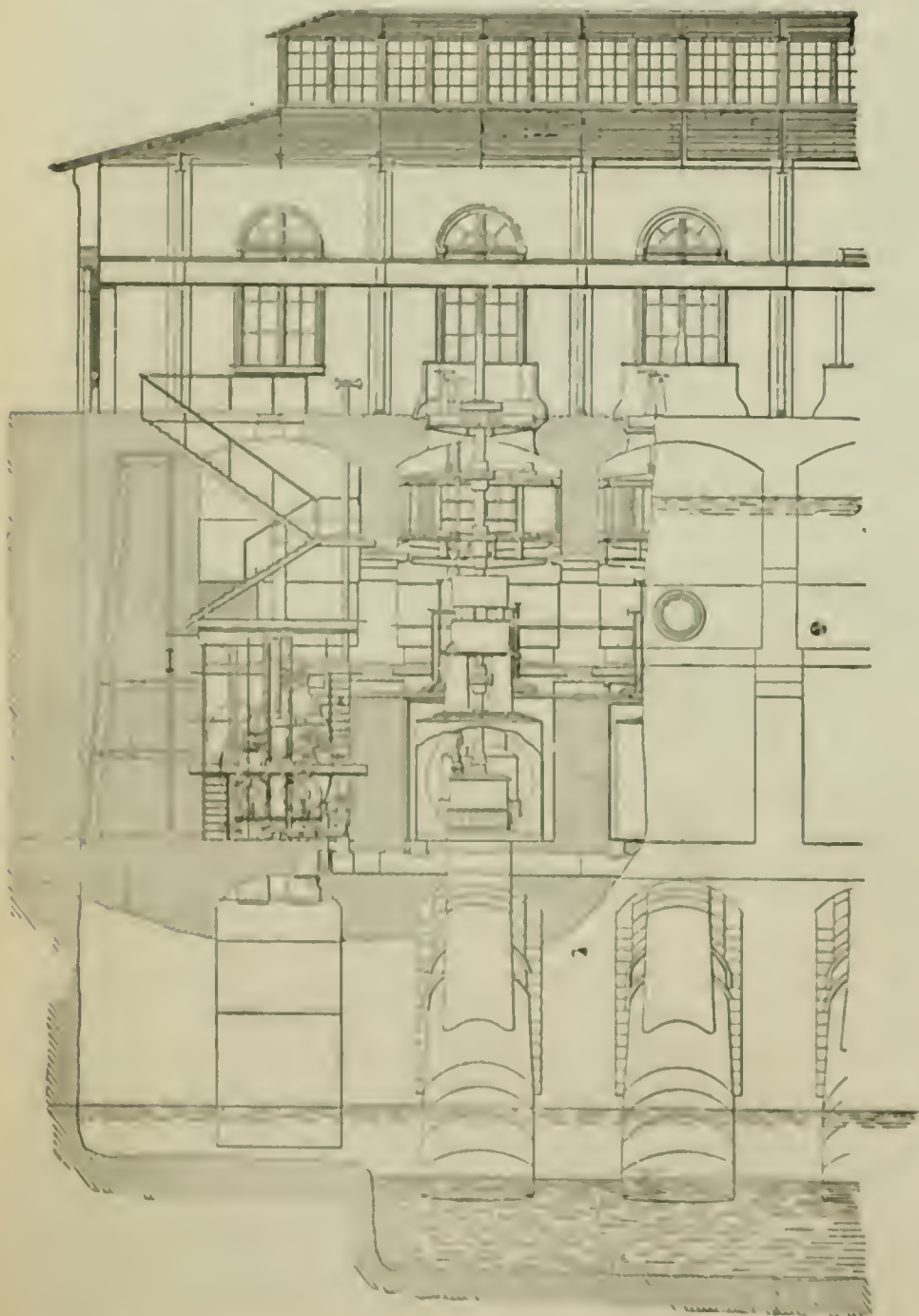


FIG. 8.—LONGITUDINAL SECTION LOOKING UP STEAM

for utilizing the water power as it flows from the canal may be readily understood.

The flume marked *A* contains a 60-inch turbine, while flume *B* contains the 42-inch or initial turbine that is directly connected to the generator shaft. This latter is the one that will ordinarily carry the load, as it is calculated to operate at a speed of 200 revolutions per minute under a head water of 40 feet. The 60-inch turbine has been installed to take care of the rise of water which occurs in the Willamette River, according to the records, once every five years. In other words, a duplicate turbine equipment is installed to take care of a change in the head water that occurs but once in five years, which shows the thorough and permanent character of the station. In the event that the larger turbine is necessary, the coupling *C* on the generator shaft is disconnected and the larger turbine started. The power is conveyed to the generator shaft by a belt tightener, *D*.

A good view of this tightener is given in Fig. 7. The large pulley is 12 feet in diameter with a 48-inch face, and carries a 46-inch vertical belt. The receiving pulley is 6 feet in diameter. The belt guide, which runs around both pulleys, holds the belt clear from the pulleys when not in use. When the 60-inch turbine is to be used, the hand wheel in the generator room closes the tightener between the two pulleys, so that the belt is drawn tight, and the same power is secured at the generator as if the small turbine were in service.

After passing through the turbines the water discharges into the draft tubes shown in the illustrations. These are so arranged that one outlet is sufficient for the two turbines. This is very clearly illustrated in Fig. 8, which shows one generator section and the pump room looking up stream.

The large draft tube rests on the shelf arrangement, which



FIG. 9.—BULL'S-EYE WINDOW.

forms an anchorage for the entire structure, as already described.

To take care of the great weight of the generator shaft and turbine—33,000 pounds—extraordinary precautions were necessary. The letter *E*, Fig. 8, represents a mechanical thrust bearing, water jacketed, capable of sustaining the entire load; but the hydraulic cylinder, *F*, just above it, is the pivot on which the load usually rests. The oil in this cylinder is kept at a constant pressure of 275 pounds per square inch, and can easily sustain the entire weight of the shaft, both from above and below.

Engineer Rice has demonstrated by tests that the hydraulic bearing of oil will hold this enormous weight in service with a very small percentage of leakage, and tests show it to be much more reliable than any mechanical bearing ever designed. In order to keep the oil in the hydraulic cylinder cool, a stream of water is constantly flowing about the oil chamber.

Still further up the shaft is another bearing *G*, which rests on cast iron beams; but this is relied on more as an

alignment bearing than anything else, and is so protected that no oil from it can flow to the parts beneath.

The letter *I* represents a bull's-eye window arranged in the river wall of the building to admit light and air to the lower sections under ordinary conditions. At times the water of the river backs up to an unusual height, and in this event the window is so arranged that it will admit the light, but not the water.

Another view of this interesting section of the structure is given in Fig. 13. It may be observed that Figs. 5 and 6 show but one of 20 sections exactly similar. Each one is entirely independent of all the others, but it is expected that the current from all the generators will be collected at one switchboard, and from this point transmitted to one main centre of distribution in the city of Portland.

The power in each section is controlled by two hand wheels that can be operated either from the generator or

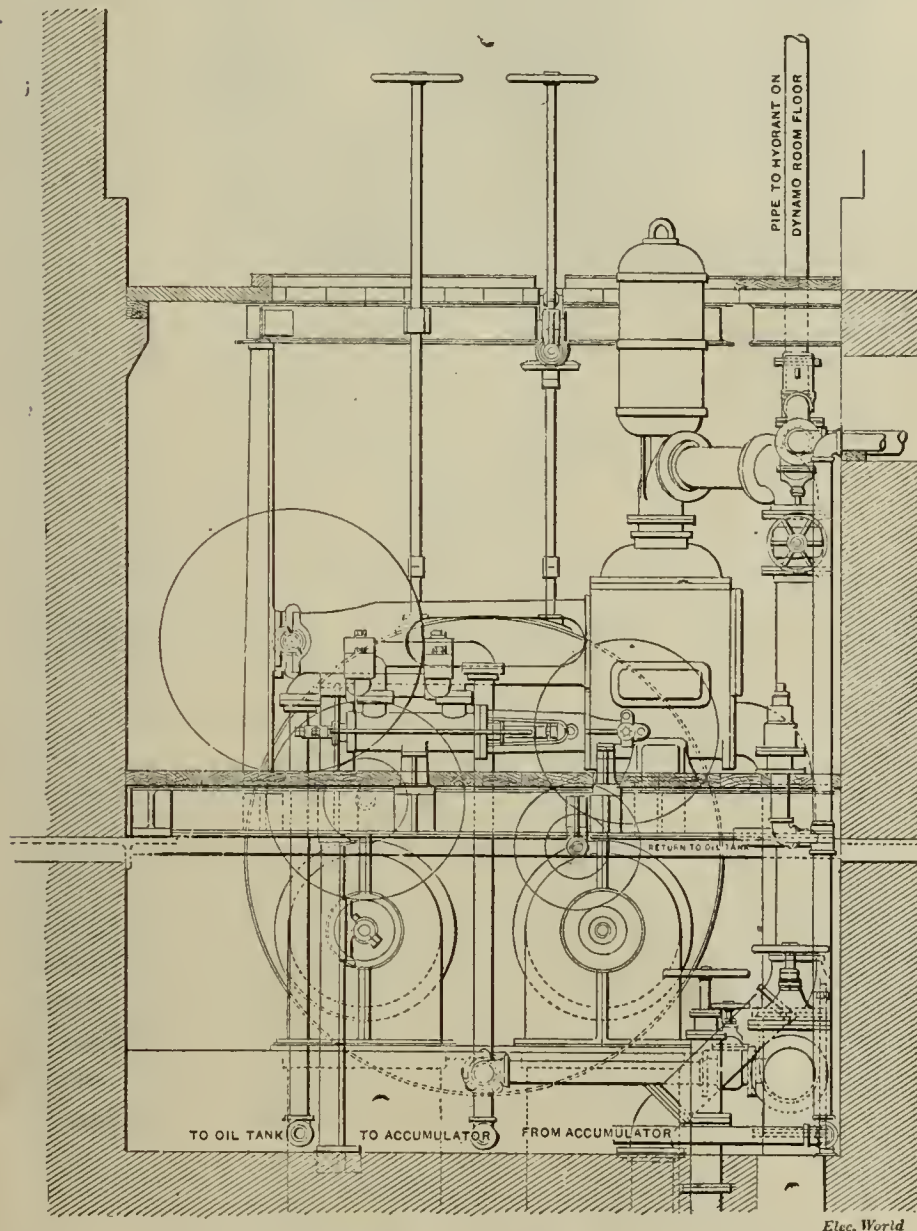


FIG. 10.—SECTIONAL VIEW OF OIL PUMP.

the lower floor, as may be seen in Figs. 5 and 6. One of these wheels serves to start either the 42-inch or the 60-inch turbine, being directly connected to the automatic governor with which these turbines are equipped. This governor is so nicely adjusted as to take care of any variation of pressure on the wheel, and keeps the speed constant. The other hand wheel with one movement brings the tightener in contact and tightens the belt on the pulleys, thereby transmitting the power from the 60-inch turbine to the generator shafts.

The water is admitted to flumes from headgates operated from a platform along the side of the building.

One exciter of 400 h. p. capacity has been determined upon as sufficient for the 20 generators, but two of these are to be installed in order that they will be ready for service with either high or low water. In this section two turbines of equal size are to be installed with no belt arrangement. Instead of the single mechanical bearing supplied to the other auxiliary turbines, the hydraulic bearing is arranged to take care of the weight of the exciter, the same as on the other generator shafts.

One of the most interesting features of the entire plant is the pumping arrangement for supplying oil to the hydraulic cylinders and water to the jackets surrounding them.

Fig. 10 gives a sectional view of the oil pump, while Fig. 11 shows it as it appears. This pump is operated from a separate turbine, as will be noticed in Fig. 11. The oil is

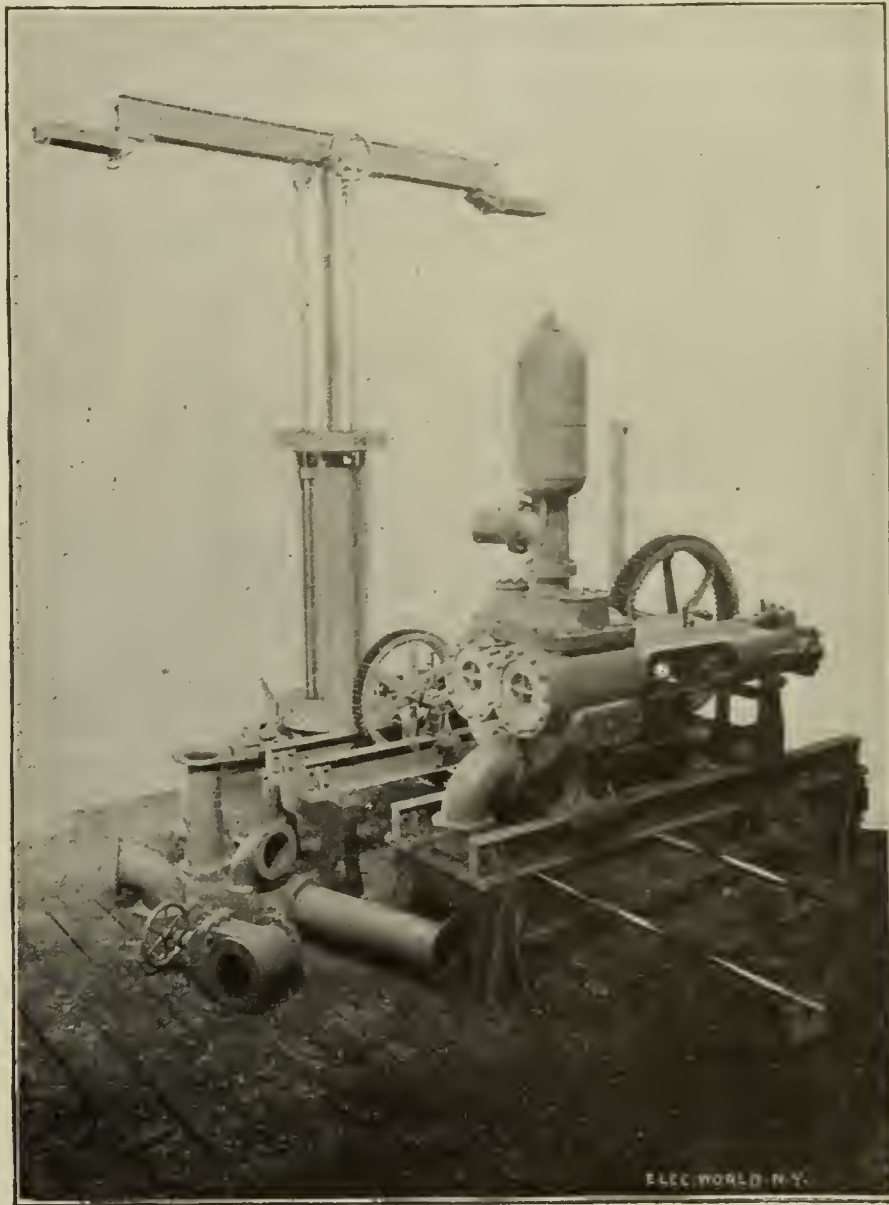


FIG. 11.—OIL PUMP WITH ACCUMULATOR.

pumped into the accumulator shown in Fig. 11. This keeps the pressure of oil at 275 pounds to the square inch when supplying the hydraulic cylinders. The upright shaft with cross-beam is connected to the turbine gate and automatically regulates the supply of oil in the cylinder. That is, if the quantity of oil in the accumulator were to be reduced, the

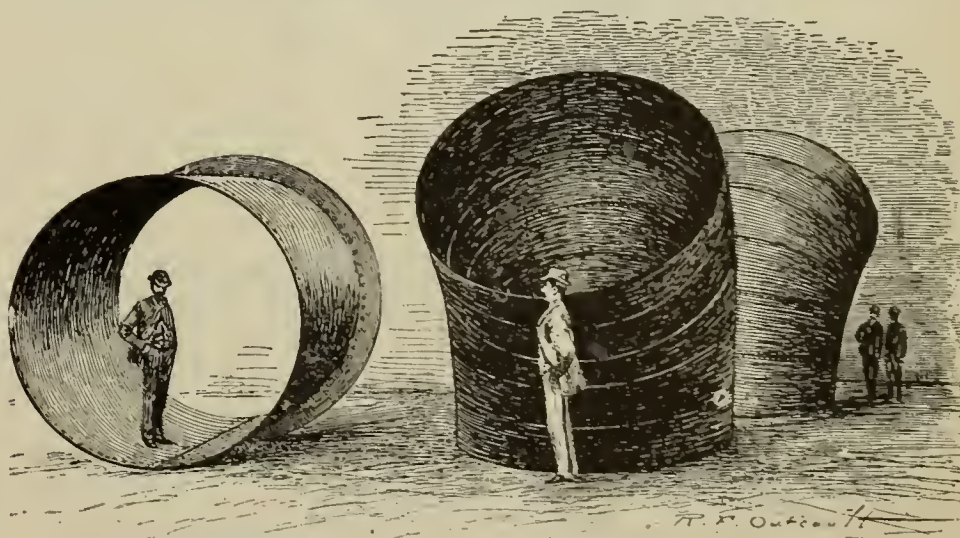


FIG. 12.—DRAFT TUBES.

turbine gates would be opened to a greater angle and more water admitted so as to take care of the additional oil called for.

Another pump is devoted to supplying water to the water jackets around the cylinders. Both are operated by a 15-inch improved cylinder gate Victor turbine.

The generator room is supplied with a 12-ton electric

crane for handling the armatures, etc. This crane has a longitudinal travel of 368 feet, and a cross travel of 24 feet 6 inches.

The switchboard will be placed on the columns which carry the crane.

The turbine used in this installation is what is known as

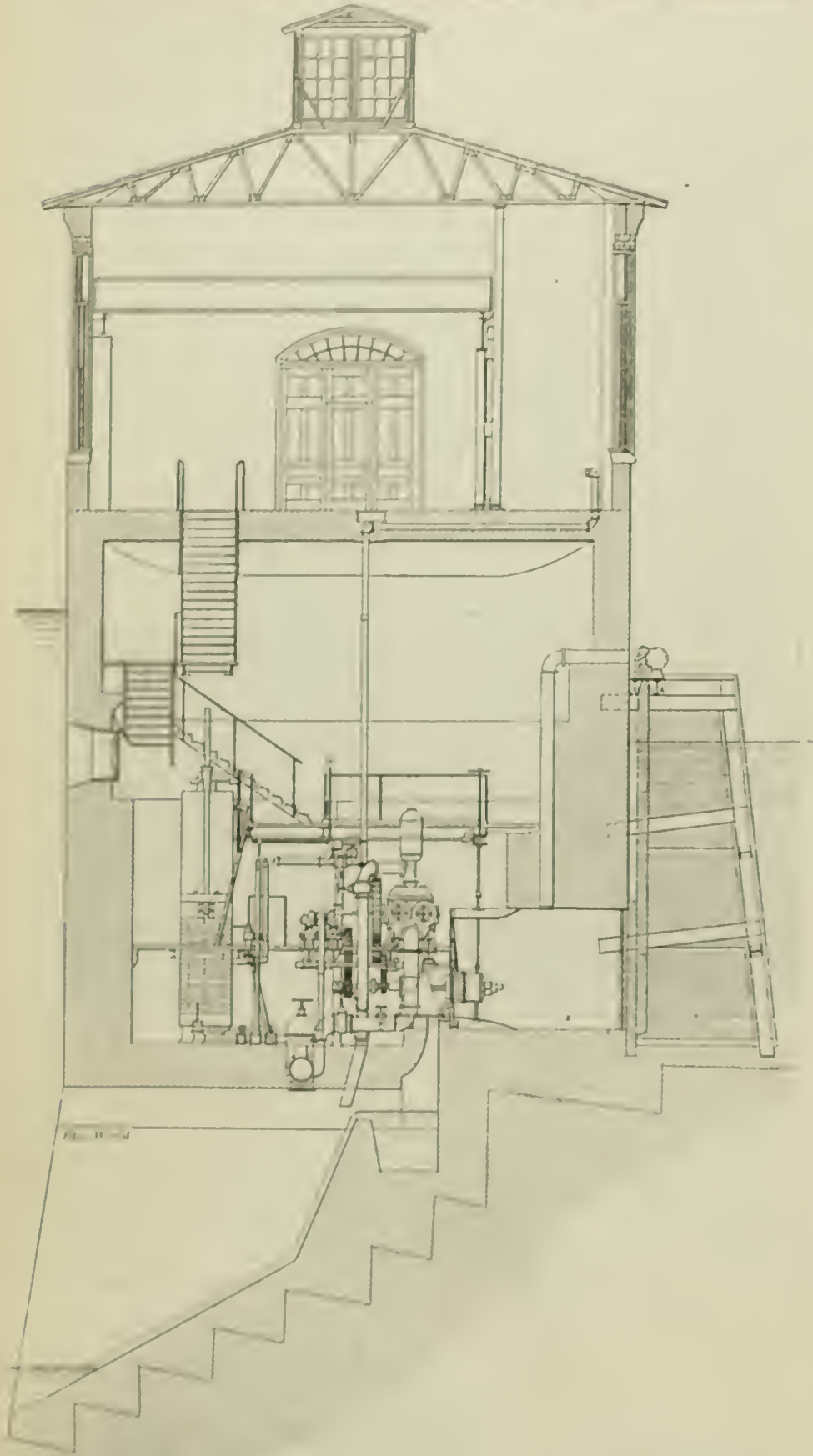


FIG. 13.—SECTIONAL VIEW OF PUMP ROOM. the cylinder gate Victor turbine, built by Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio, and designed especially to meet the demand for high partial gate results. Its remarkable steady motion, high speed and great efficiency, together with its close regulation at full and partial gates, recommended its selection for this plant.

The entire power equipment has been manufactured by the Stilwell-Bierce & Smith-Vaile Company at their extensive shops at Dayton, Ohio. All the plans for the development of the entire plant were drawn by their well-known engineer, Mr. A. C. Rice, who has devoted a great deal of time and careful study to this plant.

The electrical part of the equipment is to be supplied by the General Electric Company, and promises to present

many new features of interest in three-phase electrical transmission. Mr. P. F. Morey is president of the company,

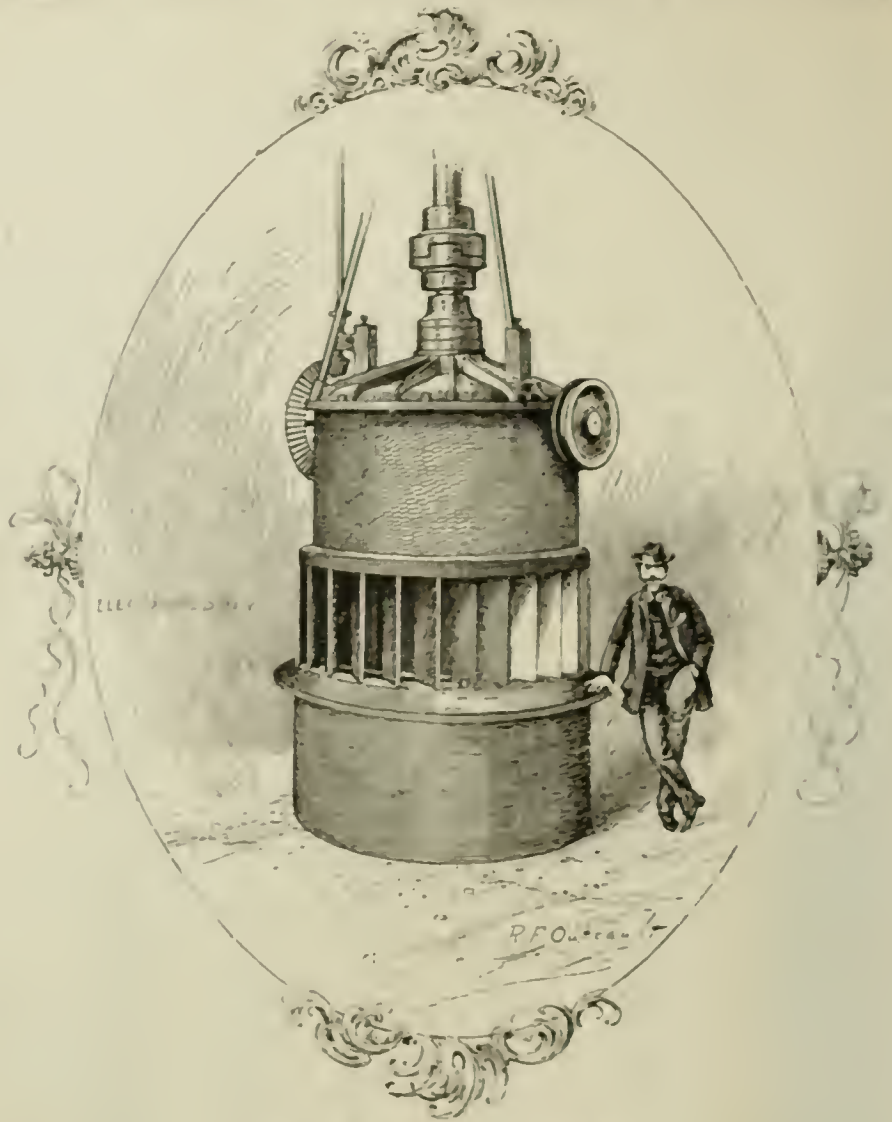


FIG. 14.—THE TURBINE.

W. C. Cheney superintendent, and T. W. Sullivan resident engineer.

Alternate Current Working.—V.

BY HARRIS J. RYAN.

The impedance of a circuit is that which limits the amount of current to be established by a given alternating E. M. F., just as the ohmic resistance limits the direct current that is established by a given amount of direct E. M. F. Alternating E. M. F. divided by the impedance of a given circuit equals the current that will be established. Since the resultant of induction and resistance E. M. Fs. is the hypotenuse of the right angle triangle of which their values form two sides, we have

$$\text{Resultant } E = \sqrt{E_R^2 + E_L^2}.$$

$$\text{Impedance } \frac{E}{C} = \sqrt{\frac{E_R^2}{C^2} + \frac{E_L^2}{C^2}}.$$

$$\frac{E_R^2}{C^2} = R^2 \text{ and } E_L = \omega L C, \frac{E_L^2}{C^2} = \frac{\omega^2 L^2 C^2}{C^2} = \omega^2 L^2.$$

Substituting these values, we have

$$\text{Impedance} = \frac{\sqrt{R^2 + \omega^2 L^2}}{E}.$$

$$C = \frac{E}{\text{Impedance}}.$$

Circuits sometimes possess capacity and resistance, or capacity, induction and resistance, and the impedance value for such conditions must also be known. The relation between the E. M. F. to which the terminals of a condenser having a capacity K are subjected and the quantity of electricity stored, Q , is given in the following expression:

$$Q = EK.$$

The current through the condenser at any instant is equal to the rate of change of the quantity of stored electricity. Consequently the difference of potential at the terminals

of a condenser suffers a rate of change that is proportional to the current through the condenser. It will be remembered that the E. M. F. of induction is proportional to the rate of change of magnetism or current causing the induction. On the other hand, the condenser current is proportional to the rate of change of pressure at its terminals. Perhaps the complete exchange of the laws of variation of the values of

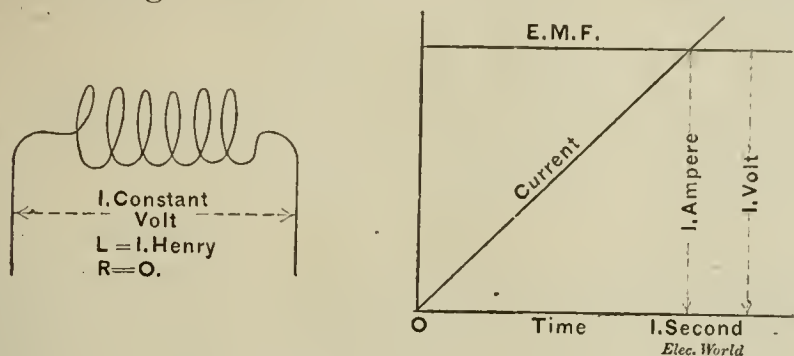


FIG. 14.

current and E. M. F. with respect to time for induction and capacity effects is better seen by a study of Figs. 14 and 15. In the diagram of Fig. 14 the relation between current and the developed E. M. F. is plotted for a circuit having a coefficient of induction of unity or one henry. It is seen that the rate of change of current is one ampere per second and is numerically equal to the developed E. M. F. When the induction and the rate of change of current are not unity the developed E. M. F. equals the product of the rate of change of current into the value of the induction coefficient. The

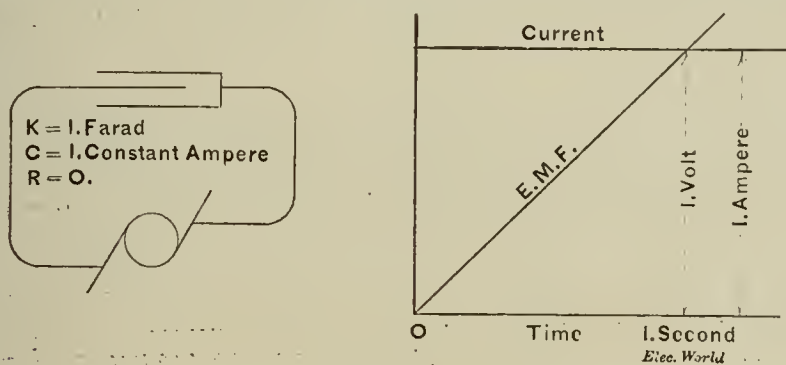


FIG. 15.

diagram of Fig. 15 gives the relation between the current through a condenser and the developed E. M. F. The rate of change of E. M. F. equals the value of the current when the capacity is unity or one farad. For a capacity value other than unity the current is equal to the product of the rate of change of the developed E. M. F. into the value of the capacity.

The outcome for alternating currents of this change of the relations of E. M. F. and current to time in going from induction to capacity effects is illustrated in Figs. 16 and 17. The curves in Fig. 16 are drawn for a circuit having a coefficient of induction of one henry, and those in Fig. 17 for a capacity of one farad. The curves of Fig. 16 are identical with those of Fig. 7 except that the words current and amperes have been substituted for magnetization and lines. It will be remembered that the coefficient of induction is the value with which the current must be multiplied to get a result equal to the product of the turns in the circuit into the number of lines of magnetization established through them. Consequently when the number of turns and the coefficient of induction are each unity the values of the current and magnetization are equal numerically. The current curve in Fig. 16 was, therefore, determined by means of the planimeter in precisely the same manner as the magnetization curve in Fig. 7. The ratio of E_{max} to C_{max} when $L = 1$ and $\sim = 1$, is 2π . For capacity effects this relation is inverted; the condenser current is proportional to the rate of change of the E. M. F. that it causes, while the induction E. M. F. is proportional to the rate of change of

current that causes it. Accordingly, in determining the relation between the maximum values of the condenser current and E. M. F. for a periodicity and capacity each equal to unity the curve of current is first plotted. The curve of E. M. F. is then determined by plotting as ordinates the areas developed by the current curve or precisely in the same manner as that in which the curves of magnetization were determined for Figs. 6, 7 and 8. The value obtained for the ratio of the maximum current to the maximum E. M. F. is 2π . This, it should be noted, is the inverted relation of induction effects. Since the capacity current is proportional to the rate of change of the E. M. F. it follows that the shorter the period or the greater the periodicity the greater will be the current that a given E. M. F. will establish through a condenser. The capacity current will, therefore, vary as

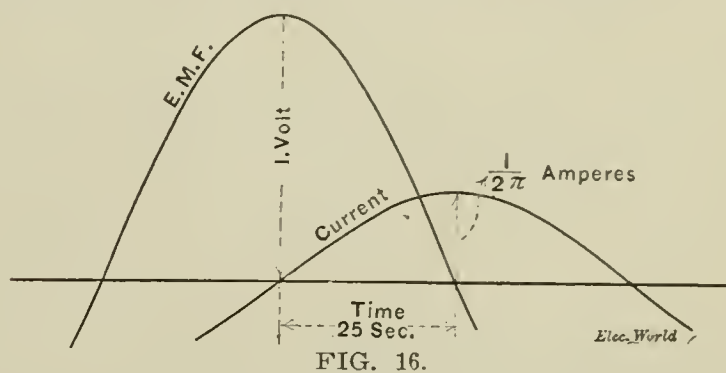


FIG. 16.

the periodicity, capacity, and E. M. F. These properties are given in the following workable expression:

$$C = 2\pi \sim K E,$$

$$C = \omega K E,$$

where K is the capacity in farads.

The capacity current (see Fig. 17) is 90° ahead of the capacity E. M. F., so the E. M. F. that sets it up through the ohmic resistance in the circuit will also be 90° ahead of the capacity E. M. F. The resultant of the two E. M. Fs. is the hypotenuse of a right angle triangle of which they form the sides, or

$$E = \sqrt{E_R^2 + E_K^2},$$

$$\text{Impedance} = \frac{E}{C} = \sqrt{R^2 + \frac{E_K^2}{C^2}} = \sqrt{R^2 + \frac{1}{\omega^2 K^2}}.$$

$$\text{Impedance} = \sqrt{R^2 + \frac{1}{\omega^2 K^2}}.$$

The resultant of E. M. Fs. in a circuit due to ohmic resistance, induction and capacity is the hypotenuse of a right angle triangle, one side of which is the ohmic E. M. F. and the other the difference between the induction and capacity

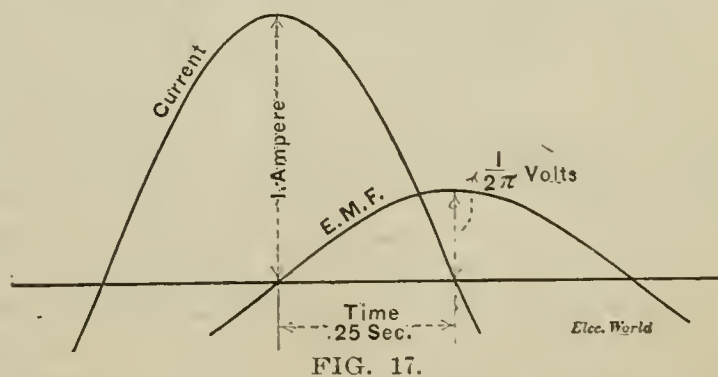


FIG. 17.

E. M. Fs. (see Fig. 18). The expression for the impedance of a circuit possessing resistance, induction and capacity is

$$\text{Impedance} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega K}\right)^2}.$$

The application of the radial diagrams and the impedance values is illustrated in the following examples.

(To be continued.)

"Industries and Iron's" Opinion of Analogies.

"Analogies are only fit for political speeches and are quite out of place before people of intellect."

Transformation of Alternating Currents.

BY CHARLES PROTEUS STEINMETZ.

With very great interest I have read Mr. Scott's valuable paper on alternating currents, presented to the National Electric Light Convention at Washington.

Having worked myself in this direction, I may add a few remarks, which, while perhaps of lesser interest, may go a step further toward explaining the fundamental principles underlying the transformation of electrical energy.

Let there be drawn, Fig. 1, a sine wave of alternating current, as curve *I*.

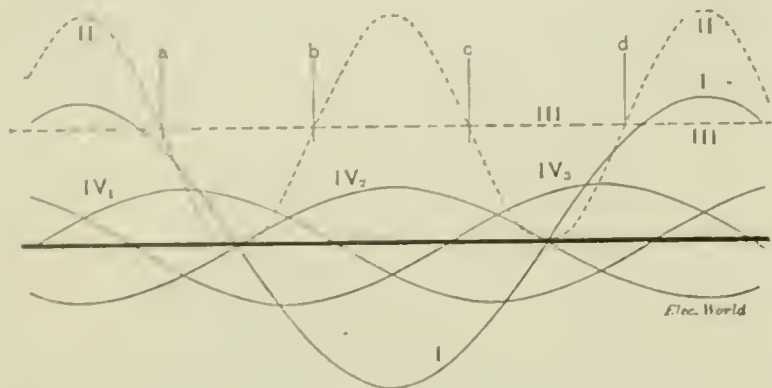


FIG. 1.

Then, the wave of energy transmitted by this current will be a wave of double frequency, as shown in dotted line by curve *II*, if the circuit is non-inductive. If the circuit is inductive, this curve will intersect the zero line, but otherwise have the same character.

Take, however, the waves of the E. M. Fs., or the currents in a balanced polyphase system, as, for instance, a three-phase system. The three waves differ in phase by one-third of a period, and are represented in Fig. 1 by the curves *IV*₁, *IV*₂, *IV*₃. Their curves or waves of energy are three sine waves of double frequency of the same character as curve *II*.

Adding the values of power in the three circuits at any instant gives a constant quantity, as represented by straight line *III*.

The same holds for any balanced polyphase system.

We get thus: "The flow of energy in a balanced polyphase system, as well as in a continuous current system, is constant, while the flow of energy in a single-phase alternating current system is fluctuating with a frequency twice the frequency of the E. M. Fs."

The consequence hereof is, as I have shown in the discussion of Lieut. Patten's paper ("Transactions of American Institute of Electrical Engineers," 1892, page 92), that polyphase currents and continuous currents can be transformed into each other without storage of energy, while the transformation of single-phase currents into continuous currents or polyphase currents and inversely requires storage of energy, which cannot be gotten economically by electro-magnetism, since the efficiency of an electro-magneto electric transformation of energy is very low, due to the losses of energy by hysteresis (see "Transactions of American Institute," 1892, page 746).

This constancy of the flow of energy in all the polyphase systems is their foremost and perhaps only advantage over the single-phase system, by enabling their mutual transformation without storage of energy.

Thus, as I stated last summer before the International Electrical Congress at Chicago (in the discussion of power transmission before section C)—

"Any polyphase system can be transformed into any other polyphase system by means of two stationary transformers only."

Some numerical data on such a transformation between quarter-phase and three-phase circuits, taken from a set of

tests, which I made some time ago, may be of some interest in showing the complete balance and the high efficiency which can be reached, an efficiency indeed as high as in the transformation from one system into the same system.

The tests were made with a frequency of 33 cycles, and at the quarter-phase side the voltage was kept constant at 100 volts per phase.

The first two columns give the amperes per phase on the quarter-phase side at 100 volts impressed; the third, fourth and fifth columns the amperes on the three-phase side; the sixth, seventh and eighth columns the volts measured at the three-phase side, and the last column the efficiency of transformation.

TABLE I.

Quarter phase—Three Phase Transformation, 33 cycles; 100 volts per phase primary

Primary, Quarter phase—		Secondary, Three phase—						Output W.	Efficiency per cent.
<i>C</i> ₁	<i>C</i> ₂	<i>C</i> ₁	<i>C</i> ₂	<i>C</i> ₃	<i>V</i> ₁	<i>V</i> ₂	<i>V</i> ₃		
....	....	....	....	....	114	114	115	....	....
9	8.5	5	5.5	5	111	111	112	1,025	58.5
12	11.7	11	11	11.7	108	108	109	2,280	96.1
17.5	17	16.5	16.5	15.5	105	105.5	106	3,190	92.5
20.5	20	18.5	19	19.5	103	103	104	3,670	90.5
31	28	27	30.6	30.6	98	97	97.5	5,360	90.9

As seen, the efficiency reaches 96.1 per cent., and then gradually drops off, due to the increasing $C^2 R$ loss in the transformers, which were greatly overloaded in the last readings, their total capacity being about 2,000 watts.

Referring now to the design of the transformers for changing the system, we shall proceed in the following way:

As has been shown elsewhere, for alternating E. M. Fs., currents and magneto-motive forces, the law of parallelograms holds.

If now we have two magnetic circuits, as transformers, carrying magnetic fluxes displaced in phase by any angle, say 90 degrees, these magnetic fluxes may be produced by exciting the primary coils of the transformers by means of two M. M. Fs. differing in phase by the same angle, and will induce in the secondary circuits E. M. Fs. differing by 90 degrees also, which can be represented in the diagram, Fig. 2,

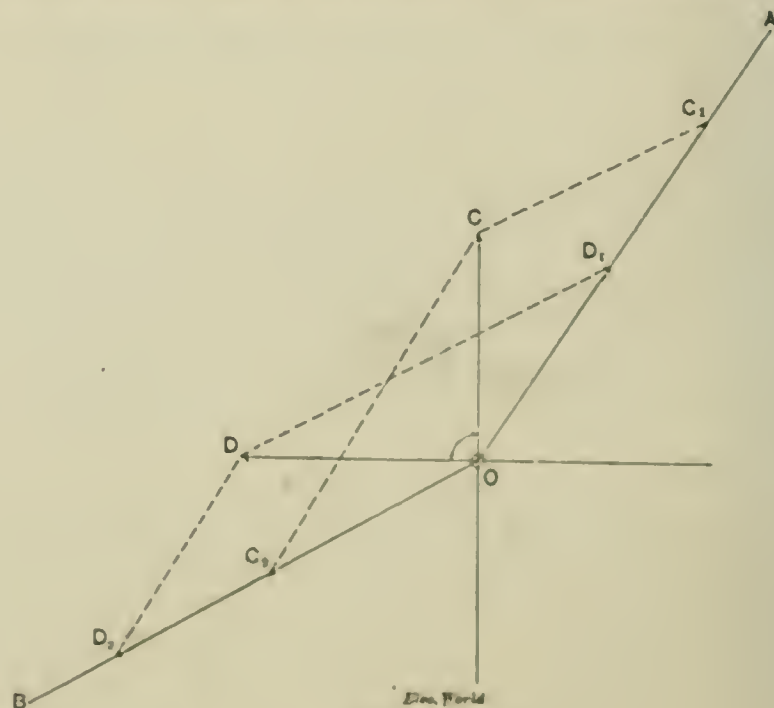


FIG. 2.

by directions *OC* and *OD*. It is not even necessary that the two fluxes have the same intensity, but they may be different; for instance, the second may be one-third the intensity of the first.

It is simple now to get by the combinations of E. M. Fs. of these two directions; that is, by connecting in series the proper numbers of turns of both transformers, resultant E. M. Fs. in any desired phase or phase relation; for instance, two E. M. Fs. of equal intensity differing in phase by 135 degrees, as represented in the diagram, Fig. 2, by *OA* and *OB*.

Thus, if *OC* is the secondary E. M. F. desired in one transformer produced by 100 turns and *OD* the secondary

E. M. F. of the other transformer, of equal intensity, hence produced by 300 turns (since the flux in the second transformer is only 1-3), and the two primary E. M. F.s. are equal but differing in phase by 135 degrees, as represented by OA and OB , we have to complete the parallelograms OC^I , CC^{II} and OD^I , DD^{II} , and get

$$OC^I = 52 \text{ turns,}$$

$$OC^{II} = 30 \text{ turns,}$$

as the two components of OC ;

$$OD^I = 90 \text{ turns,}$$

$$OD^{II} = 156 \text{ turns,}$$

the components of OD .

Hence, the first transformer will contain 52 turns of the first and 30 turns of the second phase as primary and 100 turns as secondary, and the second transformer will contain 90 turns of the first and 156 turns of the second phase as primaries and 300 turns as secondaries. By connecting the primary turns of the same phase in series we get from two equal primary E. M. F.s. differing in phase by 135 degrees two equal secondary E. M. F.s. differing in phase by 90 degrees.

It is obvious now that an infinite variety of combinations can be chosen to produce one polyphase system from another, but the general way will be to choose two directions, as the directions of the magnetic flux or the induced E. M. F.s., and to dissolve the primary and secondary E. M. F.s. by the law of parallelograms into components in the directions of the two induced E. M. F.s., and choose then the number of primary and secondary turns in proportion to these components.

Obviously, it is left to the skill of the designer to choose the directions of the magnetic fluxes so as to produce the desired phase with minimum number of turns, that is, minimum expenditure of copper and of energy. When dealing with larger units, the total efficiency and weight efficiency are occasionally found higher by choosing three transformer units, carrying fluxes displaced in phase by 120 degrees.

In general, however, I think it is now the custom to use in the transformations of polyphase systems, especially three-phase systems, two transformers only, and the use of three transformers has become antiquated, except in cases where the third transformer takes the place of a reserve, which enables us to maintain the service of a balanced three-phase system, even if one of the transformers should give out.

There is, however, one restriction to be made, which reduces the practical value of any method of transforming from system to system by stationary transformers. This is, the flow of energy in the secondary circuit is the same as the flow of energy in the primary circuit, and consequently if the secondary circuit is unbalanced by an unequal distribution of load, and thereby gives a fluctuating power curve, the primary circuit becomes unbalanced also, and no matter what system is used will give the same fluctuations of the flow of energy, so that the liability of polyphase systems to get unbalanced by unequal distribution cannot be overcome by any change of system, but has to be reduced to insignificance by a proper arrangement and choice of the constants of the system.

Furthermore, it is to be considered that anything that can be done in electrical distribution by one polyphase system can be done by any other polyphase system also, and most of it by a single-phase system, so that there exists in these days no good reason for using polyphase systems for electrical light and power distribution in place of the low-frequency, single-phase system, which by its simplicity and ease of regulation is far superior to any polyphase system.

Thus, the only proper sphere for polyphase systems is the high potential line of long distance power transmission, where the three-phase system offers the advantage of the saving of copper of 25 per cent. over the ordinary alternating

current system, or even a larger saving, if the line is re-designed for the most economical conditions, as has been pointed out, I believe, by Prof. Forbes and mentioned by Mr. Scott in his paper.

Even in such a long distance transmission, in the receiving circuit the distribution will take place by splitting up the polyphase system into its component single-phase systems, hence by a modified single-phase system.

Coming now to the question of the transformation of the period, that is, the change of frequency by transformation, the following considerations will lead us to the solution of the problem.

Suppose in an alternating polyphase transformer the primary circuits of different phases are arranged so as to give a rotating field instead of an alternating. Then, in a stationary secondary circuit in this rotating field, the E. M. F. induced is of the same frequency N as the primary frequency. It, however, the secondary circuit rotates with a speed corresponding to the frequency N^I , then the secondary conductor will cut the lines of the rotating field at the rate of $S = N - N^I$ or $S = N + N^I$, according to the direction of rotation.

Thus, the frequency of the secondary E. M. F. will be $S = N \pm N^I$, if N is the frequency of the primary current and N^I the frequency of rotation of the armature.

Neglecting losses the secondary power will have to the primary the ratio $\frac{S}{N}$, hence will be less than primary power if the secondary rotates in the direction of the rotating field, more if it rotates in the opposite direction.

In the first case mechanical energy is given off by the revolving secondary, which may be taken up by an alternating generator and returned to the circuit. In the second case, mechanical energy is consumed and may be supplied by an alternating motor from the circuit.

This transformation has the disadvantage of requiring revolving mechanism, but has the advantage of efficient storage of energy by mechanical momentum, hence it is independent of the balance of the circuits in the polyphase systems, and can be used also for transforming from and to single-phase currents.

A number of tests I made some time ago on this transformation of frequency gave, amongst others, the following results:

TABLE II.—TRANSFORMATION OF FREQUENCY.

Frequency of primary circuit. N	Frequency of rotation. N^I	Frequency of secondary circuit. S	Input Watts.			Output, watts. W_1	Per cent. efficiency.	System.
			Electrical. W	Mechanical. W_1	Total. W_0			
24.6	34.3	58.9	3,120	4,590	7,710	5,300	69	Primary three-phase.
25.0	35.0	60.0	2,310	2,300	4,610	3,230	70	Secondary three-phase, single-phase.

Incandescent Wiring Specifications.

The Montreal Electric Club has submitted to the architects of Montreal for adoption a set of specifications for concealed incandescent wiring as follows:

1. All wire used must be rubber covered and equal to either Habirshaw, Grimshaw or Bishop.
2. No gauge smaller than No. 16 B. & S. shall be allowed to be used.
3. Wire for — volt current, on two-wire principle, loss not to exceed 2 per cent.
4. All joints to be well made and properly soldered and shellaced, covered with a layer of rubber tape, also with an outer covering of good black friction tape.
5. Place necessary cut-outs as required by Board of Fire Underwriters' rules, the same to be on slate or porcelain bases and double pole.

6. Where wires pass through walls and floors they are to be protected by an extra covering in the shape of a durable and moisture proof insulating material, excepting soft rubber tubing, equal in thickness to the insulation on the wire.

7. Where wires run along ceilings and walls, they must be kept at least 2 1-2 inches apart; where passing through holes in the walls and flooring, each wire must have a distinct hole for itself.

8. All speaking tubes, gas pipes and metallic substances of like nature are to be avoided, but where it is necessary to cross same, the wires must be bridged over with wood or hard rubber tubing. If the pipe is for hot water or steam, an air space of at least 4 inches is to be allowed between wires and pipes. All wires crossing water pipes should pass over said pipes if possible or be protected from drip.

9. Outlets for single-pole switches may be left where there are not more than 8 amperes to be controlled; where there are more than this quantity, the outlets must be arranged for doubled-poled switches.

10. No staples or metallic fastenings will be allowed for holding wires in place.

11. Outlets must be taped when passing through plaster.

On Certain New Prefixes Proposed for Physical Unit Magnitudes.

BY EDWIN J. HOUSTON, PH.D., AND A. E. KENNELLY, F. R. A. S.

The increasing extent to which scientific unit magnitudes are being used in physical research has received a check by the inconvenient size of some of the fundamental C. G. S. units, particularly the dyne and the erg.

In order to lessen this inconvenience, we would propose the following additional prefixes, which we have found convenient in our own work.

For example, instead of writing "one thousand megergs" we would suggest the term "one begerg"; and, similarly, for the expression "one million megergs," the term "treg-erg," and for a "billion megergs" a "quegerg," following the analogy presented by the words million, billion, trillion and quadrillion.

Again, instead of writing "the one thousandth of a microfarad," we would suggest the use of the term "bicrofarad," and also the tricofarad as the millionth of a microfarad where necessary.

The meaning of these suggested prefixes is, therefore, as follows:

Bega = 1,000 million, or a billion, or 10^9 .

Trega = one million million, or a trillion, or 10^{12} .

Quega = 1,000 trillion, or a quadrillion, or 10^{15} .

Bicro = 1,000 millionth, or 10^{-9} .

Tricro = one trillionth, or 10^{-12} .

The following applications of these prefixes will suggest their advantages.

From 1 metre = 1. metre = 100. cms.,
and 1 mm. = 0.001 metre = 0.1 cm.,

and 1 micro-metre = 1. micron = 0.000,001 metre
= 10^{-6} metre = 10^{-4} cm.,

1 bicro-metre = 1 bicon = 0.000,000,001

metre = 10^{-9} metre = 10^{-7} cm.,

1 tricro-metre = 1 tricon = 0.000,000,000,001
metre = 10^{-12} metre = 10^{-10} cm.

The micron is of the order of the length of a light wave in the ether, and is a fundamental unit of magnitude in microscopy.

The bicon is a magnitude which will be useful in dealing with the mean free path of gaseous molecules, according to the kinetic theory of gases.

The tricon is of the order of molecular dimensions, according to the estimate of Kelvin.

From 1 megadyne = 10^6 dynes = approximately the earth's gravitational force on one kilogram of matter.

One begadyne = 10^9 dynes = roughly the earth's force on one ton of matter, i. e., the weight of one ton.

One tregadyne = 10^{12} dynes = roughly the weight of 1,000 tons.

1 megarg = 10^6 ergs = 0.0737 foot-pound at Greenwich.

1 begerg = 10^9 ergs = 73.7 foot-pounds at Greenwich.

1 tregerg = 10^{12} ergs = 73,730 foot-pounds at Greenwich = 37 foot-tons approximately.

From 1 megohm = 10^6 ohms.

1 begohm = 10^9 ohms = 1,000 megohms.

1 tregohm = 10^{12} ohms = 1,000,000 megohms.

1 quegohm = 10^{15} ohms = 1,000 tregohms.

A begohm is about the insulation of one mile of well insulated conductor.

A tregohm is about the resistance required to limit the deflection of a high grade mirror galvanometer under one volt to one scale division of one millimetre at one metre range. Such a galvanometer might be called a tregohm galvanometer.

A quegohm is the limiting resistance with one volt and unit deflection of an extremely sensitive mirror galvanometer, which might be termed a quegohm galvanometer.

From 1 microfarad = 10^{-6} farad.

1 bicrofarad = 10^{-9} farad, or 1/1,000 microfarad.

The C. G. S. electromagnetic unity of capacity being 10^9 farads is consequently a begafarad. The use of these prefixes, therefore, assigns a convenient name to the C. G. S. unit of capacity, which would otherwise require a special denomination.

From 1 henry = 10^9 cms.

and 1 microhenry = 10^3 cms.

1 bicrohenry = 1 cm.

Laboratory of Houston and Kennelly, Philadelphia,
March 29, 1894.

Moonlight Tables for May, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of May under his modified form of moonlight schedule.

TABLE NO. 1. Standard Moonlight System.				TABLE NO. 2. Frund's New Moonlight System.			
Date	Light.	Date	Extng.	Date	Light.	Date	Extng.
1	7.20 P. M.	2	4.00 A. M.	1	7.20 P. M.	2	4.00 A. M.
2	7.20 "	3	4.00 "	2	7.20 "	3	4.00 "
3	7.30 "	4	4.00 "	3	7.30 "	4	4.00 "
4	7.30 "	5	4.00 "	4	7.30 "	5	4.00 "
5	7.30 "	6	4.00 "	5	7.30 "	6	4.00 "
6	7.30 "	7	3.50 "	6	7.30 "	7	3.50 "
7	7.30 "	8	3.50 "	7	7.30 "	8	3.50 "
8	7.30 "	9	3.50 "	8	7.30 "	9	3.50 "
9	7.30 "	10	3.50 "	9	7.30 "	10	3.50 "
10	11.10 "	11	3.50 "	10	7.30 "	11	3.50 "
11	11.50 "	12	3.50 "	11	7.30 "	12	3.50 "
12				12	7.40 "	13	3.50 "
13	12.20 A. M.	13	3.50 A. M.	13	7.40 "	13	12 M.
14	12.40 "	14	3.50 "	14	12.50 A. M.	14	3.50 A. M.
15	1.10 "	15	3.50 "	14	7.40 P. M.	15	12 M.
16	1.40 "	16	3.50 "	15	1.10 A. M.	15	3.50 A. M.
17	2.20 "	17	3.40 "	15	7.40 P. M.	15	12 M.
18	No Light.	18	No Light.	16	7.40 "	16	12 "
19		19		17	7.40 "	17	12 "
20	7.40 P. M.	20	0.40 P. M.	18	7.40 "	18	12 "
21	7.40 "	21	10.40 "	19	7.40 "	19	12 "
22	7.40 "	22	11.30 "	20	7.40 "	20	12 "
23	7.40 "	24	12.10 A. M.	21	7.40 "	21	12 "
24	7.50 "	25	12.50 "	22	7.40 "	22	12 "
25	7.50 "	26	1.20 "	23	7.40 "	23	12 "
26	7.50 "	27	1.40 "	24	7.50 "	25	12.50 A. M.
27	7.50 "	28	2.00 "	25	7.50 "	26	1.20 "
28	7.50 "	29	2.20 "	26	7.50 "	27	1.40 "
29	7.50 "	30	2.50 "	27	7.50 "	28	2.00 "
30	7.50 "	31	3.10 "	28	7.50 "	29	2.20 "
31	7.50 "	1	3.30 "	29	7.50 "	30	2.50 "
				30	7.50 "	31	3.10 "
				31	7.50 "	1	3.30 "
Total hours, 170.10				Total hours, 215.40.			

Note.—These schedules are made up on sun time. Where standard time is used and it varies considerably from sun time, the proper deduction or addition must be made to all the times here given.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE
PRINCIPAL FOREIGN
ELECTRICAL JOURNALS.
BY CARL HERING.

NOTE.—Owing to the crowded condition of this department the following changes will be made, the object being to enable more space and attention to be given to abstracts of articles and papers of a more important nature. Almost every issue of each of the foreign journals contains descriptions and data, often with illustrations and tables, of local central stations and isolated plants; unless they appear to be of special interest they will not be noticed hereafter. References to descriptions of steam and gas engines, boilers, fuels, etc., and all other subjects not belonging under the heading of electricity and magnetism, will in general be omitted. The Swiss monthly "Journal Telegraphique" (in the French language) contains probably the best telegraph and telephone statistics of the world, and as this Journal is doubtless accessible to those specially interested in this subject, references to such statistics and descriptions in that Journal will hereafter be omitted. Serials in the nature of a treatise on a subject will be noticed only once; this will apply also to papers which are continued in several issues and which are merely referred to in these columns as distinguished from being abstracted. When the same paper or article is reprinted or abstracted in several journals, only the first appearance will be noticed, except if the original is in a foreign language and the reprint is an English translation, in which case the references to the translation will also be given, as usual. Very good abstracts, generally longer than can be given here, are published in the monthly journal of the Institution of Electrical Engineers (London), and in the Proceedings of the Institution of Civil Engineers (London), which abstracts will be noticed only in case the original article has not been mentioned in these columns.—C. H.

ELECTRO-PHYSICS.

Point of Application of Electromagnetic Forces.—"L'Ind. Elec.," March 10, reprints a Physical Society paper by Mr. Pellat on this subject, in which he explains the fact that the work of electromagnetic forces is zero.

Apparatus for Demonstrating Ampere's Law.—"L'Elec.," March 10, reprints from a German paper an illustrated description of a lecture apparatus, devised by Dr. Raps, in which no mercury is required, the contacts being sliding contacts, and the apparatus itself being very large.

MAGNETISM.

Intense Magnetic Fields.—In a recent paper by Du Bois from "Wied. Ann.," mentioned in the Lond. "Elec.," March 16, he states having obtained a field of 38,000 C. G. S. units (gausses) in an air space of several millimetres, and an induction in iron of 60,000, which is believed to be the highest value yet observed.

Magnetarium.—In a Physical Society paper abstracted in the Lond. "Elec. Eng.," March 16, Mr. Wilde describes a hollow geographical globe wound over the whole surface with insulated wire parallel to the equator, and containing within another similar sphere inclined at 23 1-2 degrees; by revolving this at different rates and sending currents through the wires the magnetic conditions of the earth can be imitated, both as regards distributions and secular variations.

Magnetization of Soft Iron.—Mr. Joubin's Academy paper is abstracted in "La Lum. Elec.," March 10; he verifies experimentally the conclusions made in a previous paper regarding the characteristic equation of the intensity of magnetization as a function of the susceptibility.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Phase Meters.—In the first part of an article by Mr. Hess in "La Lum. Elec.," March 10, he describes and illustrates a number of devices (all of which have been described in these columns) for measuring the difference of phase, special attention being given to that of Mr. Claude (described in the Digest April 22, 1893). He calls attention to

the importance of making this measurement, as it enters in the calculation of the energy just as the voltage and the current do; the importance of this factor was not appreciated until quite recently. He describes an experimental verification of the fact that the phase difference varies with the frequency, the contrary having been assumed in explaining the existence of a phenomenon analogous to magnetic hysteresis. The usual synchronizing indicator may be easily adapted to measure differences of phase by connecting the secondary to a voltmeter, from the reading of which the difference of phase can be calculated; for small differences the two primaries had better be connected so that the resulting field is the addition of the two components and is then proportional to the cosine of half the angle of lag; the third winding and the voltmeter are not required if one measures the amplitude of the resulting magnetic field by the rise of temperature due to the Foucault currents, as was suggested by Mr. Claude.

Hysteresis Testing.—Mr. Parsons, in the Lond. "Elec. Eng.," March 16, describes a simple method used by his firm for comparing different samples of iron; two identical solenoids are coupled in series and into each is put a core of a definite weight of iron plates insulated with paper and having in the centre a piece of wood with a slot for a thermometer; one of these cores is considered a standard and the other is compared with it by the reading of the thermometers; the induction can be varied by the E. M. F. or by the weight of the cores. He thinks that there is no advantage in annealing the plates, but that they should be insulated from each other.

Rapid Verification of Meters.—In an article abstracted in in "L'Ind. Elec.," March 10, Mr. Picou points out how each of the more common meters may be verified by passing a constant, measured, current through them and observing the time of certain cycles from which, knowing the construction of the meter, the calibration may be made in a very short time; for the Thomson meter all that is necessary is to count the number of revolutions in a given time, knowing that 100 turns correspond to one division. Some such method, he says, is applicable to most meters. (It would have to be repeated, however, for different currents, as a meter may be correct for one current and not for another.)

Electro-Dynamometer.—The Lond. "Elec. Rev.," March 16, gives an illustrated description of the Giltay electro-dynamometer based on the principle of Bellatti, the theory being the same as that of Weber's; the improvement consists in the formation of an astatic system composed of two equal bundles of wires moving in two different coils, so that the disturbances due to terrestrial magnetism are eliminated and it becomes possible to standardize the instrument accurately.

Hydraulic Analogies.—In "La Lum. Elec.," March 10, Mr. Claude illustrates and describes some simple analogies. After comparing a continuous current to a current of water in a pipe from a high to a low reservoir, he illustrates self-induction by showing that when the valve is suddenly closed the inertia of the liquid will momentarily raise the pressure

to a greater one than the original, while if the valve is suddenly opened some time will be required before the current is steady (the usual hydraulic ram might also be given as an analogy); capacity he illustrates by placing in the circuit of the pipe a large reservoir, in the middle of which is an elastic diaphragm, which permits no liquid to pass, the charging of this condenser will extend the diaphragm in one direction, accumulating a certain limited amount of water in that vessel, the discharge is illustrated by opening a communication with this vessel; the action of condensers in series is shown by placing a number of these vessels with diaphragms in series, and a shunted condenser is shown by connecting the inlet and outlet by a pipe; accumulators may be illustrated by the same device but of very large proportions; to illustrate electric oscillations as produced by charging and discharging a condenser, he uses the same device but makes the connecting pipes very large, if the valve be then opened suddenly the rush of the water current will produce a greater pressure than that due to the height, which will increase the tension of the diaphragm, after which the diaphragm will act in the reverse direction, which process will be repeated, producing an oscillating current until equilibrium has been established; if the resistance in the pipe is increased the oscillations will be diminished.

Determining Resistances by Alternating Currents.—An abstract of Prof. Kohlrausch's article from "Wied. Ann." is given in the Lond. "Elec. Eng.," March 16.

Photometry of Projectors.—In "La Lum. Elec.," March 10, Mr. Guilbert replies to the recent criticism of Mr. Fery.

DYNAMOS AND MOTORS.

Alternating and Multiphase Currents from Continuous Current Armatures.—The continuation of Mr. Friese's article, abstracted in the Digest March 17, is contained in the "Elek. Zeit.," March 8. He discusses the current and watts, and gives the following results: for a closed circuit and single alternating current the current will be equal to the continuous current and the watts will be equal to 0.707 of that of the continuous current; for a two-phase closed circuit the current relation will be 0.707; the phase difference is 45 degrees and the watts are equal; with open two-phase connection the current ratio will be 0.5 and the watts will be equal; for closed circuit three-phase connection three currents of 0.866 times the continuous current will be obtained, while the watt ratio will be 0.917; for the open connection three currents of half the continuous current will be obtained, while the watt ratio, as before, will be 0.917; with four-phase closed circuit there will be four currents, each 0.707 times the continuous current, the phase difference will be 45 degrees and the watts will be the same as with continuous currents; he then discusses the case of a multiphase connection, using several independent circuits, and shows that in certain cases the watt capacity will be reduced to 50 per cent.; for the open four-phase connection the current ratio is 0.5, while the watts are equal.

TRANSFORMERS.

Ehrt Transformer.—The principal feature of this transformer, which is illustrated in the Lond. "Elec. Eng.," March 16, is that the coils may be removed, inspected and replaced in a very short time; the external magnetic circuit, in the form of a rectangle, is unbroken, the coils are inserted in the opening and the iron in the inside of the coils consists of two pieces shaped somewhat like keystones of an arch, and are wedged in place by driven wedges, making a good magnetic joint.

Buried Transformers.—According to the Lond. "Elec.," March 16, large buried transformers are used in the Scarborough station, described in all the English journals of March 16, as a compromise between the house transformer

and the sub-station system; the system is recommended editorially.

Early Transformer with Closed Magnetic Circuit.—Mr. Tanner, in the Lond. "Elec. Rev.," March 16, quotes at some length from a British patent to Thomas Allen, June 24, 1852, No. 14,190, in which four induction coils are connected at their iron cores at the ends in such a way as to form a complete iron circuit in the form of a square, the intention being to form "a complete electromagnetic circle"; illustrations from the patent are given.

ARC AND INCANDESCENT LIGHTS.

Controlling the Difference of Potential.—A French firm undertakes to replace the present lamps with others of higher efficiency, sharing the profit with the consumers; as a slight difference of potential in high efficiency lamps makes a very great difference, it is necessary to regulate the potential; an apparatus for doing this is described and illustrated in "L'Elec.," March 10. A fine wire coil connected to the mains makes a contact with one or the other of two points when the potential increases above 112 volts or falls below 108 volts; these contacts connect a motor in circuit, which drives a set of cams, which in turn open or close short circuits of some voltmeters, so that if the potential is too high it will be lowered by the insertion of these voltmeters; they are made preferably of copper in alkaline liquids, thus developing only comparatively small differences of potential; when not in circuit these voltmeters are short circuited, so as to be ready to take a charge.

ELECTRIC RAILWAYS.

Electric Railways in Europe.—"L'Ind. Elec.," March 10, publishes what constitutes undoubtedly the best and most complete table of statistics of electric railways in Europe in operation at the beginning of this year; it gives also a brief description of those in course of construction and a list of those projected. In the table they are classified according to countries, and the most important information is given with but few omissions in 16 columns of the tables, which occupy four full pages. Germany leads with a length of 102 kilometres and 2,934 kilowatts, after which come England with 71.4 kilometres and 2,993 kilowatts, France with 41.4 and 1,796; Austria and Hungary, 33.4 and 1,115; Switzerland, 23.6 and 706. The total number of lines is 43, total length, 305 kilometres; total power at the stations in kilowatts, 10,654; the most usual potential, 500 volts; the number of motor cars and locomotives, 538; and the number of trailers, 151. The systems are divided as follows: Accumulator, 2; overhead conductor, 31; central rail, 8; underground conductor, 2. The City and South London Railway leads in power, consuming 1,200 kilowatts; next comes the Liverpool line with 900; the maximum grade of any is 10.5 per cent. on ordinary rails and 25 per cent. with rack and pinion. There are 24 lines in course of construction, which will probably run at the end of the year. Among other things the table shows that a large number of the systems used are American; on quite a number the voltage is from 2 to 300; where two motors are used they are generally of 11 kw.

A brief summary taken from an Italian book is also given in "La Lum. Elec.," March 10.

Heilmann Locomotive.—"L'Elec.," March 10, contains an article by Mr. Haubtmann, in which he makes a comparison of this locomotive with the usual steam locomotives in use in France; he expresses himself in favor of electric traction for high speeds, but does not think that this is the proper solution, as the usual steam locomotives are much in advance of this one; he believes the solution will be by means of the present system of electric railways with central power stations. In the Heilmann locomotive he finds that one indicated horse power is obtained with a weight of about 308 pounds; after making some calculations he finds that

to mount a grade of 8 per cent. at a speed of 27 miles an hour the steam engine of the Heilmann locomotive must develop 700 h. p. in order to produce a useful power of 410 h. p. at the wheels; he believes that in that portion of the run this locomotive was furnishing all the power it could; if the locomotive is alone, without the train and on a straight level road, he believes that with this power a greater speed than 54 to 60 miles an hour cannot be obtained, and that for the intended speeds of 75 to 90 miles an hour the steam engine must generate from 1,500 to 2,250 h. p., as shown in a table which he gives. He then quotes actual runs made with steam locomotives, and shows that the results are better than those which have been made with the Heilmann locomotive.

The Lond. "Elec. Rev.," March 16, calls attention to the fact that the speed of the armature is a prime factor in the efficiency of an electric motor and shows that an electric motor is at a much greater disadvantage in starting a train than a steam engine; the efficiency of a motor is very high at constant speed, but this or anything approaching it is just the condition which cannot be obtained; by way of illustration he compares the Heilmann locomotive to a pump and water turbine, the pump being driven by a steam engine; every time the turbine is started a current of water runs through without doing any work, the energy of the water not being available until speed has been obtained; but if the turbine be replaced by a water pressure engine with pistons and cylinders, the water cannot run through without doing work; this is the case with the steam engine; it considers the Heilmann locomotive an obvious absurdity.

The same issue contains a reply to Mr. Lea, which, however, contains nothing new.

High Speed Railway.—In a long editorial in the Lond. "Elec. Rev.," March 16, the Behr system is discussed unfavorably, special attention being called to the centrifugal force in rounding curves; the Lartigue, or single rail system, is to be used and the centre of gravity is to be maintained at the rail level, that is, at the point of support; the editorial calls attention to the fact that this would not take up the effect of the centrifugal force on the passengers, and it is claimed that it is absolutely essential for passenger traffic that the resultant of gravity and centrifugal force be a normal to the surface of the seats; it does not consider the scheme practicable.

Series Traction.—In the Lond. "Elec. Eng.," March 16, Mr. N. W. Perry compares series traction with the usual method and describes briefly his series system, which has already been described in these columns.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Balancing a Three-Wire System with Only One Machine.—Mr. Edgcumbe, in the Lond. "Elec. Rev.," March 16, suggests a system in which a shunt dynamo is connected directly to the outside mains, and through multiple switches to any desired cells at the ends of a series of accumulators, the neutral wire being connected through a multiple switch to any of the accumulators near the middle of the series, thus enabling an excess of volts to be obtained on either side.

Rates of Charging.—The Lond. "Elec.," March 16, discusses unfavorably the custom of allowing an increasing rate of rebate to large consumers, as such consumers are more often a nuisance; those which should be encouraged are not necessarily those whose bills are large, but those whose bills are large in proportion to the lamps they use, however small the actual bill may be.

Synchronizing Alternators.—Mr. Ruddle, in the Lond. "Elec. Rev.," March 16, states that during the past 15 months they have synchronized at their station about 1,000 times without the slightest trouble and without having

found it necessary to use any special fuses or switches, the only apparatus being a synchronizing lamp; he thinks that the synchronizing depends very much on the governor of the engine; with a slow speed Corliss engine coupled by ropes, alternators may be synchronized without any fear, no matter what the conditions of the load.

Synchronizing Indicator.—According to "La Lum. Elec.," March 10, the Lahmeyer synchronizer consists simply of a vibrator operated by an electromagnet and producing a sound, the disappearance of which indicates that synchronism is attained.

Polyphase Currents.—An Academy paper by Mr. Blondel on a new simplified method for the calculation of polyphase alternating currents is abstracted at some length in "L'Ind. Elec.," March 10.

Electric Windlasses.—In "La Lum. Elec.," March 10, Mr. Boucherot gives an illustrated description of the installation of windlasses in a large warehouse in Paris.

Automatic Cut-Out.—The Lond. "Elec. Eng.," March 16, gives an illustrated description of a large automatic cut-out for 1,500 amperes, in which a short solenoid releases a spring switch.

WIRES, WIRING AND CONDUITS.

Ship Wiring.—The article by Mr. Kennedy is continued in the Lond. "Elec. Rev.," March 9; he advocates having the switch and fuse in one cover, against which practice he claims there is some unaccountable prejudice; fuses should be prepared on a carrier, the practice of using a wire held beneath screws should not be allowed; he claims that perfect conductivity is much more important than perfect insulation, even though it is neglected by the rules; regarding insulation he claims that with lead covered wires rubber may be dispensed with if every joint is watertight; as joints are the greatest difficulties to deal with, the fewer they are the better, which he gives as one of the greatest advantages of single wiring over double wiring; the single-wire system which he advocates is really a two-wire system, with a concentric wire thoroughly insulated and concentric with the return wire, which may be insulated or not.

A large amount of correspondence on this subject is contained in the same issue; Mr. Tidd states that with double wiring the leads may be run as desired regardless of their position with reference to the compass, on which they will have no appreciable effect; he takes exception to Mr. Kennedy's statements regarding the fittings and believes the best preventive of poor wiring is not to insist on a complicated system; the single-wire system, he says, is by far the cheapest, but by far the most dangerous, owing partly to the number of poor contacts made with the ship; the concentric wire system is very good until a fault occurs, but that the trouble then begins; this safeguard is quite unnecessary on board ship; the ideal system is one which anybody can repair. Mr. Cline thinks that both the single and double wire system are good if properly carried out; in the former the positive terminal should be connected to the ship, which will avoid corrosion at the screw contacts; the lead for each lamp should be brought from one side and the return from the other side of the ship, all lamps on the compass deck or the one below it should be wired on the double-wire system up to a distance of 30 feet; there should always be two lamps at each compass, one on each side with concentric or twin wires brought through brass or copper pipes from below up, and the number of lamps in these quarters should be equalized, one-half being run on each side of the ship. Mr. Boot speaks of using two deviation cards to steer by, one for the day, when the dynamo is not running, and the other for the night; if the field of the dynamo causes the error, its position or that of the mains should be altered, but if this is impossible, the error produced, which is a constant factor, should be taken into ac-

count. Mr. Mavor claims that single wiring is the worst and being the cheapest is the one generally adopted by incompetent firms; double wiring is much preferable, and its great safety and reliability are well purchased at the increased cost; no system is permanently durable, unless persistently and continuously protected throughout by a waterproof sheathing; wood casing, no matter how good, cannot be made fireproof, a statement which he emphasizes, but concentric wiring can be made absolutely fireproof and waterproof; with ordinary precautions a compass disturbance can be kept well within one degree with single wiring; double wiring gives only a fancied security; concentric wiring in the neighborhood of the compass entirely avoids disturbances.

In the third article of the series by Mr. Kennedy in the Lond. "Elec. Rev.," March 16, he discusses double wiring; he claims that in this system there is double the chance of faults occurring than in single wiring; but little information is given in this section.

The same number contains some correspondence, giving, however, nothing new; Mr. Barker claims that lead covered cables are undeniably the best, the greatest difficulty being in the frequency with which the joints of the lead covering fail, even when made by the most skillful workmen; the double wire system he believes to be not only the safest, but the surest to keep in good working order.

Loss of Volts in Alternating Leads.—A Physical Society paper by Mr. Parry is reprinted in the Lond. "Elec. Eng.," March 9, in which he discusses the extra loss due to inductance, which he says can be taken into account with very little extra trouble and by approximations, he claims it is remarkably simple; he first discusses the subject mathematically on a basis of the vector properties of the quantities involved (giving results which, however, are not sufficiently simple for ordinary practical use); he then gives a series of curves, showing the principle according to which graphical tables may be made, but the curves which he gives are not sufficiently complete, illustrating only the method (their alleged simplicity is hardly sufficient to warrant their general use); in conclusion he gives an empirical expression for an approximate determination, which, though simpler, is nevertheless somewhat complicated.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Indicating the Positions of Ships in a Harbor.—According to the Lond. "Elec. Eng.," March 9, Mr. Stephenson has been making some successful experiments for locating the positions of vessels at harbor entrances when the weather prevents observations from being made; he proposes to lay a cable on the bottom, charging it with some sort of intermittent current; the vessels have a coil of bare copper wire dipping into the water at the bow and another at the stern, and connected through a telephone; experiments showed the method to be feasible and the instrument to be very delicate; in another system there are no earth connections, the wires being insulated and the action being a true induction through the water.

Telephone Rates in Europe.—The Lond. "Elec.," March 16, gives the rates for most of the European countries, all of which, with the exception of those in London, are very low as compared with those in this country.

ELECTRO-CHEMISTRY.

Minimum Electromotive Force in Electrolysis.—In an Academy paper abstracted in "L'Ind. Elec.," March 10, Mr. Leblanc claims to have anticipated Mr. Nourrison by about three years in verifying experimentally that there is a minimum and constant electromotive force in the electrolysis of different substances; the figures for a number of alkaline compounds are given; for different bases and acids he finds that it is the same in all, being about 1.70 volts, which he explains by assuming that they are all dependent on the

same phenomena, namely, the decomposition of water, which he therefore believes is not a secondary but a primary reaction. In a subsequent note by Mr. Berthelot he claims to have published this twelve years ago, citing the reference to his publication.

Purification of Sewage.—The Lond. "Elec. Rev.," March 9, discusses the Hermite process; it estimates roughly that the power required will be about 1 h. p. working continuously for every 500 head of the population; it discusses the question whether the antiseptic chemicals are cheaper when prepared in this way than when chemicals are simply added to the water; it thinks that this depends on the position of the town; where a supply of water is plentiful, it may be much cheaper to add the chemicals. The Lond. "Elec.," March 9, quotes at some length from the medical paper, "Lancet," regarding the Hermite process at Worthing, giving, however, nothing new.

Theryc-Oblasser Accumulator.—Mr. Theryc, in the Lond. "Elec. Rev.," March 16, gives some figures regarding this accumulator, without, however, giving a clear description of it. It is claimed that 13 amperes (ampere hours) per pound have even been exceeded at a discharge of .45 ampere (per pound); the accumulators have been tested by a French railway and the French Navy for fifteen months; a locomotive is being built for 700 nominal and 1,100 maximum horse power for running at a speed of 65 miles per hour on a level. A horse power can be obtained with 48 pounds of total weight in a volume of one-third of a cubic foot, which is claimed to be from 2 1-2 to 6 times less than with the best accumulators known; the lowering of the capacity is less than 10 per cent, for each increase of .45 ampere per pound, and they can stand without damage up to about 2.5, 4 and even 6 amperes per pound, the nominal rate being from 1.36 to 1.80, which is claimed to be from four to six times more rapid than that of the best known accumulators for the same output.

Coloring Leather.—A process is described in the "Zeit. fuer Elek.," March 1, in which the leather is placed on a horizontal conducting table, preferably zinc, forming the positive pole of the electrode; as much of the coloring liquid as will be retained is poured over this and the negative pole connected to the leather; decomposition takes place and the coloring matter penetrates the leather; the current is continued for a few minutes. Designs can be produced by covering the leather with a metallic plate in which the pattern has been cut, this template being connected to the negative pole; below the open spaces the coloring will be darker than below the metal; the process can be used for all animal and vegetable substances.

Electrolytic Bleaching.—According to "La Lum. Elec.," March 10, the Knoeffler & Gebauer process consists in passing a current at the rate of 600 amperes per square metre of electrodes through a 5 to 10 per cent. solution of chloride of sodium, in which free chlorine will be generated in increasing proportion to the temperature; if, for instance, the increase is 21 degrees there will be 0.40 per cent. of free chlorine, and if the bath is maintained at this temperature by regulating the liquid which is added, the regularity will be perfect and will require no diaphragms and no addition of chalk.

MISCELLANEOUS.

Welding.—The "Elek. Echo," March 3, contains some comparative data for the power used in the Thomson process and in the Lagrange & Hoho process (in which the iron is heated by immersion in an electrolyte when the current is very strong); it assumes that the strength of the welds in the latter are, or can be, the same as in the blacksmith's process; regarding the consumption of energy it shows that the mean per centimetre of cross-section is almost three to four times as great in the latter process as in that of Thomson.

Electric Canal Towing.

We illustrate a system of electrical towing for canals, the invention of Mr. T. D. Davis, 628 Park avenue, Syracuse, N. Y., a gentleman well known in connection with steam propulsion on the Erie Canal.

The system provides for towing canal boats in tows or trains by an electric motor running on a narrow gauge track on the bank of the canal. Each end of the boat is connected to the inner rail by a triangular guide, the outer end of which is directed with a horizontal guidewheel on each side of the rail and also a vertical wheel carrying the weight of the free end. These guides hold the boat at a uniform

in perfect line with the chamber, as shown by the boat, *K*. To place a boat in this position, when steered by rudders, as now practiced, required from three to five minutes' time,

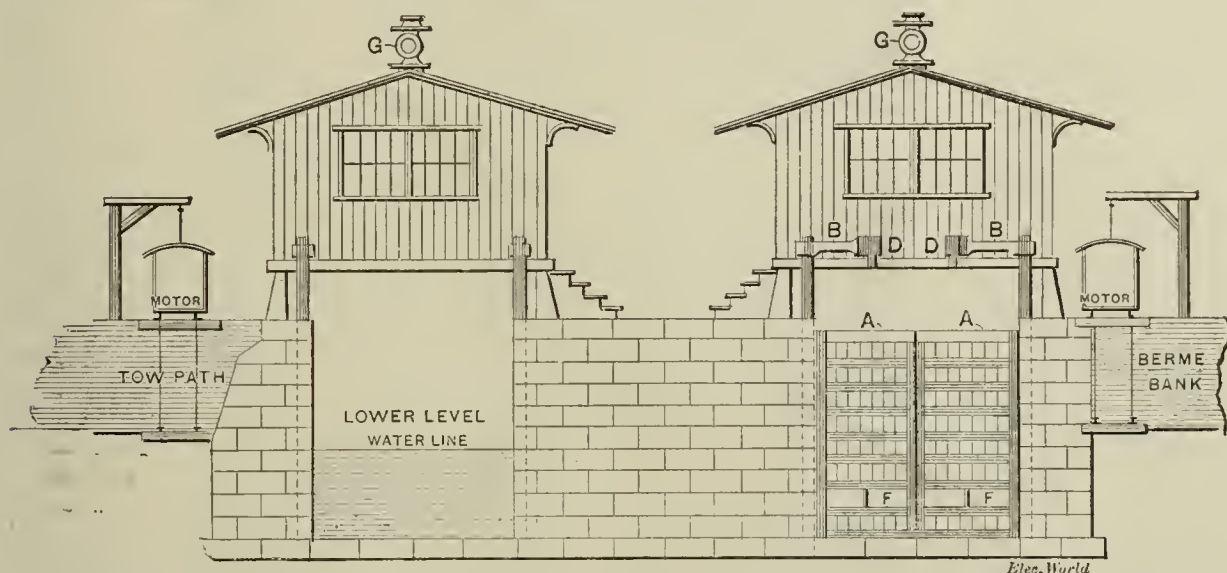


FIG. 1.—VERTICAL SECTION OF LOWER END OF DOUBLE LOCK.

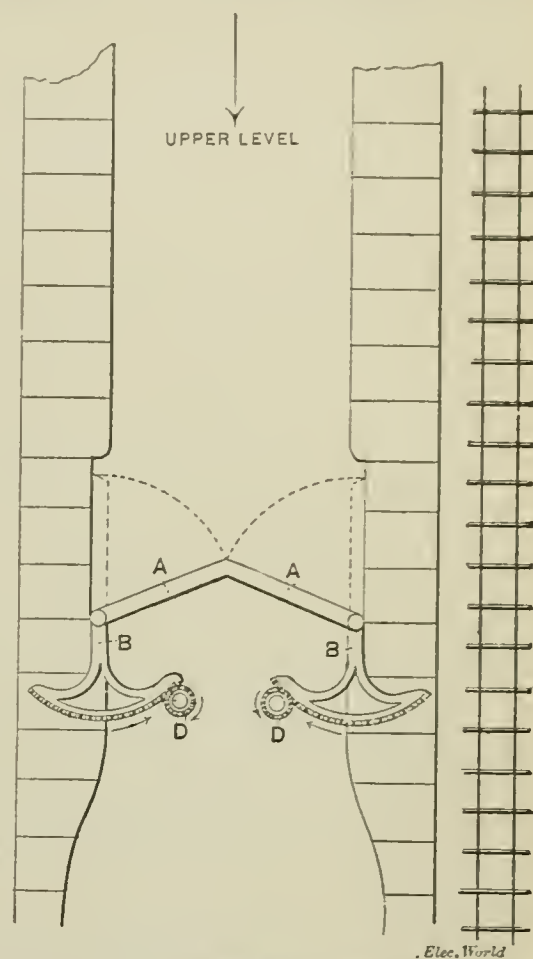


FIG. 2.—FLAN OF CHAMBER OF A LOCK.

distance from the bank and the boat therefore requires no steering.

By this system many more boats can be moved through the locks, and as the amount of traffic depends upon the locking, the capacity of a canal will thus be largely increased.

The time now required to lock a loaded boat down is about 10 minutes; adding three minutes for changing the lock for the next boat makes a total of 13 minutes, and at this rate about 112 boats can be locked in 24 hours. With a lock provided with electrical equipment and the boats de-

while about two minutes only is required to pull the boat into the lock when once in line. Thus the time lost in entering or starting the boat into the lock is by the towing system all saved.

Annual Report of the Bell Telephone Company.

The annual meeting of the Bell Telephone Company was held in Boston Wednesday, March 28, and the following directors were re-elected: T. B. Bailey, Francis Blake, C. P.

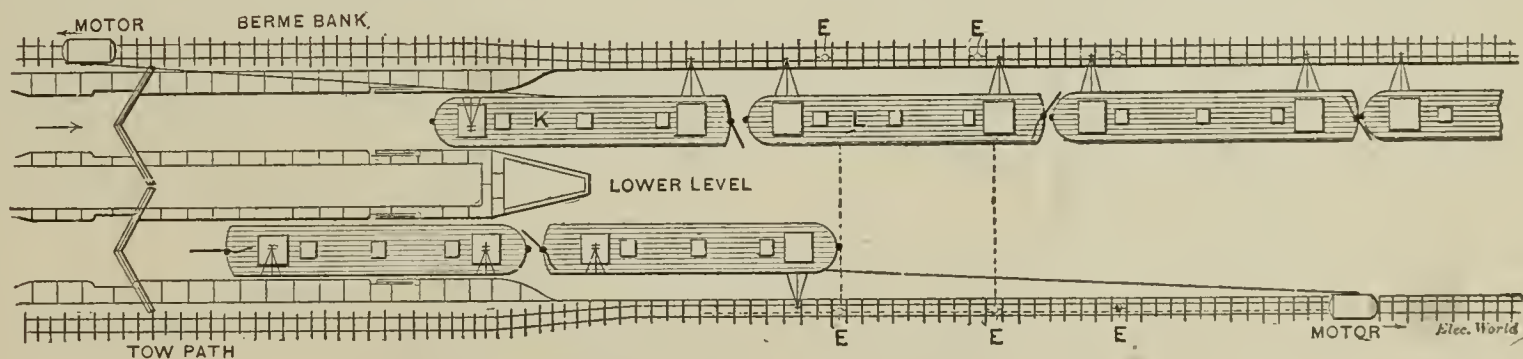


FIG. 3.—BOATS ENTERING AND LEAVING LOCKS.

livered at the locks in perfect line with the lock, as this system provides, the time can be reduced to about 7 1/4 minutes, at which rate 200 loaded boats can be locked through each way every 24 hours.

Fig. 1 is a vertical section of the lower end of a double lock on the Erie and Oswego canals, and Fig. 2 a plan of one chamber of a lock. *A A* are the gates; levers *B B* are secured to the upper ends of the vertical shafts to which the gates are attached, and integral with the levers are sectors operated by pinions *D D*, or by frictional gearing driven by a small electric motor. The valves *F F*, for filling and emptying the lock, can also be operated by the same motor. The whole will be under the control of and operated by one man, without leaving his position. Fig. 3 is a plan view of a lock, showing a boat leaving the lock on the towpath side and one entering it on the berme bank side.

In order to enter a lock it is necessary for the boat to be

Bowditch, G. L. Bradley, Alex. Cochrane, W. H. Forbes, H. S. Howe, C. E. Hubbard, G. G. Hubbard, J. E. Hudson, C. E. Perkins and Thomas Sanders.

The report of the year shows that the company earned in 1893, \$5,781,076 gross and \$3,925,485 net. Of the net all was paid in dividends except \$586,329, which was charged off to depreciation.

The annual report states that the output of telephones amounted during the first seven months of the year to more than 25,000, when the financial panic caused the return of instruments to exceed the output, and part of the gain thus made was lost, the total output of the year being 13,771. The number of daily exchange connections fell off during the latter part of the year, so that the aggregate which had previously shown a marked increase from year to year has remained almost unchanged since the last report. In spite of the financial stringency, however, most of the licensed

companies have found means to complete the work of extension and improvement already in hand. Noteworthy progress has been made in the laying of the underground system and at the close of the year more than a third of the total mileage of exchange wire of the whole country was in operation in underground conduits.

The use of the metallic circuit has been greatly on the increase, the number of subscribers having stations equipped with that class of service being 37,648 at the close of the year, as against 23,053 at the beginning. There has been added to the long distance system during the year 423 miles of line, 9,934 miles of wire and eight new offices, making in operation Jan. 1, 1894, a total of 3,695 miles of poles and 63,529 miles of wire.

The larger cities to which the lines were extended, and in which service was opened during the year, are Detroit, Cleveland, Cincinnati, Dayton and Indianapolis. The line from Dayton to Indianapolis forms a link in a proposed through line connecting Pittsburgh and places to the east with St. Louis and the principal cities en route. The line connecting Detroit, by the way of Toledo and Maumee, with Cincinnati, crosses the above line near Dayton, and reaches directly, and through such connection, a large amount of extra territorial work of the Central Union Company in the States of Ohio and Indiana. The long distance lines now reach and connect the exchanges of 26 companies licensees.

The proportion which telephone work has assumed is shown by the fact that the telephone companies operating under licenses from the Bell company have during the past nine years expended about \$42,000,000 upon extensions and betterments of their plants. This sum is divided in round numbers as follows: Overhead and exchange, \$12,000,000; subways and cables, \$14,500,000; buildings, \$6,000,000; pole line, \$9,000,000. Previous to that period the construction account stood at the sum of \$31,000,000, which makes a grand total of \$73,000,000. The following statistics affording a comparison between the use of the telephone in this and other countries may prove of interest:

In the United States, with a population of 63,000,000, there are 237,000 exchange subscribers, a number larger than that of all continental Europe, with its population of more than 300,000,000. In Great Britain, with a population of 38,000,000, there are but 45,000 telephone subscribers; in Germany, with 49,000,000, 86,500 subscribers; in France, with 38,000,000, no more than 24,000 subscribers.

The general system of the operating companies throughout the country has been to charge the subscriber a fixed sum for exchange service, a plan which appears to have worked satisfactorily, but it is by no means certain that in the future a system of tariff rates, that is, charging a subscriber according to the number of times a telephone is used, may not prove more equitable. Some experiments have been made to see if in the great cities the case of those who want only a limited use of the telephone at a lower rate cannot be met. Application has been made to the Legislature at its present session for authority to increase the capital stock of the company to \$50,000,000. That amount is necessary, it is claimed, for the perfection of the lines already built and for the development and extension of the system to paying points in the United States.

The following is the statement of the treasurer of the American Bell Telephone Company for the year ending Dec. 31, 1893:

LEDGER BALANCES DEC. 31, 1893	
DEBTORS	
Telephones.....	\$1,266,182.03
Real estate.....	950,984.11
Stocks.....	37,065,131.12
Merchandise and machinery.....	13,311.83
Bills and accounts receivable.....	3,573,053.07
Cash and deposits.....	2,843,678.36

CREDITORS.	
Capital stock.....	\$20,000,000.00
Debenture bonds, 1888.....	2,000,000.00
Bills and accounts payable*.....	1,550,596.07
Patent account (profit and loss).....	10,137,493.98
Profit and loss.....	5,682,227.13
Reserve.....	4,191,012.63
Surplus.....	2,151,011.61
\$45,712,340.52. \$45,712,340.52	

COMPARATIVE STATEMENT OF EARNINGS AND EXPENSES.		
EARNINGS.		
	1892.	1893.
Rental of telephones.....	\$3,303,753.10	\$3,513,711.42
Dividends	1,422,047.93	1,824,431.98
Commission from ex-terr. lines.....	101,306.32	108,621.38
Commission from teleg. business.....	29,417.31	29,192.79
Real estate.....	67,868.14	68,097.06
Interest	168,830.22	225,926.28
Miscellaneous	7,663.57	11,086.68
	\$5,100,886.59	\$5,781,076.99
EXPENSES.		
Expenses of operation.....	\$378,272.89	\$392,770.39
Legal expenses.....	87,767.28	114,852.47
Real estate.....	35,666.19	44,532.41
Interest on taxes.....	279,638.93	300,368.38
Commission	648,689.25	690,380.58
Royalty	10,000.00	10,000.00
Concessions	246,914.53	257,829.92
Miscellaneous	2,262.74	44,857.15
	\$1,689,211.81	\$1,855,591.30
Net earnings.....	3,411,674.78	3,925,485.69
Surplus account, Dec. 31, 1892.....	2,151,011.61	
Net earnings, 1893.....	3,925,485.69	
		6,076,497.30
Regular dividends, 1893.....	\$2,214,156.00	
Extra dividends, 1893.....	1,125,000.00	
Reserve for general depreciation.....	450,000.00	
Reserve for depreciation of insts.....	136,329.69	
		3,925,485.69
Surplus account, Dec. 31, 1893.....		\$2,151,011.61

Census Statistics.

Hon. Carroll D. Wright, Commissioner of Labor, in charge of the completion of the eleventh census, has transmitted to the Secretary of the Interior a report which presents preliminary totals for all classes of mechanical and manufacturing industries in the United States as prepared by the Division of Manufactures. The following are the statistics relating to the electrical industry:

ELECTRICAL APPARATUS AND SUPPLIES.	
Number of establishments reporting.....	189
Aggregate capital represented.....	\$18,997,337
Total value of plants	6,170,507
Value of land.....	714,542
Value of buildings.....	1,496,293
Value of machinery, tools and implements.....	3,959,672
Live assets	12,826,830
Miscellaneous expenses.....	1,154,462
Average number of employes.....	9,485
Total wages.....	\$5,366,188
Officers, firm members and clerks above 16 years, males.....	640
Wages for same.....	\$826,986
Officers, firm members and clerks above 15 years, females.....	43
Wages for same.....	\$22,152
Operatives, skilled and unskilled, above 16 years, males.....	6,221
Wages for same	\$3,469,140
Operatives, skilled and unskilled, above 15 years, females.....	970
Wages for same.....	\$243,039
Children operatives.....	44
Wages for same.....	\$7,543
Pieceworkers, males, above 16 years.....	1,068
Wages for same.....	\$613,707
Pieceworkers, females, above 15 years.....	499
Wages for same.....	\$183,621
Children pieceworkers, not any.	
Cost of materials used.....	\$,819,498
Value of products, including receipts from custom work and repairing.....	19,114,714

ELECTRIC LIGHT AND POWER.

The statistics under this classification are confined to the
*Of this amount \$1,200,000 is for the dividends payable Jan. 15, 1894, to stockholders of record, Dec. 30, 1893.

city of New York, the District of Columbia and the city of St. Louis. Commissioner Wright stated that it was found impracticable to make a complete canvass of the entire United States for the collection of statistics pertaining to the generation of electricity for lighting and power purposes.

Number of establishments reporting.....	144
Aggregate capital represented.....	\$33,838,549
Total value of plant.....	19,167,012
Value of land.....	1,743,017
Value of buildings.....	2,106,418
Machinery, tools and implements, value of.....	15,317,577
Live assets.....	14,671,537
Miscellaneous expenses.....	755,201
Average number of employes.....	2,004
Total wages.....	\$1,556,623
Officers, firm members and clerks, males, above 16 years.....	205
Wages for same.....	\$268,325
Officers, firm members and clerks, females, above 15 years.....	5
Wages for same.....	\$3,056
Operatives, skilled and unskilled, males, above 16 years.....	1,791
Wages for same.....	\$1,284,502
Operatives, skilled and unskilled, females, above 15 years.....	1
Wages for same.....	\$240
Children operatives.....	2
Wages for same.....	\$500
Pieceworkers, males, above 16 years, not any.	
Pieceworkers, females, above 15 years, not any.	
Children pieceworkers, not any.	
Cost of materials used.....	1,155,789
Value of products, including receipts from custom work and repairing.....	4,783,224

ELECTROPLATING.

Number of establishments reporting.....	313
Aggregate capital represented.....	\$33,838,549
Total value of plant.....	888,173
Value of land.....	155,760
Value of buildings.....	129,420
Machinery, tools and implements, value of.....	602,993
Live assets.....	1,162,961
Miscellaneous expenses.....	182,826
Average number of employes.....	2,162
Total wages.....	\$1,260,475
Officers, firm members and clerks, males, above 16 years.....	388
Wages for same.....	\$364,115
Officers, firm members and clerks, females, above 15 years.....	9
Wages for same.....	\$4,608
Operatives, skilled and unskilled, males, above 16 years.....	1,529
Wages for same.....	\$802,578
Operatives, skilled and unskilled, females, above 15 years.....	87
Wages for same.....	\$28,152
Children operatives.....	68
Wages for same.....	\$13,794
Pieceworkers, males, above 16 years.....	73
Wages for same.....	\$43,750
Pieceworkers, females, above 15 years.....	8
Wages for same.....	\$3,478
Children pieceworkers, not any.	
Cost of materials used.....	1,084,057
Value of products, including receipts from custom work and repairing.....	3,121,642

GALVANIZING.

Number of establishments reporting.....	27
Aggregate capital represented.....	\$1,301,973
Total value of plant.....	464,593
Value of land.....	144,300
Value of buildings.....	128,900
Value of machinery, tools and implements.....	191,393
Live assets.....	837,380
Miscellaneous expenses.....	99,192
Average number of employes.....	846
Total wages.....	\$473,111
Officers, firm members and clerks, males, above 16 years.....	83
Wages for same.....	\$110,233
Officers, firm members and clerks, females, above 15 years.....	2
Wages for same.....	\$1,000
Operatives, skilled and unskilled, males, above 16 years.....	733
Wages for same.....	\$349,228
Operatives, skilled and unskilled, females, above 15 years.....	4
Wages for same.....	\$880
Children operatives.....	11
Wages for same.....	\$3,650
Pieceworkers, males, above 16 years.....	13
Wages for same.....	\$8,120
Female pieceworkers, above 15 years, not any.	
Children pieceworkers, not any.	
Cost of materials used.....	1,940,712
Value of products, including receipts from custom work and repairing.....	2,957,143

Apparatus for the Taking of Alternate Current Curves.

BY N. H. GENUNG.

Joubert is supposed to have made the first real reproduction of alternate current curves by employing a contact point rigidly attached to and revolving with the armature of the generator, and adjusted so as to make connection with a fixed brush once in each revolution. By this means he charged a condenser to the voltage of the generator at some definite and known part of the period. Some time after this curves of E. M. F. and current in both the primary and secondary of induction coils were taken by Dr. Duncan and others, the above mentioned contact device being employed. In order that the exact workings of a transformer may be known, the instantaneous values of current and E. M. F. in both circuits must be simultaneously picked out and measured at definitely known positions throughout a complete cycle, and the results plotted. Prof. Ryan was the first to undertake the practical carrying out of a piece of work of this kind, and the numerous papers published by him and his associates in the year 1890 containing an enormous amount of valuable experimental data, have given us exact knowledge as to the relative phases of current and E. M. F. on commercial apparatus working under varying conditions, which, up to that time, had been a matter of pure guess work. Thus, both theoretically and practically, the transformer, as to its working conditions, was placed on a perfectly definite basis. In other words, "transformer indicator diagrams" have done for the transformer what characteristic curves have done for the continuous current machine, and what the indicator card has done for the steam engine. Prof. Ryan in his work employed necessarily the contact maker and an electrometer of his own design. Many others have since employed essentially the same outfit in continuing these valuable investigations. Aside from this alternate current working has of late become so prominent a feature of electrical engineering that in many of our leading technical schools the taking of transformer curves by the instantaneous contact method has come to form a part of the prescribed laboratory course.

The arrangement of contact maker and electrometer, as employed by Prof. Ryan and others, is essentially as shown in Fig. 1. The lines *M* and *N* come from a switch so arranged

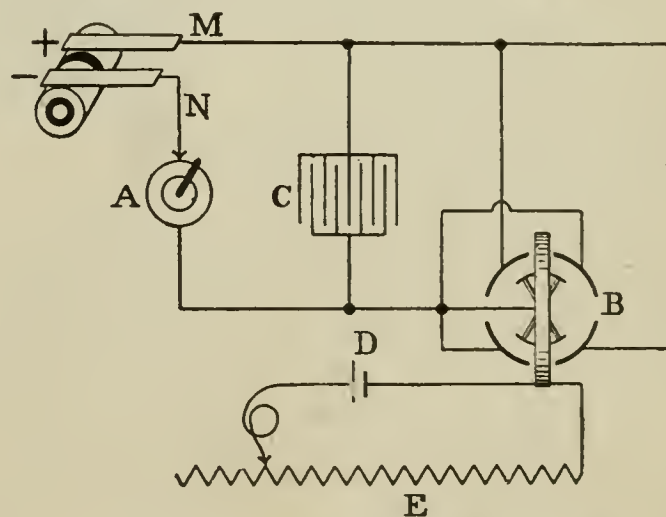


FIG. 1.—ARRANGEMENT OF APPARATUS.

that pressures from different circuits may be conveyed to the electrometer through the contact device *A*. Values of current are obtained by measuring the fall of potential around a non-inductive resistance of known value through which the current is made to flow. The condenser shown at *C* has usually been found necessary to obviate the effect due to leakage of the electrometer, the latter being of extremely small capacity and the circuit being closed through the contact points for but a very small fraction of each revolution. The electrometer, as designed and improved by Prof. Ryan for the purpose in view, is shown in Fig. 2.

This instrument, not so perfected, was employed by Prof. Ryan in his earliest work on transformers, and has ever since been employed by him and many others almost exclusively in work of the same or of a similar nature. The

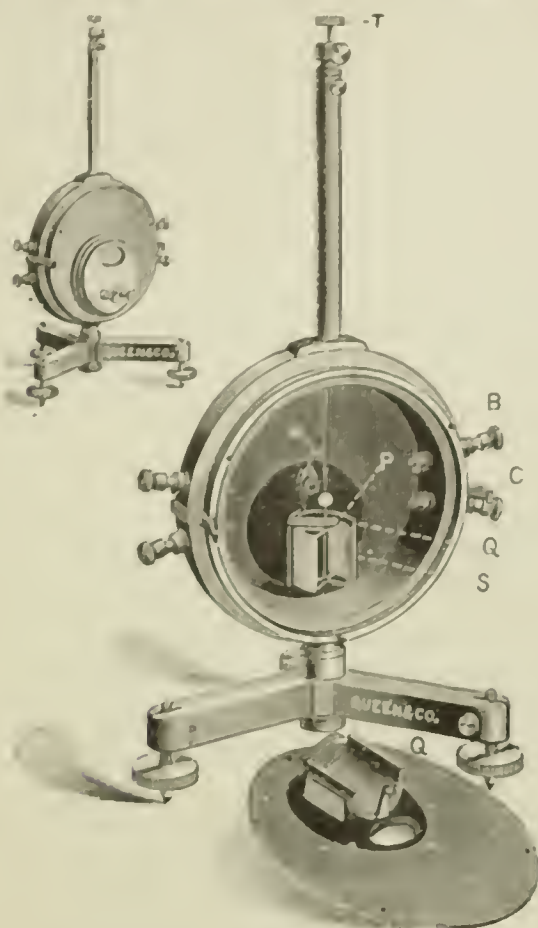


FIG. 2.—RYAN ELECTROMETER.

quadrants are here mounted on quartz plates to insure high insulation, thus rendering the use of a condenser seldom, if ever, necessary, and are faced with mica so as to prevent short circuiting should the needle accidentally touch them. The cover plates carrying the quadrants are held accurately in position by spring clips and pins, and the opposite quadrants are connected automatically by metal strips. A small magnetic needle is rigidly attached to the system and situated exactly at the centre of the circular case, on the outside of which are wound two coils of a different number of

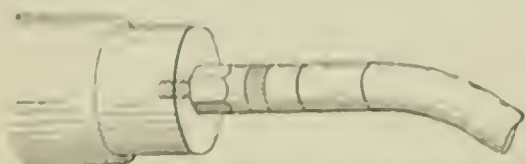


FIG. 4.—FLEXIBLE SHAFT CONNECTION.

turns, which, together with the binding posts for the same, are completely insulated by means of hard rubber. The instrument may be used in one of two ways, either the E. M. F. may be calculated from the deflections produced, or a zero method may be employed, the needle being returned to zero by means of a current in one or both of the coils acting on the magnetic needle at the centre. The latter method is the more accurate and is entirely free from errors due to variations in the earth's field. The voltages are with this latter method determined in terms of the current flowing in the coils surrounding the case. The strength of current flowing may be regulated and its value determined very conveniently and accurately by the combination of a standard cell and known resistances, as shown in Fig. 1 and as employed by Prof. Ryan.

The contact maker which is to accompany this or whatever other measuring device it may be desired to employ, is shown in its most complete form in Fig. 3. The metal base carries a revolving ebonite cylinder driven by means of a flexible shaft, very rigid so far as torsion is concerned, easily attached to the end of the armature shaft, as shown in Fig. 4, thus making perfect alignment of the contact maker unnecessary. Brushes connect the insulated binding posts to

two brass rings on the circumference of the hard rubber cylinder. The steel knife edge plug *G* attached to ring *A* may be adjusted so as to just touch at each revolution the sharpened end of a piece of piano wire forming a part of the third brush *C*, which presses continuously against ring *B*. This brush, as shown, may be accurately set and clamped in any desired position with reference to the armature shaft by means of the finely divided scale at the end. This arrangement of brushes and rings avoids the use of flexible con-

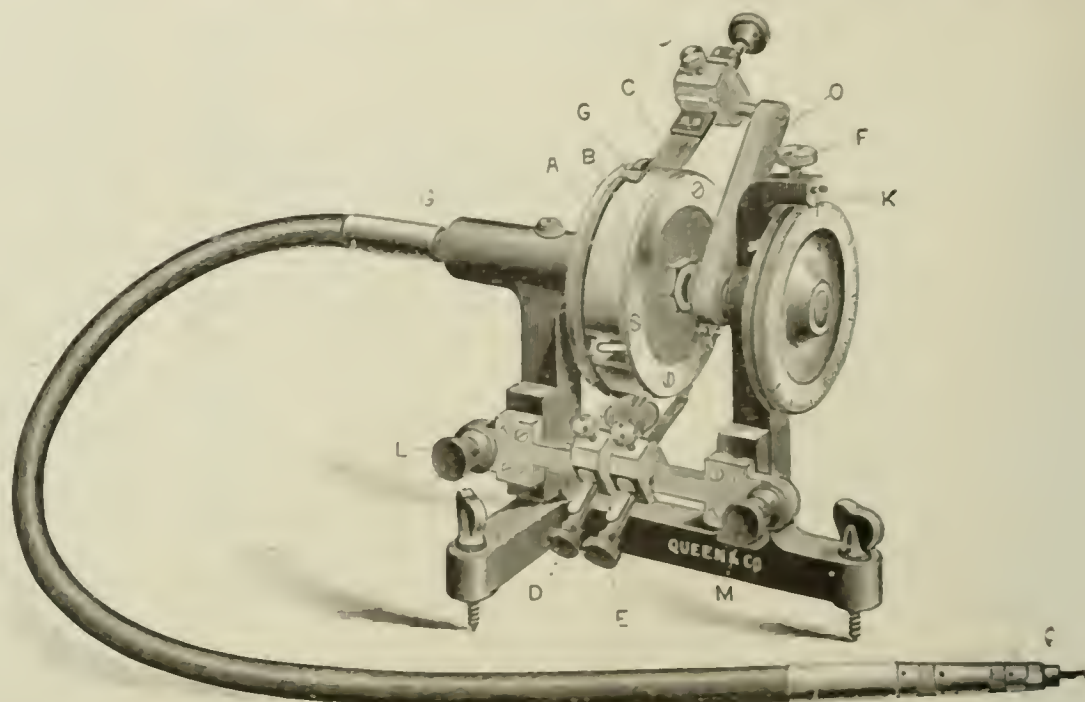


FIG. 3.—QUEEN CONTACT MAKER.

nectors, which are more or less apt to become entangled in the rotating parts. All parts necessarily handled in the course of the work are perfectly insulated, so that the operator may run no risk of coming in contact with the live circuit.

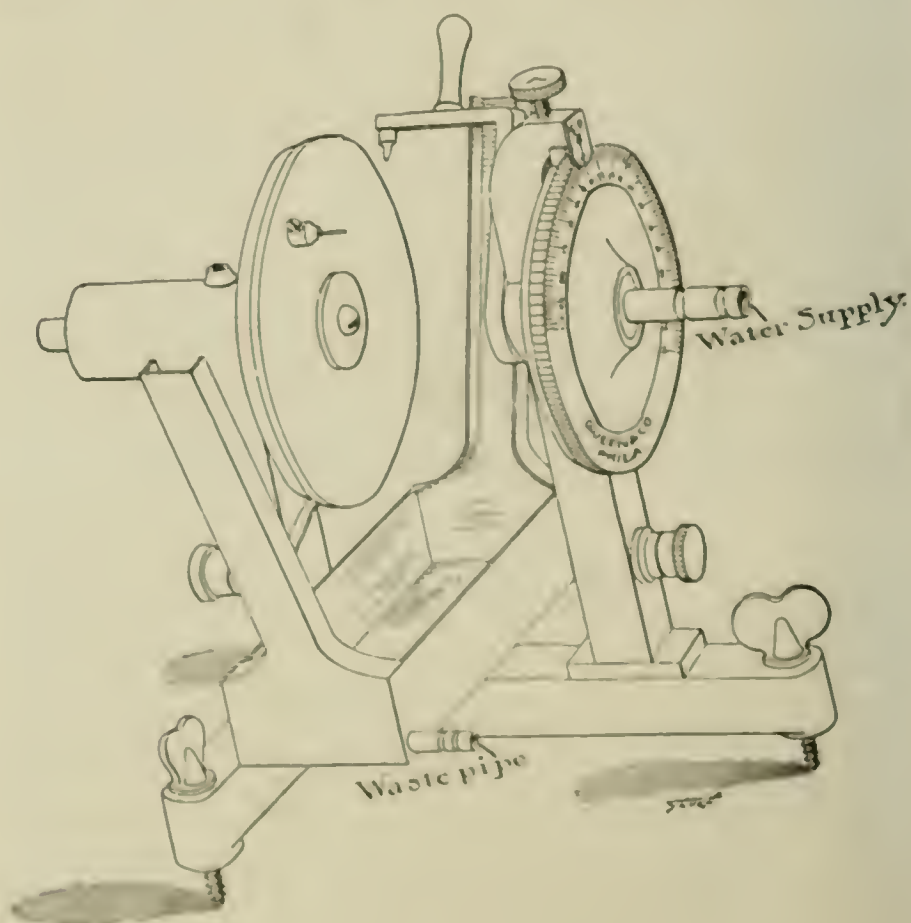


FIG. 5.—WATER JET CONTACT MAKER.

A contact maker of a somewhat different design was recently worked out jointly by Profs. Ryan and Bedell, and was fully described some time since at a meeting of the American Institute of Electrical Engineers. It differs from the other form in that a needle point is substituted for the steel plug, as shown in Fig. 5, and a fine jet of water for the third brush, the jet being maintained by a small reservoir of water a few feet above the nozzle, connection being

made by a flexible rubber tube. A binding post in metallic communication with the nozzle serves as one terminal, while connection with the needle point is made through a brush resting against the revolving disc. The nozzle points slightly away from the disc, so that there is no possibility of a second contact when the projecting needle point is in the course of its revolution, on the opposite side of the disc. Should the generator be a many pole machine, more than one contact point may be inserted, so that a contact may be had with each cycle if desired.

Both these forms of contact maker have been run for hours without interruption, during all of which time a fine sharp contact was to be had.

New Electrical Machinery.

The Walker Manufacturing Company, which has, for many years, enjoyed the reputation of being without an equal in the construction of cable railway equipments, power transmission plants, and all classes of very large machinery, has

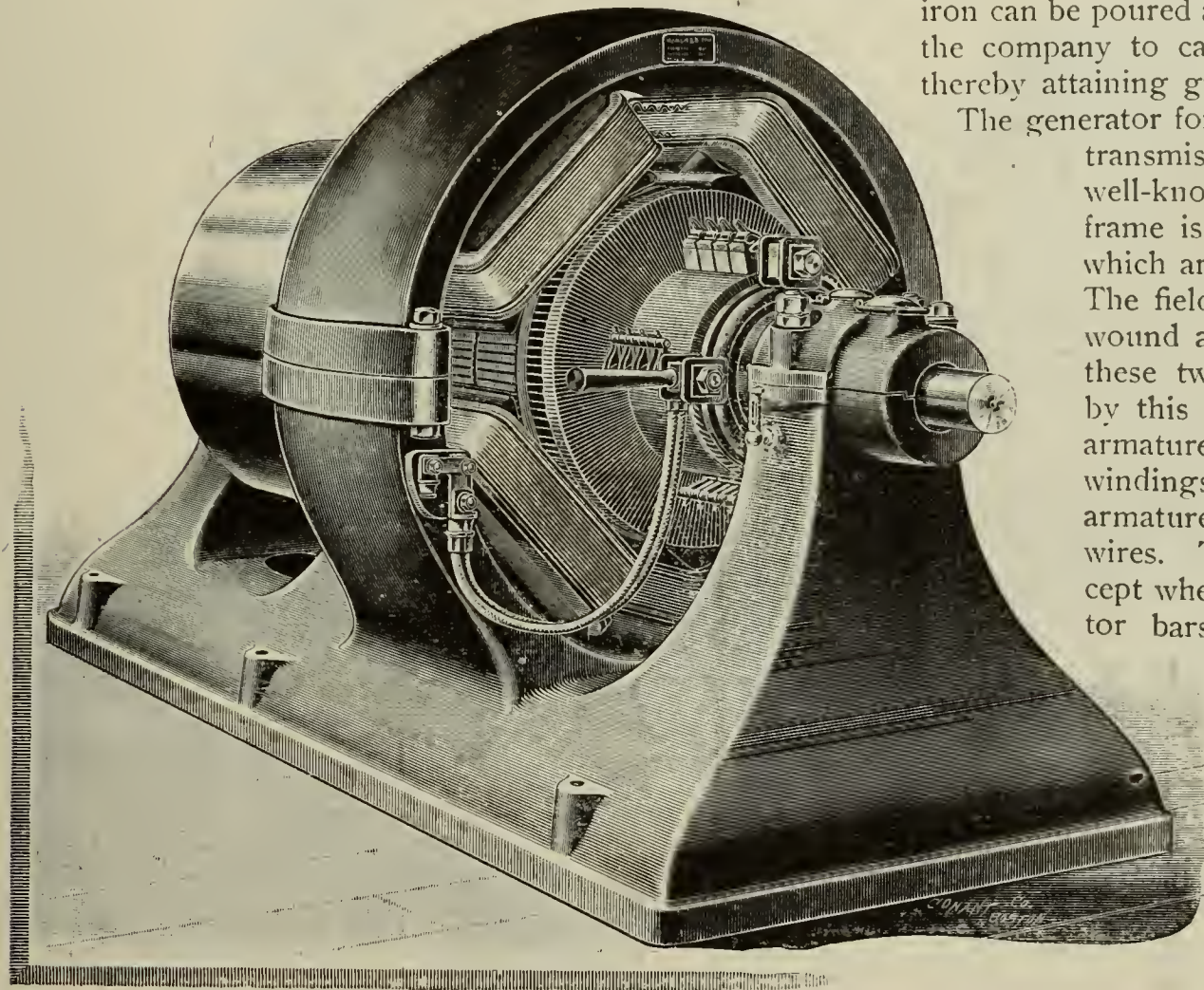


FIG 1.—THE GENERATOR.

now added to its extensive business an electrical department, and now enters the market, ready to supply electric generators for both direct and alternating currents, of any capacity, from 150 to 5,000 horse power, with an electromotive force varying from 500 to 10,000 volts, and a complete line of electric motors for both direct and alternating current work.

These machines—both generators and motors—are constructed for street railway use, ordinary power transmission, mining and a special line in which they anticipate large developments in the near future, extra large alternating machines for long-distance transmission of power. Street railway companies throughout the world, who are so well acquainted with the excellent work uniformly executed by this firm, will need but the assurance that especial attention has been given to the particular requirements of street railway engineering to insure them that the highest degree of excellence, in both mechanical and electrical construction, will be attained.

The plant of the Walker Manufacturing Company is one of the largest and most complete in the country, and is mod-

ern in all its equipment. The buildings cover 250,000 square feet of ground, are constructed of brick, iron and glass, and are situated on the shores of Lake Erie, at Cleveland, Ohio. The machine shop consists of three long bays, each containing a 30-ton travelling crane, which moves through its entire length. Iron galleries at either end are fitted up as winding rooms and for the manufacture of insulating materials.

The testing room is equipped with switchboards and resistances for testing generators, brakes for testing motors, and a 1,000 h. p. engine will be erected immediately for testing the large multipolar direct coupled generators. The tracks of the Lake Shore and Michigan Southern Railroad enter the testing room below the floor level, and all machines can be lifted by the large cranes from the testing racks directly to the cars. The pattern shops occupy a large two-story building, completely fitted up with modern wood-working machinery. Two large foundries occupy another building, and are perfect in their equipment. They contain four mammoth cupolas, spacious core ovens and numerous travelling cranes, from five to thirty tons capacity each. Fifty tons of iron can be poured at once into a single mold, which enables the company to cast their large machines in fewer parts, thereby attaining greater rigidity.

The generator for street railway and direct current power transmission shown in Fig. 1 is 250 h. p., of the well-known four-pole type, slow speed. The frame is cast in one piece with three bearings, which are of the ball and socket self-oiling type. The field magnets are of wrought iron and are wound and insulated entirely with mica. With these two path windings—the only kind used by this company—there can be no unbalanced armatures, no sparking and no heating. The windings are entirely below the surface of the armature, which is ironclad, with no binding wires. There are no joints in the windings, except where the wires connect with the commutator bars, and the insulation throughout the entire machine is sufficient to withstand at least ten times its normal requirements. The armature and commutator are thoroughly ventilated, as a current of cool air passes all through the interior of the machine. The commutator is excessively large and runs cold in regular operation. The small machines of this type are belted machines, and the larger ones are usually built on the engine shaft.

Experience has taught street railway men that the greatest cost in operating roads by electric motors has been the repairs made necessary by the rapid deterioration of the track and rail-joints. The only way to correct this evil is to entirely disconnect the motor itself from iron to iron contact with the axle, and prevent not only the hammer blow due to the weight of the motor, but the inertia blow due to the unyielding mass of the motor. Attempts have been made to accomplish this by suspending the motor at or near the centre of gravity. This eliminates the weight, but not the inertia blow, which is the most serious. This has forced those interested to the conclusion that the perfect motor must weigh as little as possible, be extremely strong in mechanical construction, should work to 25 h. p. without heating and not be in any way attached to the axle and wheels, except through springs which will do away with the hammering of the track to the greatest possible extent. This method of suspension gives the freedom of movement necessary for the removal of strain in rounding curves. The motor being built by the Walker Manufacturing Company combines these

suggestions of practical experience. It is a four-pole steel motor, weighing 1,200 pounds, has an easy capacity of 25 h. p., will run at any speed up to 25 miles an hour, is controlled by a series-parallel controller, of superior type and great simplicity, and is not attached to the axle in any way, except through yielding supports.

The illustration, Fig. 2, shows the general form of the motor, mounted upon 30-inch wheels and ordinary truck, portions of the truck being cut away to enable the motor to be more readily seen. The motor is entirely water and dust tight, the only opening being the lid over the commutator, which enables the two brushes to be easily reached. The frame is in two parts and made of steel. The gear housing and commutator lid are of malleable iron. Both gears and pinions are of steel. The shaft is large, being three and one-half inches in diameter, and two and one-half inches in the bearings. The bearings are very long and arranged for

A, trunnioned by its bearings, but not touching the axle. The motor is then supported at the rear by spiral springs, *C*, between lugs on the frame and the arms of the *U*, and the front end is supported by a swinging arm from the ordinary spring truck bar, *D*. It can be seen that with this suspension the motor rides freely on springs, readily adjusting itself to varying conditions, without bringing a strain or shock on any part. The gear centres are always maintained because of the *U*-shaped frame. Fig. 4 shows how the lower half of the frame is made to swing down, while the armature remains in place, one man being able to let it down and replace after inspecting and cleaning. The armature may be removed, if desired, from below; or, if the motor should not be over a pit, the upper half may be swung up and the armature removed from above. By referring to the figures it will be seen that all the bearing caps come off from below, and all the bolts pass down from above; and,

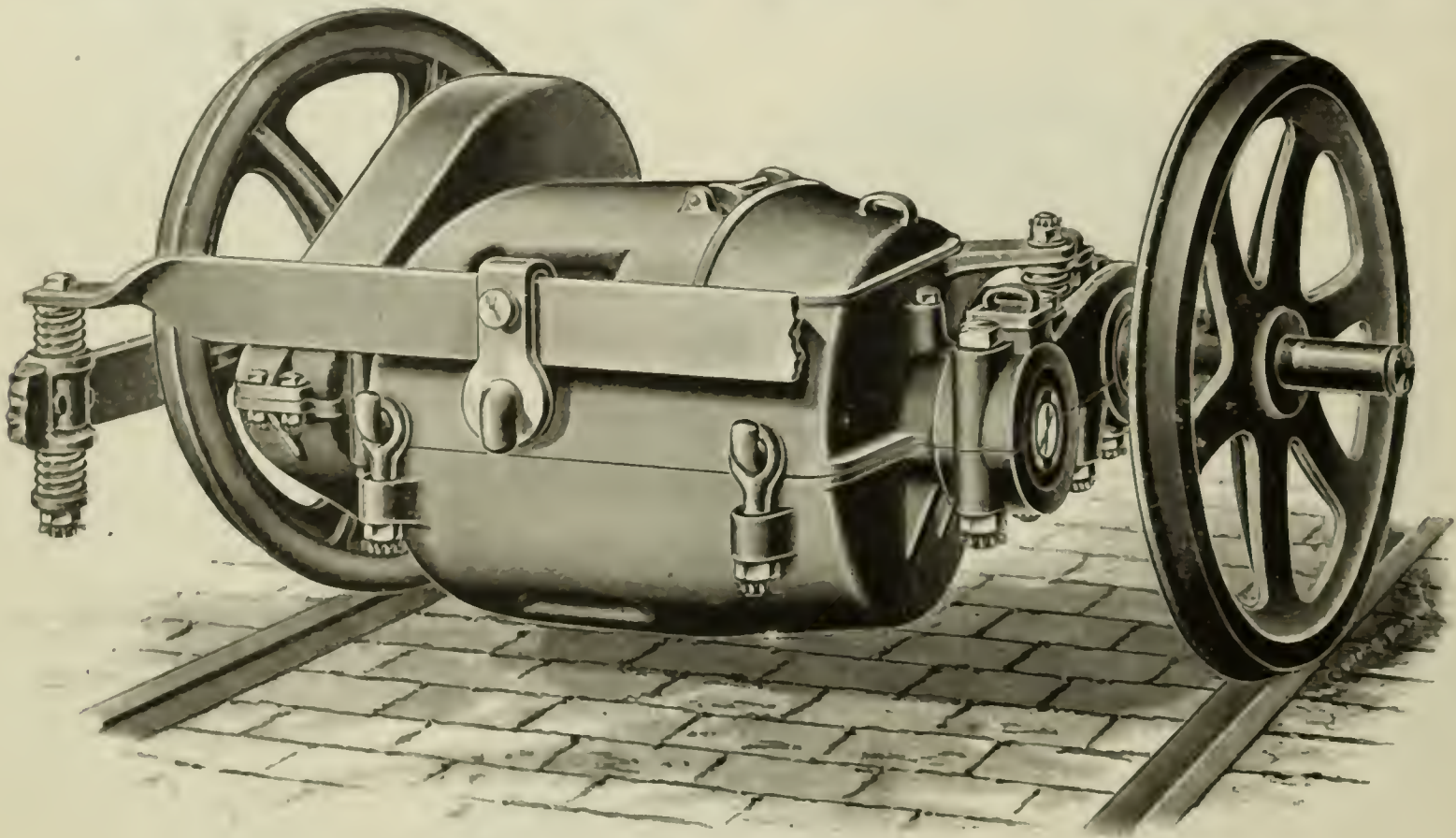
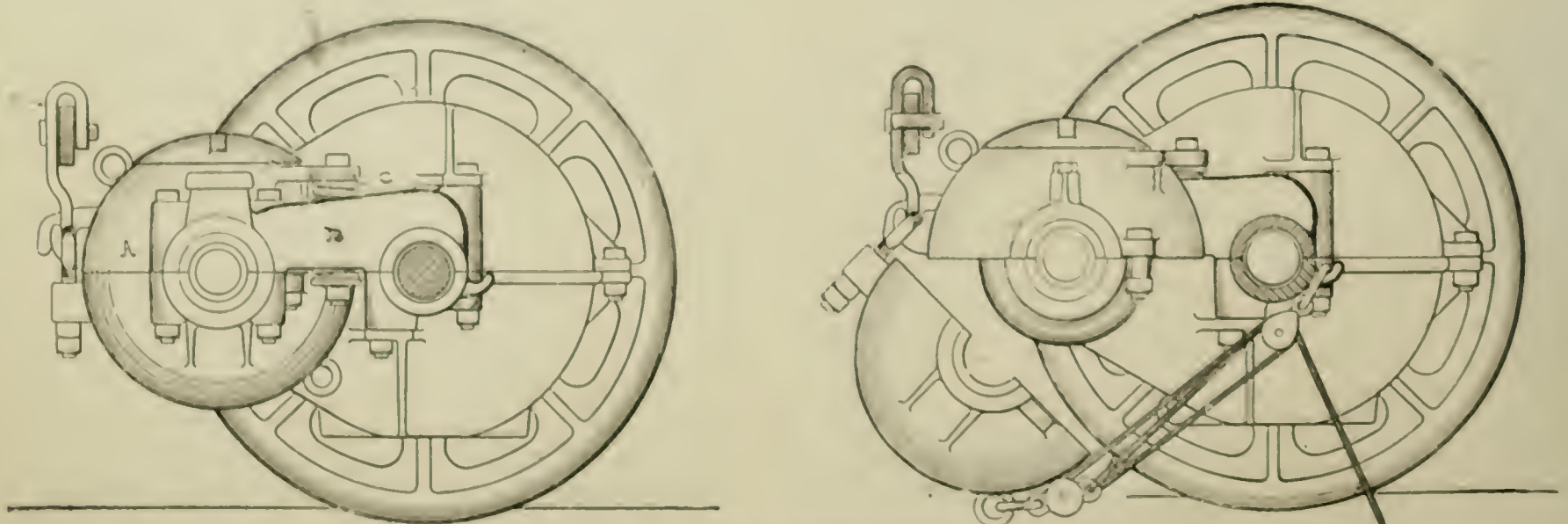


FIG. 2.—SPRING MOUNTED STEEL MOTOR.

thorough lubrication with grease. The efficiency of the motor is 90 per cent. For the better understanding of the flexible support and other points, detail cuts are shown. The motor, with gears and housing, weighs 1,600 pounds.

should a nut come off, no part of the motor can fall. The bolts are not made to take the weight of the motor, and the nuts are all locked with pins. The bearings are entirely outside of the motor casing or frame, as shown by Fig. 5.



FIGS. 3 AND 4.—END ELEVATION OF MOTOR.

Fig. 3 shows an end elevation of the motor with one wheel taken away. *B* is a cast iron *U*-shaped frame, the rounded end being journaled on the car-axle in the ordinary way. Swinging freely between the arms of this *U* is the motor,

They are solid shells, *A*, filled with the best babbitt and are supported by the bolt, *B*. The grease which comes out between the end of the thrust collar and the inner end of the bearing falls to the ground through the opening, *C*, which is

four inches by two and one-half inches, and cannot be clogged. No grease can get into the motor.

Fig. 6 shows a section of the armature. The core, *A*, is built on a separate sleeve, which receives the shaft, *B*. This shaft, when worn out, can be replaced by removing the nut, *C*, drawing out the shaft and inserting a new one, thus saving the expense of tearing the armature down and rebuilding, as not even a wire connection is disturbed. The

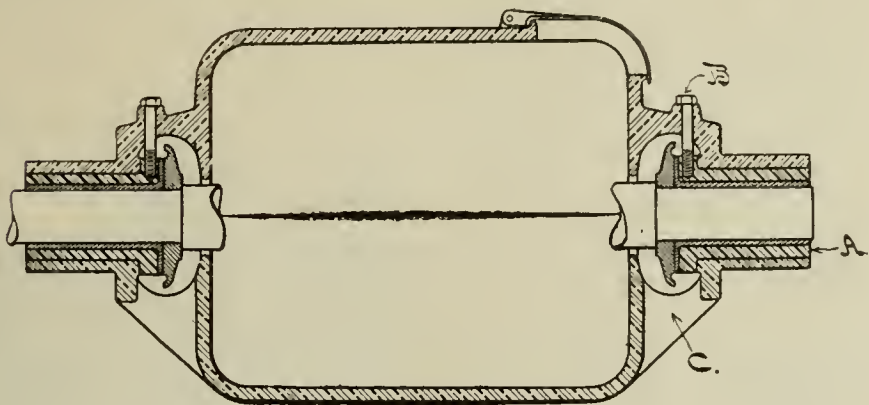


FIG. 5.—BEARINGS OF MOTOR.

commutator is on a tapered portion of the shaft, the same as the pinion, and can be more easily drawn off for refilling. Both commutator and pinion are held in place by nuts properly locked by an ingenious lock washer.

This motor contains all the long-tried constructional points which experience has proven to work well, and the weak points existing in motors of other types have been eliminated. Being flexibly supported, it will remove all trouble with rail joints, as in practice the motor runs as quietly as the old horse car. Not even the gear noise is heard, as the gears are enclosed in airtight housings and run in oil.

A cast iron motor of 35 h. p. weighing 2,500 pounds is also made for heavy work. This motor is intended for heavy street railway work, where very large cars or trains

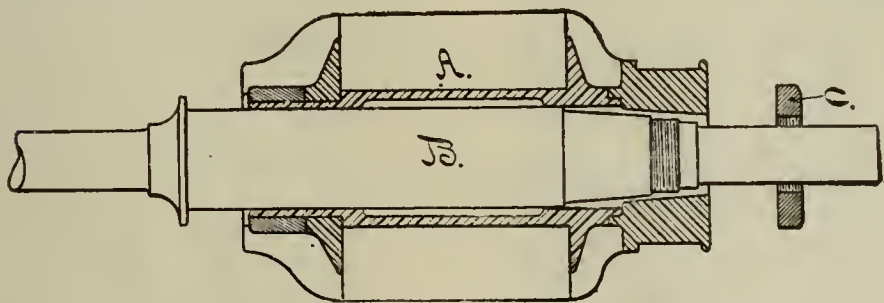


FIG. 6.—SECTION OF ARMATURE.

of cars are used. It is made of cast iron, and has an efficiency of nearly 90 per cent. It is built on the same general type as the steel motor, but is not spring mounted, being journaled on the axle like all other makes. This motor is exceedingly small and light for its output, being of about the same weight as other makes of 25 h. p. capacity. It will operate on 30-inch wheels with plenty of clearance.

The designs are already completed for large motors to operate elevated trains, or suburban and interurban railways, which will be run at high rates of speed. The life and activity which the Walker company is manifesting in entering the market with every kind of electrical machinery required by the large work which is being done and contemplated certainly augurs well for the future. The manufacture under the supervision of those thoroughly familiar with the detail of electrical machinery, and consequent ability to avoid the experimental stage of the business, together with their unsurpassed facilities, assures them success.

Central Station Customers.

The sort of customer for a central station to encourage, says the London "Electrician," is not necessarily the large consumer with his big bill, but the consumer whose bill is large in proportion to the lamps he uses, however small it may be in amount.

A Large Chemical Precipitation Plant.

The largest chemical precipitation plant, and at the same time the largest purification works in operation in this country, is located at Worcester, Mass. Improvements and extensions now nearly completed possess many interesting and unique features. The system is operated on the continuous plan, using lime and iron salts as precipitants. The iron is derived from the sewerage; the lime is stirred in agitators by means of compressed air from one compressor; while a second compressor at another point, operated by a turbine water wheel, driven by purified sewage, lifts the sludge from the ten new tanks to the sludge banks. The turbine water wheel is utilized at night to drive a dynamo, by means of which the whole works, or such parts as are desired, may be brilliantly illuminated.

There are many interesting features brought out in this electric installation. The building where the dynamo is located is 550 feet from the switchboard, so that all its current is delivered to the switchboard, which is made the centre of distribution.

The specifications called for all wiring to be concealed, so that there are no overhead wires above the basins. The main wires are led in wooden conduits, painted with two coats of P. & B. paint. There are three wires in these main conduits, one No. 14 from the rheostat to the field circuit, and two No. 000. The insulation of all the wire which is concealed is the extra heavy white core crown wire, manufactured by the Washburn & Moen Manufacturing Company. On the switchboard is a Carpenter enamel rheostat, a Queen voltmeter, an amperemeter and four single-pole jack-knife switches.

The basins are divided into four circuits, so that in the night-time, before the party who is watching the basins starts out, he can throw on the switch which controls the set of basins which he wishes to inspect. The main wire passes through the switchboard and into the laboratories, where a room is being fitted up in which experiments may be carried on with electricity. The basins are built up of cement with a wrought iron fence surrounding the walks. Each basin has four lights, and the main channel has eight, making sixty-two lights in all over the basins. Each lamp is supported by a fixture which was designed for this purpose, and is shown in Fig. 2. The base of the fixture is of cast iron, through which four bolts pass into the cement to hold the same. The fixture is built up of 2-inch pipe, 3 feet 6 inches long, and is then reduced to 1-inch pipe. Where the 1-inch pipe joins the 2-inch, there is a casting which makes a swinging connection, so that the light may be turned in different positions. There is a thumbscrew which allows the lamp to be held in any position, and a stop to prevent the fixture from turning around and twisting off the wire inside.

Above the 2-inch pipe there is a cross, and a pipe branches out 3 feet, terminating in a cast iron ball. Two feet 3 inches from the upright is an 18-inch double convex shade, from which the lamp hangs. This is supported by braces. The style of the fixture is in keeping with the fence, and makes a very presentable appearance. The feeders for the basin are run in wrought iron pipes. Where the wires from the fixtures connect to the feeders is a cast iron box, which contains a fuse cut-out, so that each lamp is fused.

The cord in the fixture is No. 18 rubber covered, silk lamp cord, covered over with rubber and a second covering of silk, which makes it really a twin cord. Running the wires in the pipes introduced many difficulties, as there were many turns to be made, and a large number of branches. Some of the wire in the pipe is No. 000, and the largest pipe used is 2 1-2 inches in diameter.

One great objection to using a waterwheel with a dynamo has been the unsteady nature of the power which the water-

wheel develops. This objectionable feature, however, was obviated by the use of the Ballard intermediate speed regulator. This regulator is the invention of Mr. H. A. Ballard, and is just being put on the market. It is built by the Columbia Electric Company. The principle is very simple, yet it fills a long felt want in the electrical field, as by its use irregular power may be easily converted into regular power and permit the running of a dynamo. The principle of the regulator is the same as that of a flyball governor. The pressure between two surfaces which have between them some substances, such as leather or vulcanized fibre, is increased or decreased as the speed varies. The regulator is substituted in place of the ordinary dynamo pulley.

The pulley of the regulator runs loose on a sleeve. This sleeve has a flange, which is faced up so that it comes against a corresponding flange of the pulley. Between these flanges is the leather or fibre, which is used as a friction. The pulley runs at a faster speed than the armature of the dynamo. Having adjusted the spring which controls the flyballs (or better, against which the flyballs act), the arma-

New Feeder Panel, Rubber Covered Wire and Dynamo Brush.

The General Electric Company has recently still further perfected its power house feeder panels. These are made for different numbers of feeder circuits, that known as form "C," adapted for two circuits, being shown in the illustration. It is fitted with a circuit breaker, two ammeters, and two single pole switches. The automatic circuit breaker is known as form "K," and is of the latest and most improved design. It will interrupt repeated short circuits without damage to itself, and can be instantly reset.

The magnetizing coils will carry 1,200 amperes continuously and can be adjusted to 1,800 amperes for temporary overloads. The fuses are of excellent design and can be cheaply and quickly replaced. They are of copper and are coiled to secure some electric magnetic effect and diminish the flashing when melting from overload. The terminals are made with a view to avoid the damage from any ordinary short circuit. These panels are designed to be bolted side by side with the generator panels, and are supported by ver-



FIG. 1.—GENERAL VIEW OF PRECIPITATING BASINS.

ture will run at a certain speed, as long as the loose pulley runs faster than the speed at which the armature runs, and it makes no difference how much faster. If the armature tends to speed up, the balls fly out and decrease the pressure between the flanges. The lamps in this installation run without a flicker.

The dynamo used is the "Columbia," which the above company is putting on the market, and with which they are meeting with great success. It has massive cast iron fields, Gramme armature, carbon brushes and self-aligning automatic oiling boxes.

Taking all and all, this makes a very complete and novel isolated plant. All the fittings were designed and built by the Columbia Electric Company at its factory. The design of the fixtures was made by Mr. H. B. Eddy, superintendent of the sewers, who is giving a great deal of attention and study to sewage purification. The details of the electric work were carried on under the supervision of Mr. J. P. Coghill, general manager of the above company.

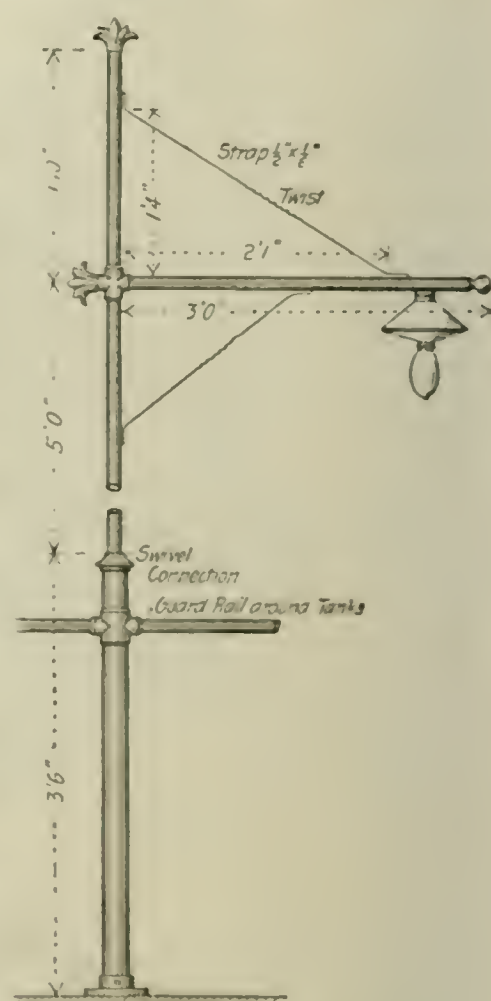
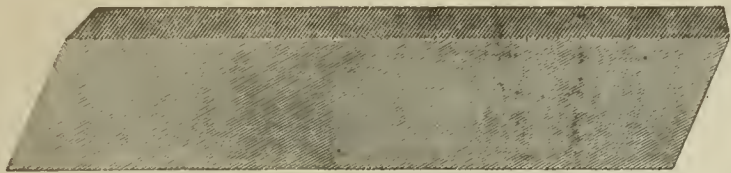


FIG. 2.—LAMP FIXTURE.

tical angle irons which can readily be bolted to the angle irons furnished with the generator panels. The bus bar is of the same height, so that the feeder panels can be connected in circuit by simply extending the line bus bar of the generator panels. Some of the forms of these panels are equipped with circuit breakers and some with fuses. The circuit breaker acts more quickly in opening the circuit, and can be more quickly closed. The fuse acts more slowly, but when blown cannot be replaced as quickly as the circuit breaker can be closed; although the first cost is less, the cost of renewing fuses is greater than of maintaining the circuit breaker.

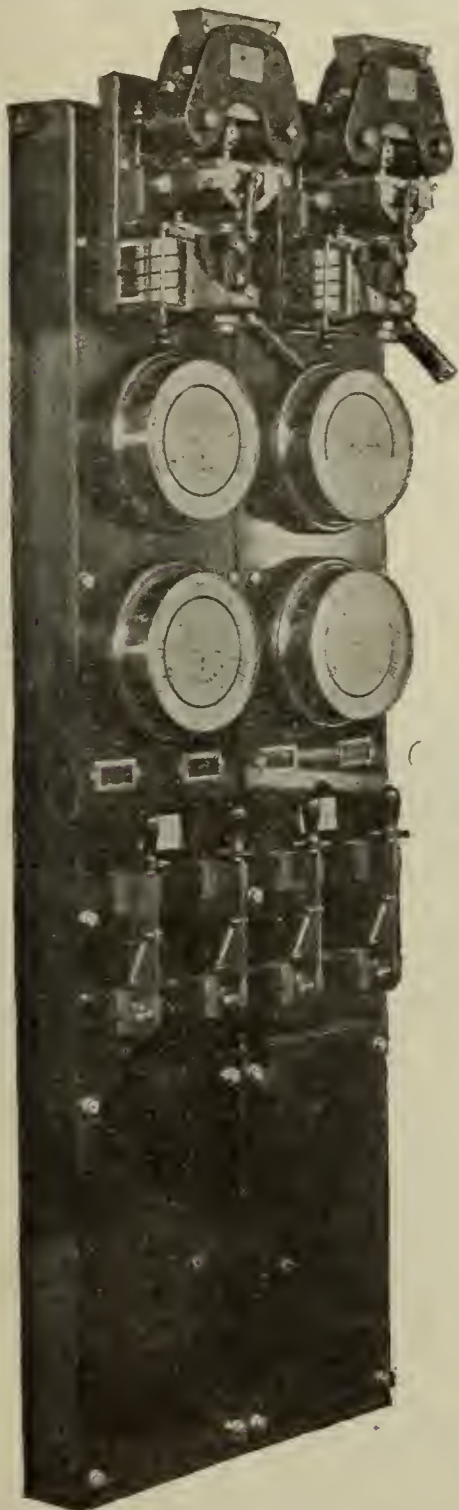
The same company has also just placed upon the market a new rubber covered wire, which is claimed to be superior to anything of the kind yet offered. This is known as the double rubber core wire, and has three coverings. Next to the wire is an inner core of soft rubber, free from sulphur, and protected by a second heavy covering of pure vulcanized rubber. Over this is a braided sheath, finished with

a weatherproof compound which serves to protect the rubber from the attacks of acids, alkalies, and from mechanical injury. Before applying the first covering the copper wire is



WOVEN WIRE DYNAMO BRUSH.

thoroughly tinned to safeguard it from corrosion. The rubber coverings are made of the best grade of fine Para rubber. The wire is made with three standard thicknesses of insula-



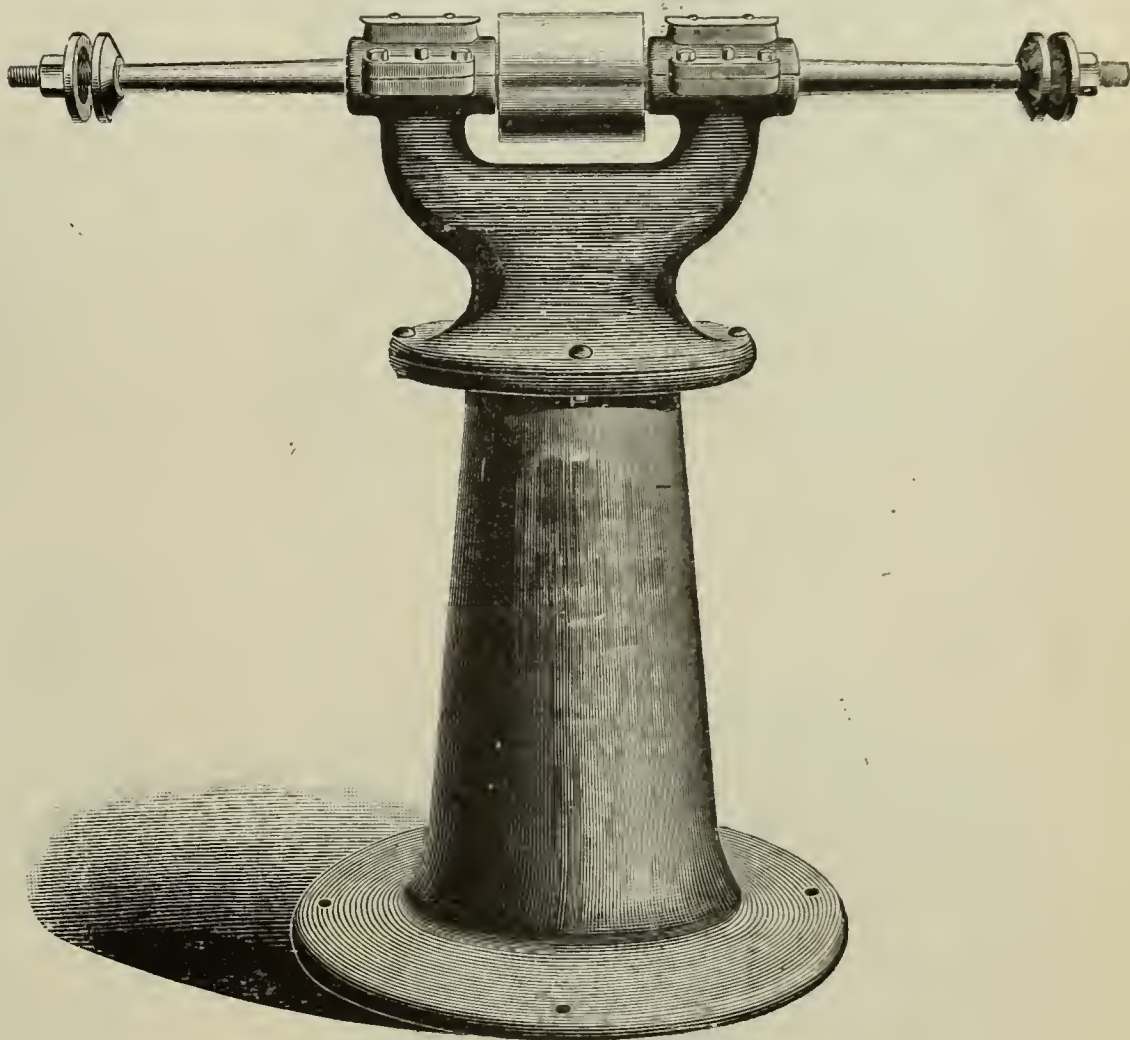
FEEDER PANEL.

tion, although it can be of any thickness desired. The lightest is intended for ordinary electric light wiring and for use on circuits not exceeding 500 volts. The second is for use on circuits not exceeding 2,000 volts, such as street railway, primary circuit alternating, and arc light circuits up to 40 lamps. The thickest insulation is for circuits up to 5,000 volts, and is devised for high tension work. Wire with the last two insulations may be armored for any class of submarine work.

Still another improvement is a woven wire dynamo brush, of which they have now ready a complete line for all of the machines they manufacture, Edison bipolar, T.-H. bipolar or multipolar, and, in fact, all, with the exception, of course, of the arc dynamo. The brushes are made of fine wire gauze, which is first wound into rolls, and then shaped into brush form under heavy pressure. They are smooth, give excellent contact, run cool and do not fray.

Polishing and Buffing Lathe.

The machine illustrated, manufactured by the Hanson & Van Winkle Company, Newark, N. J., is designed for heavy work, and fitted with extra long babbited boxes, giving the spindle sufficient bearing to insure stiffness. Without sacrificing strength the width of head has been so reduced that the machine will be found especially desirable by manufacturers of large irregular pieces, and will commend itself to those having bicycle, stove, chandelier, or car trimmings to do, as with this lathe there is no interference when working on large pieces. With this machine a large wheel can be used without the slightest jar or spring. The smallest sizes of these lathes combine all the valuable features of the size illustrated, including tapered steel spindles, etc. The No. 3, of which several hundred are in use, has in addition detachable steel taper ends to take the smallest brush or buff.



POLISHING AND BUFFING LATHE.

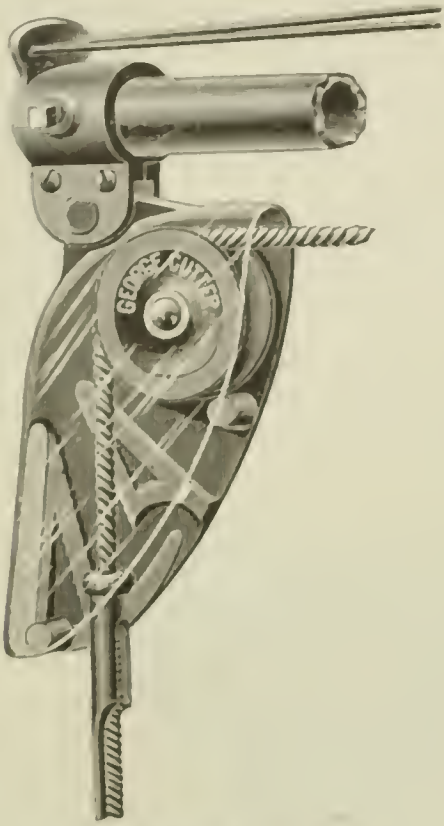
and are furnished with tight and loose pulleys, when required. These lathes can be run, it is claimed, at a higher speed than any in the market.

Mast-Arm Pulley.

The lamp supporting pulley brought out several years ago by Mr. George Cutter, of Chicago, has proved so successful for use wherever arc lamps are hung from suspension wires that there has been quite a demand for a mast-arm form of pulley. To meet this, Mr. Cutter has designed the pulley shown in our cut, built on the same general lines as the one for centre suspensions, but with a special clamp, which will fit the iron pipe commonly used on mast arms.

The clamp also serves as a cap for the pipe arm, so that the bracing can be done from this extreme point. All parts are well made and neatly japanned, the snaphook knob (shown only in part by our illustration) being of malleable iron. This knob is automatically guided into its seat when the lamp is raised, and just as readily released, there being no springs, pawls or catches to be clogged by snow or sleet. The lamp supporting feature acts as a perfect safety device, and as the action is automatic the whole ar-

arrangement combines the good points of a pivoted mast arm with the simple and rigid design of a fixed form. For this reason alone it will recommend itself to all who are using



MAST-ARM PULLEY.

the rigid mast arms, as well as to those who have not obtained the expected results with the swinging forms.

Electric Track Switch.

We illustrate a new track switch designed by Dr. C. M.

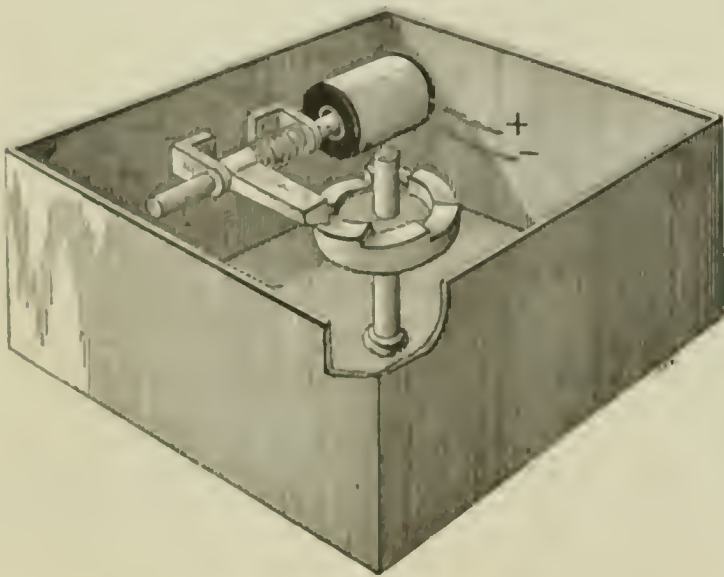


FIG. 1. ELECTRIC TRACK SWITCH.

Fitch, of South Norwalk, Conn., whose name is well known in connection with this class of street railway devices. The

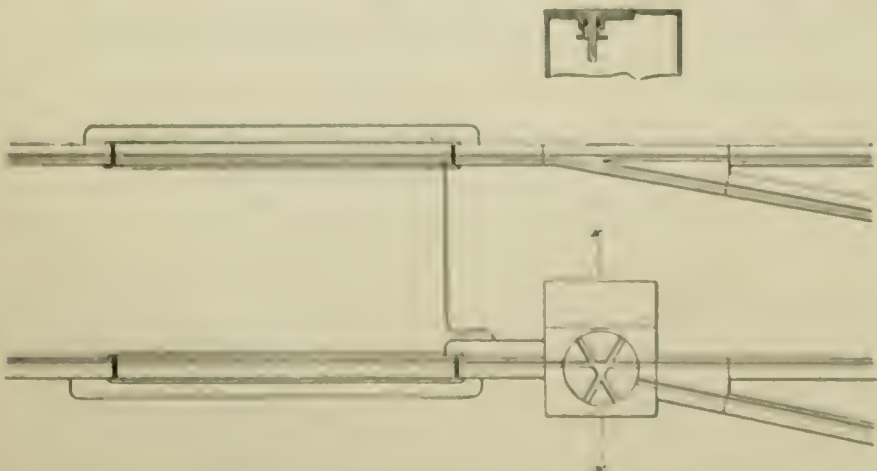


FIG. 2. ELECTRIC TRACK SWITCH

apparatus consists of a circular track plate operated by a solenoid in a water and air-tight box. Fig. 1 shows the

solenoid, which by means of a ratchet mechanism turns a vertical shaft which, passing through a shifting box, revolves the track plate. An inspection of Fig. 2 will show the manner in which the plate alternately switches on one or the other of the lines. The ratchet teeth are of two lengths so as to provide for the two different angular movements of the plate, corresponding to its two positions.

The solenoid is actuated by the current from the motor car. To accomplish this the parallel rails of the track next to the switch are insulated, and when the car comes on these the current is led to the solenoid, actuating it, and then passes to the ground. Among the advantages claimed are that the switch plate cannot become clogged like the tongue switch and that the mechanism is extremely simple and confined to an air-tight box.

Rheostat Insulation.

We illustrate a new application of micanite insulation, made by the Mica Insulator Company, 218 Water street,

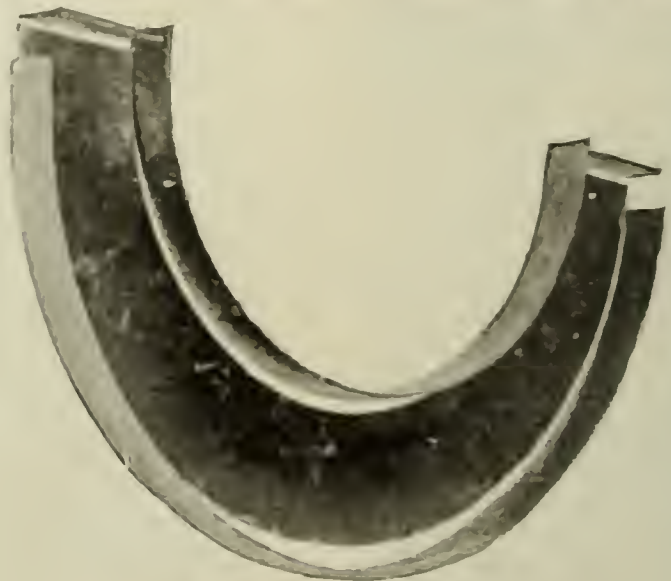


FIG. 1.—RHEOSTAT INSULATION.

New York, for use with rheostat boxes. Fig. 1 shows the micanite lining ready to be put into a box, and Fig. 2 the same in position. Among the other articles made of the



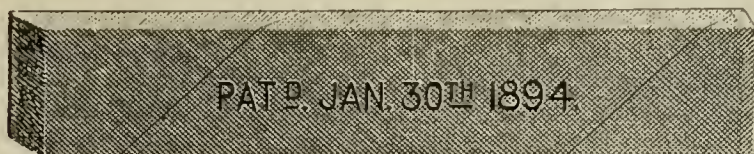
FIG. 2.—RHEOSTAT INSULATION.

same material, recently placed on the market, is a micanite Gramme ring armature spool and a micanite cloth, which is non-absorbent and has the valuable quality of remaining flexible indefinitely.

Fleming Dynamo Brush.

All who have had practical experience of dynamos will know that if the position of the tips of the brushes as they press on the commutator be not properly adjusted, the result will be "sparking at the brushes." This sparking, if allowed to continue, will sooner or later pit the surface of the commutator segments, destroy their smoothness and even-

ness and heat the brushes. Once started, the mischief goes apace, the commutator becomes untrue and worn into deep and rugged grooves; increased sparking is caused by the "jumping" of the brushes as they pass from segment to segment, and perhaps the tips of the brushes become partially fused, and the commutator is thus gradually eaten



NEW DYNAMO BRUSH.

away until its state is past all remedy. To check the evil it is necessary to continually trim the brush tips, and "true up" the surface of the commutator by trimming it in a lathe, and these often repeated processes result in a greatly reduced life of both commutator and brushes.

All sorts and conditions of brushes have been devised by dynamo manufacturers for this important but somewhat neglected part of a dynamo, such as solid copper plates, bunches of wires, carbon pencils, composite brushes made of several ingredients, etc. The brush that we illustrate, manufactured by the International Trading and Electric Company, 40 Cortlandt street, New York, is of the latest type and should commend itself to the electrical engineer. It is composed of a continuous strip of high conductivity pure lake copper gauze, the copper wire being drawn to 34 B. W. G. and then

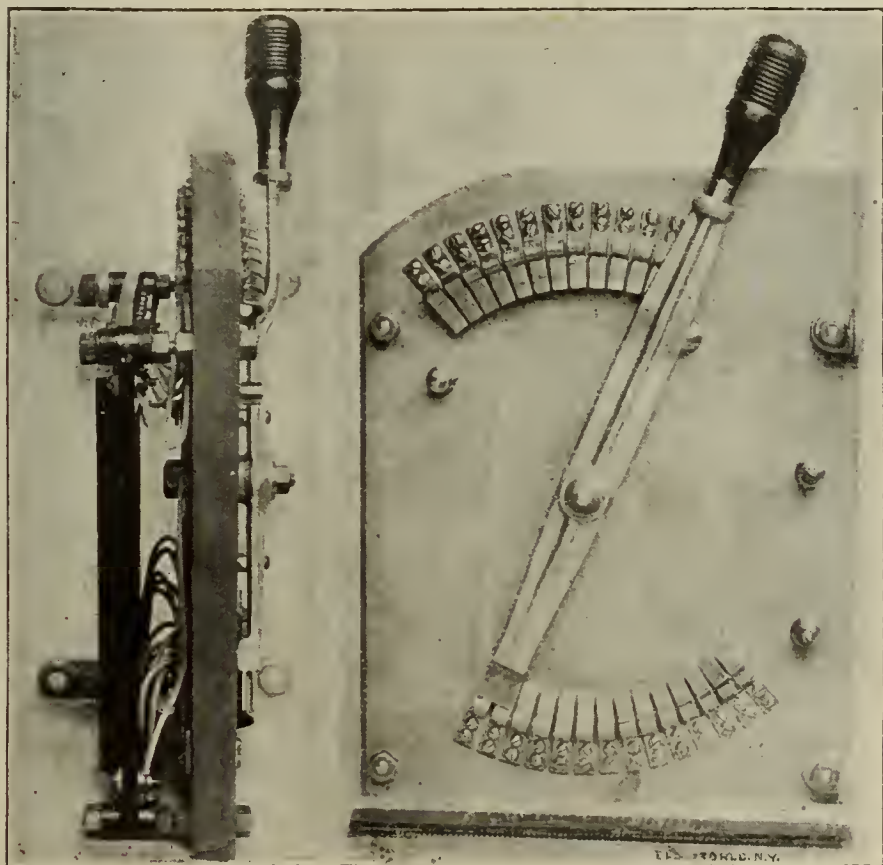


FIG. 1.—50-LIGHT THEATRE DIMMER.

woven to a mesh of 3,600 to the square inch. It is claimed that by this process of manufacturing the Fleming brush, as it is called, an article is produced that when placed on a commutator in good condition is absolutely noiseless and sparkless. The brush is also compact and flexible, readily adjusting itself to the surface of the commutator, ensuring good contact, though bearing lightly and evenly on the segments, and thus reducing to a minimum the wear on this part of the dynamo. This brush, we are informed, has been adopted for use by the United States and other governments.

Compact Rheostats.

The accompanying illustrations show several forms of the

rheostats manufactured by the Carpenter Enamel Rheostat Company, of Bridgeport, Conn. The special advantages of these rheostats are their exceedingly compact form and fire-proof qualities.

Fig. 1 shows a 50-light theatre dimmer, giving a front

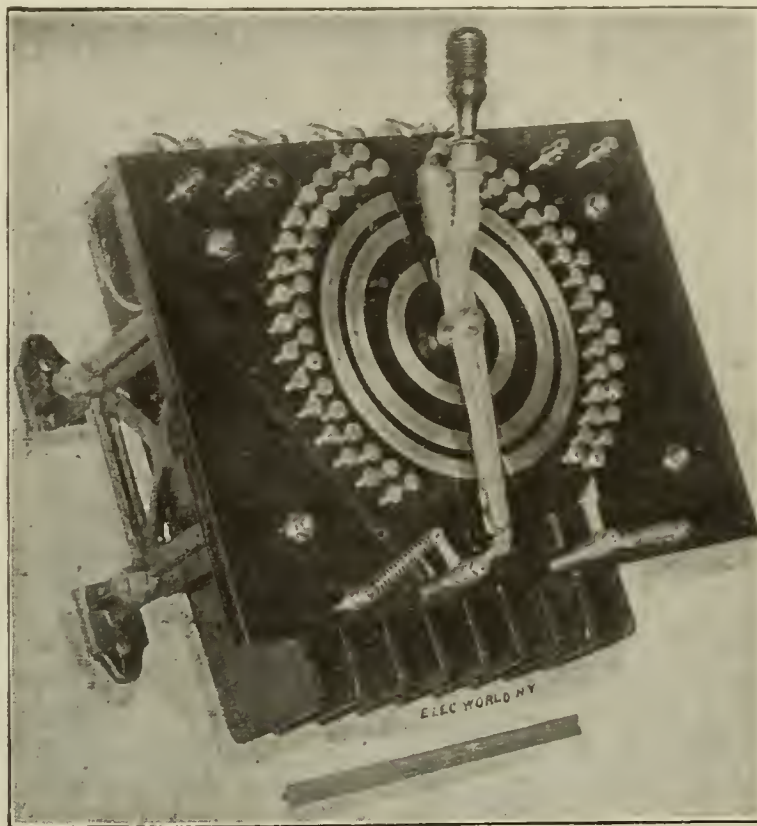


FIG. 2.—REGULATING RHEOSTAT WITH REVERSING SWITCH.

and side elevation. Its small dimensions will readily be seen from the foot rule which lies at the bottom of the rheostat. In the ordinary form of theatre dimmer it has been

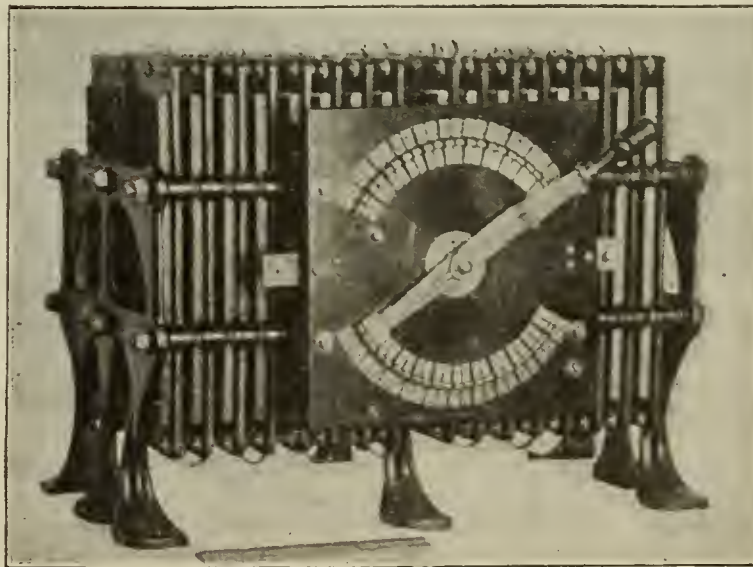


FIG. 3.—MOTOR REGULATING RHEOSTAT.

customary to locate the rheostats coils, often in the form of loose wire, at some distance from the switch, thus not only taking up a great deal of room, but presenting many opportunities for the origin of fire. The Carpenter rheostat is not only exceedingly compact but is absolutely fireproof from the very nature of its construction.

Fig. 2 shows a 10-h. p. 500-volt regulating rheostat with reversing switch. This piece of apparatus was made for the Crocker-Wheeler Electric Company, and embodies the same desirable features as that just described.

In Fig. 3 may be seen a 115-volt motor regulating rheostat made for the C. & C. Electric Company, and shows that the Carpenter form of construction is applicable as well to rheostats which dissipate a large amount of energy as to the smaller sizes.

generate electricity, manufacture and furnish electric light, power, etc. A. J. Greene, F. E. Mohr, J. W. Clendenin, H. B. Summers and Julia C. Greene are the incorporators.

THE AMERICAN DISTRICT TELEGRAPH COMPANY, San Antonio, Tex., capital stock \$3,000, has been formed to operate a system of district telegraph and telephones and do all kinds of electrical work, etc. B. F. Kingsley, C. M. Kingsley, San Antonio, Tex., and C. K. Meade, Des Moines, Iowa, are interested.

THE ST. GENEVIEVE BREWING AND LIGHTING COMPANY, St. Genevieve, Mo., capital stock \$30,000, has been formed to manufacture and generate electricity for light and power, also to manufacture beer, supply cold storage, etc. H. J. Rosier, W. W. Wilder and Valentine Rottler, of that city, are the interested parties.

THE HUNTSVILLE ELECTRIC LIGHT AND ICE COMPANY, Huntsville, Tex., capital stock \$6,500, has been formed to generate and sell electricity, furnish cold storage, etc. T. H. Hall, J. G. Ashford, T. C. Gibbs, C. G. Barrett, R. S. Rather, J. W. Thomason, C. H. Robinson, H. A. Eastham and W. S. Gibbs are the incorporators.

THE NEW YORK AND EASTERN TELEGRAPH AND TELEPHONE COMPANY, Jersey City, N. J., capital stock \$140,000, has been formed to construct and maintain telegraph and telephone lines, etc. W. J. Griffith, 135 West 49th street, H. Morris, 430 East 22d street, New York City; E. M. Millard, 468 Willoughby avenue, James Ross, 792 Carroll street, J. B. Skinner, 241 Hancock street, and A. Noden, 176 York street, Brooklyn, N. Y., and W. S. Rich, 938 13th avenue, Newark, N. J., are the incorporators.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
41 Park Row New York, April 2, 1894.

J. JONES & SON, 39 Vesey street, New York, report that they have been taking recently some heavy orders for their anti-thunder bolt paper.

Mr. B. E. DAVIS, agent for the specialties manufactured by Messrs. Pass & Seymour, Syracuse, N. Y., was in town last week and reports having had a successful trip throughout New England.

MR. EDWARD J. DALTON, manager of the New York office for M. T. Davidson, reports that his firm has recently completed 18 brass end steam pumps for use aboard the United States war vessels.

EUGENE MUNSELL & CO., 218 Water street, New York City, would be pleased to hear from their customers over the telephone. Their number is 968 Cortlandt. All communications through this source will receive prompt attention.

THE BALL & WOOD COMPANY on Saturday afternoon entertained about 500 mechanical and electrical engineers, who visited its works at Elizabethport, N. J., in response to an invitation to view a new type of compound vertical engine. It is only at the annual or other extraordinary meetings of the professional societies that such a distinguished body of men can be seen assembled, and it speaks most highly for the professional and personal reputations of Messrs. Ball & Wood that their invitation was, apparently, almost unanimously accepted. Every preparation had been made to render the visit agreeable; the main offices were temporarily transformed into a lunch room, where also two huge punch bowls occupied positions of honor, and received due attention from the visitors. Among those in attendance were an ex-engineer-in-chief of the navy, several ex-presidents of the Am. Soc. of Mech. Eng. and so many others of prominence that even a partial list would be too large for the space at our command. We shall describe the engine fully in a future issue, and now merely note that its peculiarity consists in an unusually ingenious valve gear. The exhaust valves and main steam valve are of the Corliss type, and driven from a vibrating disc like Corliss valves; the cut-off valve is within the main valve, and receives a motion which is the resultant of that of the main valve-driving disc, and of the motion from a wheel governor similar to the one used on the ordinary type of the Ball & Wood engine.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., March 24, 1894.

WARREN, MASS.—Voters will be asked at a town meeting to allow the Palmer & Monson Electric Light Company to erect poles and string wires.

ISLEBORO, ME.—Captain Winfield Pendleton, of Isleboro, states that his proposed telegraph and telephone line from Isleboro to

Belfast and Northport will not be built this year, but that it ultimately will.

THE CITY COUNCIL of Boston is to consider a report from a sub-committee recommending an expenditure of \$15,000 to provide for the employment of electrical experts in the several fire districts. The idea is to give the fire department the benefit of all the scientific and practical information for use in its daily work, and in emergencies.

THE PROPOSED SUBWAY in Boston is seemingly not gaining friends, and more opposition is developing each day. It does not seem to strike a popular chord, and many of those who have studied the matter feel that the final result will not be entirely what is hoped for, namely, a complete relief of the congested districts. The matter is still under discussion by proper authorities.

THE MATHER ELECTRIC COMPANY, Manchester, Conn., informs us, through its secretary, that Messrs. Angier & Co. are its authorized representatives in Boston and vicinity. The company has no other representative in Boston, and this is to correct the announcement recently made to that effect. Mr. Angier is well known in the electrical field, having been for a long time connected with the firm of Claflin & Kimball, 116 Bedford street, Boston, Mass.

Pittsburgh Notes.

PITTSBURGH, March 31, 1894

THE SECOND AVENUE TRACTION COMPANY of this city has decided to operate an electric launch on the Monongahela River, between Glenwood and Homestead.

GENTLEMEN INTERESTED in the Creighton, Kensington and Parnassus Electric Street Railway have asked for a charter to build a bridge across the Allegheny River at Creighton. The bridge will be used in connection with the electric road.

THE AMERICAN TELEGRAPH AND TELEPHONE COMPANY has been organized in Brushton, and has asked the Borough Council for the right to string wires, and will commence operations immediately. Brushton is a town about six miles from Pittsburgh.

BUILDING on the new works of the Westinghouse Electric and Manufacturing Company, at Brinton, is rapidly progressing. The foundation of the immense machine shop is almost completed, and the putting up of the walls of the structure is commencing.

THE ALLEGHENY CITY electric light plant has recently greatly increased its capacity of arc lights. For a number of years the company has been using the tower light system, but it was not long ago decided to take these towers down and substitute them with mast arm lights.

IT MAY BE INTERESTING to the electrical trade to learn that all of those companies in this city which are known as "the Westinghouse interests" are dividend-paying investments. These companies are capitalized in round figures at \$30,000,000, comprising the following: The Westinghouse Air Brake Company, the Westinghouse Electric and Manufacturing Company, the Standard Underground Cable Company, the Union Switch and Signal Company, the Allegheny County Light Company, the Westinghouse Machine Company, the Philadelphia Company and the Allegheny Heating Company.

News of the Week.

Telegraph and Telephone.

TOPEKA, KAN.—The Topeka-Harrison Telephone Company has applied for a franchise to construct and operate a telephone line. S. J. Bear and A. K. Rodgers are interested.

WISCASSET, ME.—A telephone company has been organized at Wiscasset by Joseph P. Tucker, A. S. Erskine and F. A. Creamer. The system will be put up and operated this spring.

THE HARRISON INTERNATIONAL TELEPHONE COMPANY has secured handsome offices at 44 and 46 Wall street, New York. This company is organized under the laws of Illinois with a capital of \$80,000,000, and the following well known gentlemen as officers and directors: President, Stephen B. Elkins; secretary, Patrick Egan; vice president, C. M. Ferree; general manager, H. J. Hanford; directors, R. C. Kerens, George R. Peck, T. J. Hurley, Robert P. Porter, William Warner, L. E. Ingalls, H. M. Holden, A. L. Stone, Stephen B. Elkins, C. M. Ferree and the chief electrician, Dr. E. M. Harrison.

Electric Light and Power.

DURAND, WIS., is considering electric lighting.

SHELDON, ILL., will vote in April on a bond issue for electric lights.

ELKHORN, WIS.—Residents of Elkhorn are asking for electric street lighting.

OSCEOLA, IOWA.—An electric light plant will be put in during the coming year.

NORWICH, N. Y.—The Norwich Illuminating Company proposes to reconstruct its electric light plant.

MARBLEHEAD, MASS.—Marblehead has voted to establish an electric light plant at a cost of \$60,000.

DENVER, COL.—The county commissioners will consider plans for an independent plant for lighting the court house.

FREELAND, PA.—The Freeland Light, Heat and Power Company has been granted a contract to light the borough of Freeland.

GENESEO, N. Y.—The village trustees of Geneseo have decided to try electric lighting, and they will advertise for bids this week.

CHATHAM CENTRE, N. Y.—H. C. Spengler intends putting up a good-sized electric lighting plant in Chatham to furnish the village with lights.

CHARLOTTE, N. C.—The Charlotte Consolidated Construction Company is in the market for two alternating light machines and necessary apparatus.

WOODBURY, N. J.—Solicitors are now seeking subscribers in Woodbury, Clayton, Glassboro and Wenonah for electric light plants, which a syndicate of capitalists proposes to erect.

RICHMOND, VA.—In the matter of the resolution to appropriate \$75,000 for a municipal electric light plant, it was decided to send same to committee on light for estimates and report.

PHILADELPHIA, PA.—The sub-committee of Councils, electrical committee, to which has been referred the matter of a city electrical plant, has reported adversely on economical grounds.

CLEVELAND, OHIO.—The repair shop of the Cleveland Electric Company was burned to the ground March 24. All the valuable machinery, including several motors, was burned. Loss \$50,000, insured.

MEMPHIS, MO.—A contract has been closed with the Franklin Electric Company, Kansas City, Mo., for an incandescent electric lighting plant including new steam plant and Edison incandescent dynamo and construction.

FALL RIVER, MASS.—It is stated that the Edison Illuminating Company will build an addition to their plant on Hartwell street, and will put in a compound engine of 400 h. p. with direct attachment to the dynamo.

LEAVENWORTH, KAN.—It is proposed to erect an electric fountain at the Soldiers' Home when the electric railway is extended there. It will cost \$50,000, to be defrayed by the Home, the city and the railway company.

WASHINGTON, D. C.—Sealed proposals will be received at the office of the commissioners of the district to 2 P. M., April 12, for furnishing 225 lamp posts. J. W. Ross, Geo. Truesdell and C. F. Powell are the commissioners.

VALPARAISO, IND.—The City Council is considering the establishment of an electric light plant, the present plant being insufficient in size to be an incandescent system, and it is also considering more street lights and telephones.

EVANSTON, ILL.—The Council committee on lighting recommended that the Evanston Electric Illuminating Company put in a 50-light machine in the city's plant at South Evanston, and that new lights be put at various parts of the city.

ERIE, PA.—The Common Council has finally passed the ordinance granting permission to the Merchants and Manufacturers' Electric Light Company to string wires and erect poles in certain streets for the purpose of supplying light and power.

SAVANNAH, GA.—The Council has decided that it is inadvisable that Savannah should purchase and operate a municipal electric light plant at present, and a contract has been awarded to the Brush Electric Light Company for three years.

ST. LOUIS, MO.—The Subway Commission has requested City Electrician Andrew J. O'Reilly to make plans and specifications for a conduit system to extend from Cass avenue to Chateau avenue and from 20th street to the river, to include a number of ducts.

WASHINGTON, D. C.—Senator McPherson and Mr. Cadmus have introduced bills incorporating a company of New York and New Jersey capitalists, who propose to supply electric light for the streets of Washington, in competition with the Washington Gas Light Company.

SAVANNAH, GA.—Plans are ready for a complete new station to be built by the Brush company. Building will commence at once, and the plant will be completed and ready by Oct. 1, 1894. The company has all it needs in electric machinery, but will install new boilers and condensing engines.

The Electric Railway.

DAYTON, OHIO.—The City Street Railway will erect a brick power house on Emily street.

AUSTIN, TEX.—E. J. Burns, of Dallas, Tex., has bought the

Austin dummy line, and the motive power will be changed to electricity.

WAVERLY, PA.—Bids for the buildings and power house of the Waverly, Sayre and Athens Street Railway have all been rejected, and the work will be done by the day.

CHICOPEE, MASS.—The Chicopee aldermen have given a hearing to the petitioners of the Wymanlea Electric Railway Company, and voted to lay the matter on the table.

ASBURY PARK, N. J.—It is proposed by the Seashore Traction Company to build an electric railway from Asbury Park to Pleasure Bay, to connect with steamers to New York.

DARTMOUTH, MASS.—The contract for building the Dartmouth and Westport Electric Railway has been awarded to Arthur Hodges, of Boston; the road is to be ready June 20.

ALBION, N. Y.—Over \$50,000 of the \$60,000 required has been subscribed towards the road which Emmons, Dwyer & Co., of Syracuse, propose to build from Batavia to Oak Orchard.

LOCKPORT, N. Y.—W. C. Reed, of the Lock City Electric Railroad construction force, states that the work of getting options for the Williamsville-Lockport railway is almost completed.

NORWALK, OHIO.—The Sandusky, Milan and Norwalk Electric Railway Company will sell the remainder of the \$16,500 in bonds to extend the line in Norwalk to the city limits, work to begin at once.

LOCKHAVEN, PA.—The proposed electric railway is now a certainty, the sum of \$10,000 having been subscribed. The following are the committee to organize a company: W. H. Mayer, L. M. Patterson and T. H. Harmon.

ALLENTOWN, PA.—The Eastern Transit Company has decided to extend its lines to Chain Dam, and the contract has been awarded to the Lehigh Valley Construction Company, of which H. O. Duerr is manager, at Bethlehem, Pa.

PITTSBURGH, PA.—Longfellow, Alden & Harlow, of 6 Beacon street, Boston, Mass., have made plans for the proposed power house, to be known as the Vandegrift Power Building, to be located at Penn avenue and Third street.

JACKSONVILLE, FLA.—The Jacksonville Street Railway Company has advertised for bids for furnishing electric power for the lines of the company, and they are now being received. J. E. Hartridge is general counsel to the company.

BALTIMORE, MD.—The Piedmont Construction Company, in which many prominent Baltimore capitalists are interested, has secured a desirable site for the power house for the electric railway at Charlottesville, the construction of which will soon begin.

ITHACA, N. Y.—The Cayuga Lake Electric Railway Company, capital stock \$25,000, has been chartered at Albany to build a road from Percyfield, on the lake road, Ithaca, to the southeast corner of Cayuga Lake. Alfred Hand, Horace E. Hand and E. L. Fuller, of Scranton, Pa., are interested.

BALTIMORE, MD.—The Legislature has passed the bill incorporating the Columbia and Maryland Railroad Company to build an electric or other railway from Baltimore to Washington and other points. Stephen Gambrill, brother-in-law of Senator Gorman, is one of the incorporators.

SOUTHINGTON, CONN.—Engineer T. H. McKenzie, of Southington, has been engaged by the Bristol-Plainville Tramway Company to make a survey of the proposed line from Bristol to Plainville, thence to Compounce Lake. Residents of Southington are urging that the road be extended to their town.

HOOSICK FALLS, N. Y.—The Hoosick Railway Company has made an application to the Highway Commission for permission to build and operate an electric railway on the highway leading from Hoosick Falls to and through North Hoosick and Wallcomsac. The petition will be heard at public meeting April 6.

SAVANNAH, GA.—The reported consolidation of the electric street railways has not taken place, and it is not probable it will be done for the present. The terms offered by Mr. J. S. Collins, president of the Electric Railway of Savannah, were not satisfactory to Mr. Parsons, of the Savannah Street Railway.

BOSTON, MASS.—The Magnetic Electric Railway Company, of Boston, is holding meetings in Portland, Me., with the object of perfecting arrangements to build and operate a new system of electric railway, invented by Edward H. Brown, of Salem, Mass. L. G. Burnham, H. W. Peabody and C. E. Hubbard, all of Boston, Mass., are interested.

CHESTER, PA.—Colonel Samuel A. Dyer, president of the Union Railway Company, of Chester, has bought a controlling interest in the stock of the Chester, Union, Chester and Media, and the Chester, Darby and Philadelphia railways, and he will form them into one company, to be known as the Chester Traction Company, and make important improvements and extensions.

AN IMPORTANT SUIT.—The case of the Adams Electric Company vs. the Lindell Railway Company will be heard before Judge Hallett, in St. Louis, on April 20. This is the well known case involving the alleged infringement of the method of centring an electric motor over an axle. Dr. Wellington Adams claims to be the inventor of this "method," and Colonel Hill, Ex-Governor D. R. Francis, Congressman Seth W. Cobb, Major C. C. Rainwater, Judge

Given Campbell and Prof. Francis E. Nipher and other prominent citizens of St. Louis are interested. The winning of the suit by the Adams company would involve the question of a royalty to be paid by all electric railway companies.

Personal Notes.

MR. JAMES H. RHOTEHAMEL was married on Tuesday, March 28, at Chicago, to Miss Nancy Rex. Mr. Rotehamel is president of the Columbia Incandescent Lamp Company, of St. Louis, and is widely known and very popular in the electrical field. We feel sure that their many friends will join us in extending best wishes to the happy couple.

Miscellaneous Notes.

AN ELECTRICAL GOAT.—Mr. G. Wilfred Pearce contributes an amusing account to a New Jersey newspaper of a goat named Home Rule, attached to the Edison laboratory and lamp works, which in return for its food from the hay and excelsior packing bins renders faithful and prompt service in butting over book agents, lightning rod men and English tourists, who visit the factory for the purpose of taking up the time of Wizard Edison. Home Rule has, like a well conducted policeman, a beat, which he patrols with unfailing regularity. It commences early in the morning at the lamp works, and extends to the Pennsylvania depot, where he welcomes the New Brunswick contingent; after that he keeps on to the Delaware depot to welcome Edison and others, and woe betide the great inventor if he has failed to put a store of peanuts in his hat for Home Rule. That happened not long ago, but Home Rule "got square" by chewing up the Wizard's new Dunlap silk hat and book of tickets on the railroad. This remarkable goat, we are informed, cares not a whit for poisons or the powerful currents of electricity. It is an unusual day when he does not drink a gallon of battery solution, or chew up a yard of live electric wire in the lamp factory.

Trade and Industrial Notes

THE LAW BATTERY COMPANY, 85 John street, New York, is presenting to its friends and patrons a novelty in the form of a glass pen to be used as a steel pen.

THE HORN, BRANNEN & FORSYTH MANUFACTURING COMPANY, Philadelphia, received the contract for supplying combination gas and electric fixtures for the new Federal building at Troy.

CHARLES PLUMB, 89 Erie street, Buffalo, has invented and constructed an accumulating influence machine for medical purposes, particularly for the treatment of rheumatism and nervous affections.

THE OHIO BRASS COMPANY, Mansfield, Ohio, reports that it is receiving satisfactory results from its new catalogue, and that the general favor with which its manufactures are received are most gratifying.

THE CHICAGO INSULATED WIRE COMPANY, 207 South Canal street, Chicago, Ill., is finding a strong demand for insulated wire, which it manufactures in all varieties, as well as its special lamp coil.

THE ROWELL & CHASE COMPANY, 1217 Union avenue, Kansas City, Mo., has opened a branch office of the Sioux City Engine and Iron Works, and will handle a full line of the goods in addition to that of many other houses.

THE SHERBORNE ELECTRIC INSTALLATION, Sherborne, Dorset, England, sends us circulars descriptive of the Sherborne combination gas engines and dynamos, and of omnibus and bicycle storage batteries and electric lamps.

W. H. STANLEY has leased the premises of 806 Walnut street, Philadelphia, lately occupied by O. D. Pierce & Co., where he intends to keep on hand a large assortment of electrical supplies and also carry on the electrical construction business.

THE STROWGER AUTOMATIC TELEPHONE EXCHANGE, of Chicago, has ordered 100 No. 1 standard magneto telephones from the Western Telephone Construction Company, of Chicago, to replace the battery telephones of the exchange at La Porte, Ind.

THE SHORT ELECTRIC RAILWAY COMPANY held its annual meeting on March 27. The old board of directors was re-elected, and the following officers chosen: President, B. F. Miles; secretary and treasurer, Bethune Duffield, Detroit, Mich.; general manager, S. M. Hamill.

THE BEACON VACUUM PUMP AND ELECTRICAL COMPANY, Boston, has made a reduction in the price of the "New Beacon" lamp. The great advances made in the improved lamp have resulted in such a greatly increased output that it has been possible to make the reduction referred to.

THE "I. X. L." TEMPERED COPPER COMPANY, Buffalo, N. Y., has removed its office and works from 226 Ohio street to 132 Niagara street. The material sold by this company is guaranteed pure unalloyed copper, and has been tested and tried by many of the largest electrical houses in the country, from whom some very flattering testimonials have been received.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY has issued another of the handsome technical monographs for which it is noted, the present one being devoted to the Wurts non-arcing railway lightning arrester. The descriptions are largely written from a technical rather than a commercial standpoint, and illustrated with a number of good engravings.

THE HYDRAULIC MACHINERY WORKS, 204 E. 43d street, New York, has had printed on cardboard, to be hung up in the workshops, "Points well worth remembering," in regard to hydraulic jacks, directions under 18 heads being given for their use and repair. The same company has also issued two catalogues, one being devoted to hydraulic jacks and the other to punches and shears.

THE NATIONAL TELEPHONE MANUFACTURING COMPANY, 620 Atlantic avenue, Boston, Mass., has just produced a new magneto telephone, which, it is predicted, will prove very popular. It will be remembered that this company produced a very fine mechanical telephone, and the success of that instrument augurs well for the one which it has just brought out.

THE BISHOP GUTTA-PERCHA COMPANY has issued a 42-page pamphlet entitled "Tables, Rules and Information for Architects and Electrical Engineers," which contains wiring tables for 50 and 100-volt lamps, full data in regard to the celebrated Bishop white core wires, a copper wire table and the New York Board of Fire Underwriters' rules for safe wiring, to which a useful index has been added.

THE HART & HEGEMAN MANUFACTURING COMPANY, of Hartford, Conn., is now comfortably located in its new home at 26 High street, that city, where it possesses abundant facilities for the manufacture of its well known electrical specialties and the transaction generally of its rapidly increasing business. Manager Pease has a thoroughly satisfied look for everybody and everything in his new abode.

THE BUCKEYE ELECTRIC COMPANY, Cleveland, Ohio, has issued two circulars describing its new special lamp and new railway lamp. The former is but 4½ inches long, the standard type being 5½ inches, and its neat and compact shape makes it particularly convenient for steamer and household lighting. The railway lamp has an anchored filament, and is uniform in current, as well as voltage, burns brilliantly and gives long life.

THE STIRLING COMPANY, manufacturers of the Stirling water tube safety boiler, sends us a copy of a recent report of a test by Prof. Geo. H. Barrus on a Stirling boiler at the power house of the Portland (Me.) Railroad Company. Mr. Barrus reports that "the best results obtained, namely, an evaporation of 12.06 pounds of water from and at 212 degrees per pound of combustible, might have been still further improved by a further adjustment of the draught openings."

QUEEN & CO.'S portable photometer is meeting with a very considerable sale among the cities where the arc lighting companies are not giving satisfactory service. Scarcely a week passes without inquiry from city and town officials dissatisfied with the quality of lighting afforded them. Then the city electrician investigates the instrument, and finding how comparatively simple is its operation and how portable it is, and that it is the only portable photometer in America, naturally recommends its purchase by the municipal government.

THE STANDARD UNDERGROUND CABLE COMPANY, of Pittsburgh, reports an order this week from the Philadelphia Traction Company amounting to about \$300,000, which, in connection with the order obtained last June from the same company, amounting to \$250,000, represents over half a million of business from this company alone—a strong indorsement of the wire manufactures of the Standard Underground Cable Company, and reflecting credit upon Vice President Marsh and Eastern Manager G. L. Wiley, the popular officials of the company.

THE ELECTRIC APPLIANCE COMPANY is beginning the usual spring campaign on the swinging ball lightning arrester, and is meeting with its usual success. The swinging ball lightning arrester is particularly adapted for a line arrester, and is almost exclusively used in this way. The manufacturers promise something new this season in a station arrester built on an equally effective principle, and claim that an equipment combining the swinging ball lightning arrester on the line and its station arrester at the station will afford unfailing protection.

THE BRUSH ELECTRIC COMPANY held its annual meeting on March 26, at the office, on Belden street, Cleveland. The officers' reports indicated a prosperous business, despite the financial conditions that have existed. The organization for the ensuing year is unchanged, with one exception—the election of Mr. S. M. Hamill as second vice president. He will also retain the managership of the works. The other officers elected are: Pres-

ident, W. H. Lawrence, first vice president, C. A. Coffin; treasurer, B. F. Miles; general counsel, W. B. Bolton; secretary, A. H. Hough; assistant general manager, L. H. Rogers; superintendent, C. W. Phipps; assistant superintendent, C. N. Black.

MR. E. J. SPENCER has severed his connection with the General Electric Company, and has opened an office at Room 513, Security Building, St. Louis, Mo., as a consulting and contracting electrical engineer. Mr. Spencer, by his experience of nearly nine years in the corps of engineers in the United States army, by three years' special work in the factories of the Thomson-Houston Company, at Lynn, Mass., and recently for more than a year in charge of the installation, maintenance and removal of the exhibit and materials of the General Electric Company at the World's Fair, is well prepared for the line of work he has chosen, and no doubt will meet with the success his ability and experience merits.

MESSRS. VALLEE BROS. & CO., now at 17 North Sixth street, Philadelphia, will remove to 617-619 Arch street about April 15. They will have in their new quarters two large floors, each being 30 by 160 feet, which will give them increased facilities to handle their large and rapidly growing business. It is their intention to carry a full line of electric railway, telephone and telegraph supplies, as well as their well known line of electric light supplies, which will also be largely increased. The business of this firm has grown to such large proportions in the past two years as to render their present establishment totally inadequate to handle their business with proper convenience, and they were consequently forced to seek larger quarters. They have arranged to issue a catalogue of the various supplies they are selling, which will be mailed to their customers as soon as completed.

JOHN WOOD, JR., of the Schuylkill Foundry and Machine Works, Conshohocken, Pa., is sending out a catalogue containing interesting information concerning Wood's patent water tube steam generator, which also describes the many advantages of the system. There are many thousands of horse power of these boilers in use, and the partial list of some who have adopted them shows that they have been subjected to years of test in nearly every service connected with manufactures and electric plants, and the many duplicate orders are evidence of the results obtained. The advantages claimed for these boilers are: The large amount of efficient heating surface and the small space occupied for the power required; their rapid and economical steam generating powers and easy accessibility for cleaning to all parts, externally and internally; their great strength and durability and freedom from disastrous explosions, and from cast iron headers, manifold and numerous joints; they have more water and steam space than possessed by any other boiler, and a perfect circula-

tion of water, producing remarkably dry steam. As the water tube type of boiler has become almost universally adopted throughout all parts of the world, it has caused many different makes to be introduced on the market, many of which have serious objectionable features, such as numerous headers, and so much cast iron in their construction. The Woods boiler obviates these objections, and being constructed on simple and scientific principles, and made throughout of the best open hearth wrought steel, it requires little or no repairs, and effects the highest economy in the use of fuel.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon Porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient and at prices lower than ever. THE HAYDEN-BOOKER MFG. CO., 2140 DeKalb St., St. Louis, Mo.

THREE BEAUTIFUL ETCHINGS.—The latest additions to the famous "Four-Track Series" etchings, issued by the passenger department of the New York Central, consist of three beautiful and highly interesting views, entitled respectively:

No. 6.—"The Empire State Express"—Fastest Train in the World—from a photo by Yates, of Syracuse, taken while the train was running over 60 miles an hour.

No. 7.—"Horseshoe Fall, Niagara," from a photo by Jackson, of Denver. Probably the grandest and most realistic picture ever made.

No. 8.—"Gorge of the Niagara River," from a photo by Jackson, of Denver. A beautiful view of one of the most wonderful features of Niagara.

The titles of the other five etchings comprising the series are: "Washington Bridge," "Rock of Ages, Niagara Falls," "Old Spring at West Point," "999 and the DeWitt Clinton" and "Rounding the Nose, Mohawk Valley."

These etchings are all printed on fine plate paper, 24 by 32 inches, suitable for framing. A copy of any one of them will be mailed in a stiff tube, secure from injury, to any address, for 75 cents, by George H. Daniels, general passenger agent, Grand Central Station, New York.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED MARCH 20, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

516,611. POLICE SIGNAL; M. J. Burns, Lowell, Mass. Application filed Oct. 26, 1893. This comprises transmitters adapted to send signals, a central station and apparatus for distinguishing and recording the calls, two circuits, including several transmitters and the central station, a stable, and a loop extending thereto from one of the circuits.

516,612. MAGNETO TELEPHONE; H. A. Chase, Boston, Mass. Application filed Aug. 12, 1893. The combination, with an inclosing case, of a permanent magnet, having one end free from the case, and provided at its opposite end with a pole piece rigidly attached to a permanent magnet, and a support for the pole piece attached to the inclosing case.

516,613. MAGNETO TELEPHONE; H. A. Chase, Boston, Mass. Application filed Aug. 12, 1893. The combination, with an inclosing case, of a U-shaped magnet located within the case, a magnetic strip attached to the rear of the magnet, a magnetic ring supported by the case and to which the strip is connected, a cap or mouthpiece and an inductive diaphragm in proximity to the mouthpiece and magnetically connected to the ring.

516,651. AUTOMATIC SPEED REGULATOR FOR ELECTRIC MOTORS; W. Hochhausen, Brooklyn, N. Y. Application filed Nov. 26, 1889. The combination with a switch rod mounted on a conducting plate, of underlying springs electrically connected with the plate on which the rod moves, and having upturned ends, which engage with the bar.

516,653. GRAVITY BATTERY; L. F. Lary, Pottersburg, Ohio. Application filed May 23, 1893. An electrode formed by a sheet of material bent into cone shape and having an aperture at its bottom, the electrode being adapted to serve as a receptacle for an excitant and being also adapted to be unfurled and flattened out so as to facilitate the removal of chemical formations.

516,666. ELECTRIC RAILWAY SYSTEM; E. Thomson, Swampscott, Mass. Application filed May 29, 1891. The combination of a supply conductor and a section conductor connected thereto through a resistant, and an electrically propelled vehicle making successive connection with the conductors.

516,689. INCANDESCENT LAMP; G. C. Swan, Brockton, Mass. Application filed Dec. 30, 1893. A lamp having the leading-in wires passed through a flat metallic disc lying at right angles to the longitudinal axis of the bulb, the periphery of the disc being fused to the inner surface of the bulb, and the periphery of the stem being fused to the edge of the hole through the disc.

516,708. ANNUNCIATOR; C. A. McCordy, Fulton, N. Y. Application filed June 28, 1893. A bracket provided with spring fingers pivoted therein, having their outer ends held together by fusible solder and their inner ends provided with means for drawing them in contact with a bar to complete the circuit when the solder is melted.

516,713. ELECTRIC DEVICE FOR PUMPING OIL WELLS; H. F. Waite, New York, N. Y. Application filed Sept. 28, 1893. The combination with the pipe of an oil well, of a series of electric motors mounted therein at different distances from the bottom, each motor being directly connected with a propeller in the pipe, a source of electric energy, and connections between the source and the motors.

516,732. COMMUTATOR; E. R. Francis, Minneapolis, Minn. Application filed May 13, 1893. A commutator having alternate terminal plates constructed with interlocking segment stubs and alternate contact segments removably secured to the segment stubs.

516,740. ELECTRIC APPLIANCE FOR HORSES; G. R. King, Dallas, Tex. Application filed March 18, 1893. This comprises a belt carrying electric generating devices and a yielding contact plate under the belt adapted to be moved to operate the generating devices.

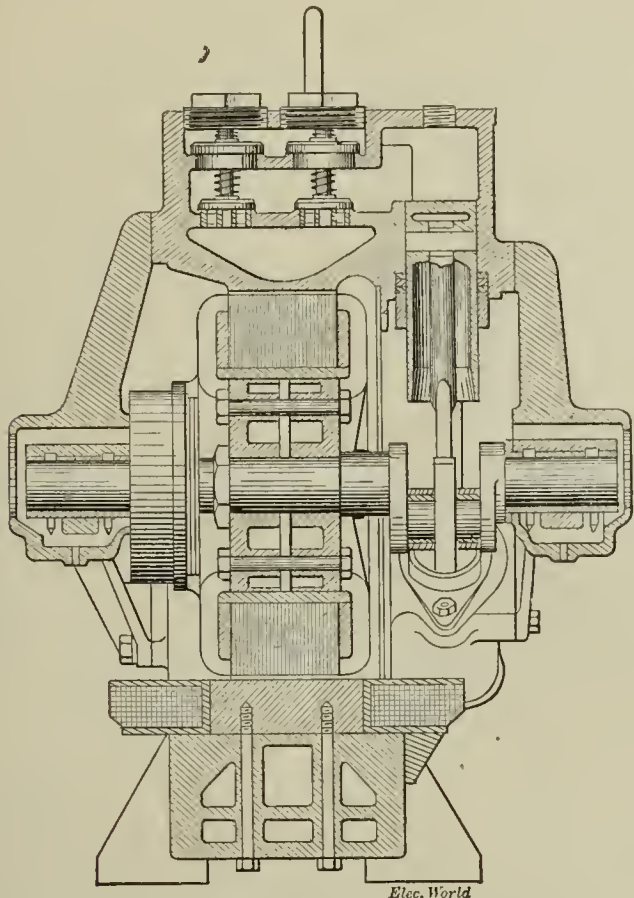
515,771. BURGLAR ALARM; W. Ritzmann, Chicago, Ill. Application filed June 12, 1893. The combination of a movable plate having a rounded metallic contact point and a companion plate provided with a barrel spring, and a metallic spring contact held normally flush with the surface of the companion plate.

516,777. TELEPHONE SWITCH; A. Stromberg and A. Carlson, Chicago, Ill. Application filed Sept. 21, 1893. The combination with a horizontally shifting telephone hook yieldingly maintained at one end of its travel, of a bracket, one edge thereof occupying a position between the members of the hook, and

Thomson, Swampscott, Mass. Application filed June 9, 1891. The combination in a regulating transformer of a fixed coil, a partly counterbalanced movable coil, one of the coils being in the main and the other in the work circuit.

516,847. MEANS FOR REGULATING ALTERNATING CURRENTS; E. Thomson, Swampscott, Mass. Application filed July 1, 1891. The combination of mutually inductive coils, one or both being vertically movable and suspended so as to be partly counterbalanced and subject to a constant gravitating force.

516,848. ARMATURE WINDING; E. Thomson, Swampscott, Mass. Application filed Nov. 16, 1892. An armature having



NO. 516,840.—ELECTRICALLY OPERATING PUMP.

undercut coil chambers, to which entrance is had through narrow openings in the surface of the armature, and coils surrounding the projections between such recesses, each wound in two layers, having the ends of the coil at the external part of the layers.

516,849. ALTERNATING CURRENT ELECTRIC MOTOR; E. Thomson, Swampscott, Mass. Application filed June 17, 1893. The method of operating an induction motor for alternating currents, which consists in partly closing the armature coils as local circuits at starting, and subsequently wholly short-circuiting the armature coils.

516,850. ELECTRICAL TRANSFORMER; E. Thomson, Swampscott, Mass. Application filed June 28, 1893. In a transformer, a casing interposed between the core and the coils, and filled with insulating fluid, the casing being provided with an insulating joint and openings for the leading-in wires.

516,853. COMMUTATOR CONNECTOR; O. N. Turner, Lynn, Mass. Application filed June 14, 1893. This comprises rectangular segments, slits cut therein, fastening pieces fitting the slits and engaged thereby, and armature connection electrically and mechanically connected to the segments by means of the slits and fastening pieces.

516,855. ELECTRICAL MEASURING INSTRUMENT; E. G. Willoughby, Philadelphia, Pa. Application filed June 23, 1893. The combination of permanent field magnets, an inclosing case, a pivoted armature arranged to move between the poles of the magnets, terminals exterior to the case and electrically connected with the armature coils, a dial plate, and a pointer movable over the dial plate, and moved by the armature.

516,862. SWITCHBOARD; E. F. Frost, Washington, D. C. Application filed May 31, 1893. A switchboard composed of a plurality of hinged leaves.

516,876. CONDUIT FOR ELECTRIC RAILWAYS; H. A. F. Petersen, Milwaukee, Wis. Application filed March 10, 1893. This comprises a conduit divided into two passages, one arranged to contain the conductors, and the other having the slot in its upper wall arranged out of line with the passage containing the conductors, and a suitable cover arranged to normally close the passage in which the conductors are located.

516,878. ELECTRIC CIGAR LIGHTER; J. Sachs, New York, N. Y. Application filed Feb. 2, 1893. The combination of a handle, passages, plugs normally disconnected therefrom, conducting mains in the passages for connecting the plugs, and an exposed heating conductor connected to the plugs.

516,879. FIRE TELEGRAPHY; S. J. Sanford, Barrie, Canada. Application filed Feb. 2, 1891. This comprises a street alarm box having a number wheel with a spiral thread formed on the

rim, and teeth formed on the thread, in combination with a weighted circuit breaker, dog and projection running in the slot.

516,892. INCANDESCENT LAMP; R. Langhans, Berlin, Germany. Application filed April 18, 1892. An exhausted lamp bulb provided with leading-in wires sealed into the same, consisting of a core or body of an alloy of one or more of the magnetizable metals with antimony, and a coating of platinum enveloping the same.

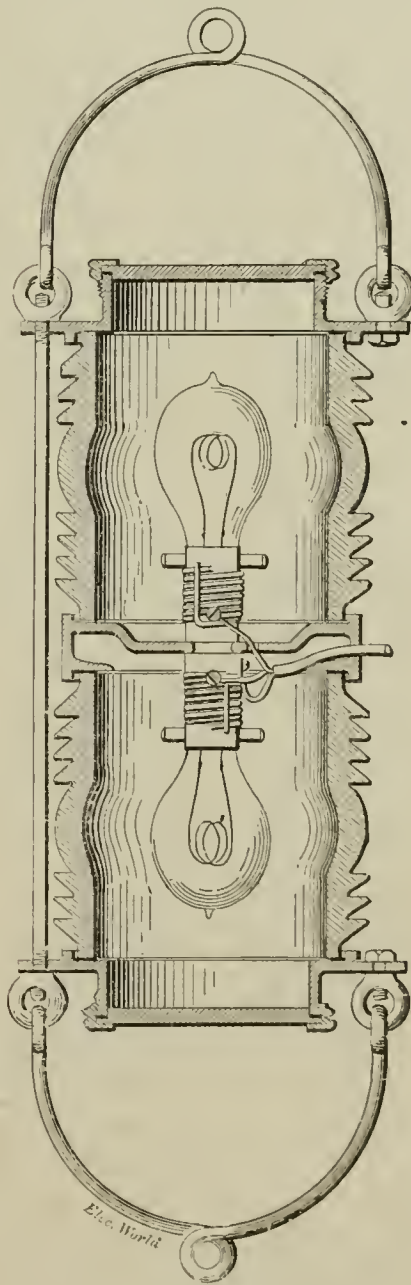
516,903. RAILWAY SIGNALING AND SWITCHING APPARATUS; J. D. Taylor, Chillicothe, Ohio. Application filed Dec. 14, 1892. The combination of a motor, a pair of crank shafts connected therewith by gearing, a transversely slotted and perforated rod connecting one of the cranks with the switch rail, and a connecting rod connecting the other crank with the bolt of the rail lock.

516,916. ELECTRIC MOTOR; C. J. Coleman, Chicago, Ill. Application filed Jan. 21, 1893. A motor having its field and armature adapted to rotate in opposite directions, and gearing connections of a differential nature between each of the same and the driven shaft.

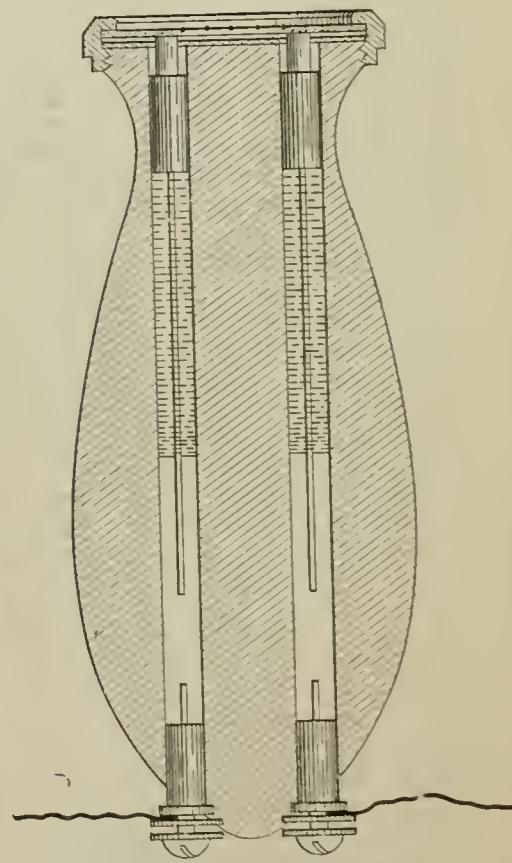
516,917. ELECTRIC MOTOR; C. J. Coleman, Chicago, Ill. Application filed Jan. 21, 1893. A motor having its field and armature adapted to rotate in opposite directions, in combination with an epicycle train of gears, forming a connection between the field, the armature and the driven shaft, and clutch mechanisms for independently holding the field and armature from rotation.

516,956. ELECTRIC ELEVATOR; R. Watson, Washington, D. C. Application filed Nov. 13, 1893. The combination with a motor, of an electrically controlled device for cutting in and out resistance in the armature circuit, a circuit extending to the car for controlling the device, and a rheostat in the car for varying the resistance in the latter circuit, whereby the speed of the car may be regulated.

516,982. TELEPHONE; A. C. White, Boston, Mass. Application filed Nov. 8, 1893. The combination with a diaphragm having one side inclosed or cut-off from communication with the medi-



NO. 516,824.—SIGNAL LANTERN.



NO. 516,878.—CIGAR LIGHTER.

um to which the other side is exposed, of a pressure equalizing or compensating device.

517,009. EXTENSION ELECTRIC CHANDELIER; A. McLean, Ansonia, Conn. Application filed Aug. 7, 1893. This consists of an outer tube and an inner tube, rods rigidly fixed in one of the tubes, and tubes rigidly fixed in the other tube, the rods and tubes having electrical connections at their outer ends and the inner and outer tubes being adapted to slide upon each other in raising and lowering a chandelier.

- contact points controlled by the telephone hook.
- 516,784. **ELECTRIC MOTOR**; P. Wuest, Jr., Philadelphia, Pa. Application filed May 16, 1892. The combination of the pole pieces, the armature, brushes, studs projecting from the pole pieces for the brushes, a non-conducting sleeve between the brush holders and the studs, and non-conducting sleeves between the brush holder and the field magnets.
- 516,792. **DYNAMO ELECTRIC MACHINE AND MOTOR**; N. C. Bassett, Lynn, Mass. Application filed Aug. 31, 1893. A dynamo having a field magnet frame composed of two substantially triangular parts, meeting along their longer sides and hinged together at one end.
- 516,794. **ARMATURE FOR DYNAMO-ELECTRIC MACHINES**; L. Bell, Boston, Mass. Application filed March 17, 1893. An armature provided with laminated teeth, the laminae arranged in groups, separated by ventilating spaces.
- 516,795. **ARMATURE FOR INDUCTION MOTORS**; L. Bell, Boston, Mass. Application filed April 3, 1893. This comprises a core, copper bars extending longitudinally along the surface thereof, and a metal disc of relatively high resistance, to which the bars are connected.
- 516,796. **REGULATION OF MULTIPHASE SYSTEMS**; L. Bell, Boston, Mass. Application filed June 15, 1893. The method of preserving the relative position of the phase in a multiphase system, the lines of which vary in resistance or self-induction, which consists in artificially raising the resistance of the lower resistance lines to that of the higher resistance lines.
- 516,797. **COIL FOR DYNAMO-ELECTRIC MACHINES**; L. Bell, Boston, Mass. Application filed Nov. 13, 1893. The combination with an inductive core having undercut coil chambers, of a separately constructed coil, consisting of a number of turns of wire, so wound that the cross section of the coil when completed is substantially the same as that of the coil chambers, but larger than the contracted openings thereof.
- 516,800. **INCANDESCENT LAMP AND METHOD OF MANUFACTURING THE SAME**; H. D. Burnett, Lynn, and S. E. Doane, Swampscott, Mass. Application filed May 17, 1893. The method of making incandescent lamps, which consists in placing the leading-in wires between the inner and outer tube, softening and compressing the tubes so as to seal in the wires, then sealing the outer tube to the neck of the lamp, exhausting the lamp by means of the inner tube, and finally sealing off the inner tube.
- 516,804. **METHOD OF TRANSMISSION OF ELECTRICITY**; J. P. B. Fiske, Lynn, Mass. Application filed May 3, 1893. This consists in varying the strength of the field of the generator supplying current to the motor.
- 516,805. **TRANSMISSION OF ELECTRICITY**; J. P. B. Fiske, Lynn, Mass. Application filed May 3, 1893. The combination of a generator having a field magnet whose series coil is divided into sections, a series wound motor taking current from the generator, and a switch adapted to short circuit or cut in the sections of the field magnet coil of the generator, and thereby vary the speed of the motor.
- 516,806. **OVERHEAD ELECTRIC RAILWAY**; J. W. Gibboney, Lynn, Mass. Application filed Oct. 12, 1893. In a safety cut-out for electric railways, a trolley line divided into sections, feeders conveying current to the sections, fuses between the feeders and the sections, and means adapted to short-circuit the sections upon the track or ground return, and thereby rupture the fuses.
- 516,807. **MOTOR ARMATURE**; J. C. Henry, Westfield, N. J. Application filed Aug. 25, 1892. An armature whose coil has a loose but direct superficial contact with the commutator bars.
- 516,808. **OVERHEAD ELECTRIC RAILWAY**; J. C. Henry, Westfield, N. J. Application filed March 8, 1893. The combination with a pole having a vertical rack, of a transverse guy wire, having an eye or loop engaging with the rack.
- 516,818. **ELECTRIC MOTOR**; W. H. Knight, Lynn, Mass. Application filed Sept. 15, 1893. In a series wound electric motor, a differential shunt winding connected to its armature terminals adapted to respond to an increased speed of the armature.
- 516,819. **INCANDESCENT LAMP**; E. R. Knowles, Middletown, Conn. Application filed Dec. 9, 1892. The combination with a screw-threaded socket provided on opposite sides with parallel indentations, in which an insulating block is adapted to slide, and contact plates secured to the opposite sides of the block, each having a spring arm extending across the inner edge of the block.
- 516,820. **SOCKET FOR INCANDESCENT ELECTRIC LAMPS**; E. R. Knowles, Middletown, Conn. Application filed Dec. 9, 1892. In a lamp socket, a washer of compressed fibre or other insulating material, having one or more teeth on one face, and four ratchet teeth on the other face.
- 516,821. **ELECTRIC SEARCHLIGHT**; E. R. Knowles, Middletown, Conn. Application filed Jan. 9, 1893. A diverging lens for a searchlight, comprising two frames, each holding a set of alternating plano-convex and plano-concave strips of glass.
- 516,822. **ALTERNATING ELECTRIC ARC LAMP**; E. R. Knowles, Middletown, Conn. Application filed Jan. 8, 1893. The combination with a carbon holder having a cross bar, of a feed rack having a transverse foot, and a plate of slate interposed between them.
- 516,823. **ELECTRICAL MEASURING INSTRUMENT**; E. R. Knowles and L. T. Robinson, Middletown, Conn. Application filed Feb. 25, 1893. An ammeter comprising two or more magnetic needles, one of which is given a lead over the other or others.
- 516,824. **ELECTRIC SIGNAL LANTERN**; E. R. Knowles, Middletown, Conn. Application filed April 17, 1893. This comprises two cylindrical lenses, a diaphragm between them, two annular heads having flanges and necks, lids, and clamping rods passing through the heads.
- 516,825. **ELECTRIC ARC LAMP**; E. R. Knowles, Middletown, Conn., and E. H. Park, Milbury, Mass. Application filed May 25, 1893. In a horizontal arc lamp, a carbon holder comprising a horizontally turning wheel, a rocker hinged to the wheel on a horizontal axis, and clamping jaws carried by said rocker.
- 516,826. **ELECTRIC ARC LAMP**; E. R. Knowles, Middletown, Conn. Application filed July 17, 1893. In a focusing arc lamp, the combination with the shunt circuit, of a pair of contact points, one of which slides in a holder and is provided with adjustable stops, and a vibrating arm playing between the stops.
- 516,827. **COMMUTATOR CONNECTION**; C. A. Lieb, New York, N. Y. Application filed July 18, 1893. This comprises a slotted segment, and a connector having elastic sides wedged into the slot and retained therein by their tendency to spread apart.
- 516,829. **COOLING ELECTRIC APPARATUS**; W. S. Moody, Lynn, Mass. Application filed July 1, 1893. This consists in supplying to the apparatus to be cooled a flow of cooling fluid proportioned to the current passing therein.
- 516,831. **STARTING AND CONTROLLING DEVICE FOR ELECTRIC MOTORS**; J. W. Moore, Boston, Mass. Application filed Nov. 25, 1893. The combination of an armature circuit divided into two branches or lines, one provided with a variable resistance and the other with a constant resistance, a solenoid, a switching device for opening and closing the armature circuit, a contact arm connected with the core of the solenoid, and with starting mechanism controlled by the operator, the operation of the solenoid being dependent upon the influence of the counter electromotive force of the armature.
- 516,834. **SERIES PARALLEL CONTROLLER**; E. D. Priest, Lynn, Mass. Application filed Dec. 1, 1893. The method of changing three or more motors from series to parallel connection, which consists in shunting one motor, disconnecting it from the series, and connecting it in parallel with another, but in series with the remaining motors, and afterwards successively shunting the remaining motors, respectively disconnecting them from the series and bringing them into parallel with those already in parallel.
- 516,835. **SYSTEM OF ELECTRICAL DISTRIBUTION**; E. W. Rice, Jr., Swampscott, Mass. Application filed March 6, 1893. This comprises compound wound dynamos connected in multiple through bus bars to groups of feeders supplying the principal current, in combination with other over-compounded current sources of higher potential supplying the distant portions of the circuit through independent groups of feeders.
- 516,836. **SYSTEM OF ELECTRICAL DISTRIBUTION**; E. W. Rice, Jr., Swampscott, Mass. Application filed May 5, 1893. This comprises a source of alternating currents, lines leading therefrom to a point of distribution, and means adapted to commute the currents and deliver them to mains feeding translating devices by the three-wire or series multiple system.
- 516,837. **ARMATURE FOR DYNAMO-ELECTRIC MACHINES**; E. W. Rice, Jr., Swampscott, Mass. Application filed Nov. 16, 1893. This comprises a core having transverse undercut notches in the surface thereof, separately wound coils of such size as to be inserted in the narrow openings of the notches into the undercut recesses therein, and keys holding the coils in the recesses.
- 516,839. **MEANS FOR MEASURING ELECTRIC CURRENTS**; L. T. Robinson, Middletown, Conn. Application filed Aug. 24, 1893. In an electrical measuring instrument, a removable scale provided with a resistance.
- 516,840. **ELECTRICALLY OPERATED PUMP**; C. Robinson, Lynn, Mass. Application filed Oct. 11, 1893. A casing for an electrically operated pump mechanism, formed with interior channels and projecting consequent pole pieces, all adapted to form a magnetic yoke for the field magnet cores.
- 516,843. **ELECTRICAL HOISTING APPARATUS**; H. C. Spaulding, Boston, Mass. Application filed Feb. 12, 1890. The combination of the armature and inclosing winding drum forming the field of an electric hoisting machine, with gearing between the armature and drum, outside the latter.
- 516,844. **LAMP SOCKET**; A. Swan, Schenectady, N. Y. Application filed April 3, 1893. A socket molded in a single piece inclosing two stampings and a screw-threaded brass piece, one of the stampings being connected to the threaded piece, and the other being provided at its inner end with an aperture adapted to permit the passage of a screw.
- 516,845. **METHOD OF CONSTRUCTING COMMUTATORS FOR DYNAMOS OR MOTORS**; E. Thomson, Swampscott, Mass. Application filed Jan. 24, 1891. This consists of cast metal segments, and earthenware insulation separating the segments.
- 516,846. **REGULATION OF ALTERNATING CURRENTS**; E.

The Electrical World.

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RAPID TRANSIT.

While the scheme for rapid transit in New York is yet in the toils of the politicians, and may finally be defeated through a Croker-Platt deal, Paris is more fortunate and is about to commence work upon an ideal underground rapid transit system. The plans, which have been approved by the government and now only require to be ratified by the Chamber of Deputies, provide for a tubular metal tunnel six and three-quarter miles long, with a diameter of sixteen feet. The motive power is to be electricity. In addition to this project is another for a subterranean network of electric roads like the underground system of London, which it is proposed to complete before the international exposition of 1900. London has already started on the construction of an electric underground system, and the scheme of still another is far advanced. In view of these measures being thus taken in Europe, it would be inexcusable for New York, the richest city in the world, to extend instead its present abominable system of elevated railways—a measure that would be against the almost unanimous wishes of its citizens and only in the interests of the Manhattan monopoly and its political hirelings. That the present underground bill is in danger is shown by the action of Senator Lexow and others in attempting to smuggle a bill through the Legislature that would not only indefinitely extend the elevated roads but effectually put off the prospects of real rapid transit by electricity. As we have remarked before, the adoption of an electrical underground system in New York means a great deal for the electrical industries. The undoubted superiority of electricity for the purposes of rapid transit thus demonstrated, it would not be long before other large cities would adopt the same method; of these we need only name Boston, Philadelphia and Chicago, whose needs are but little less than New York.

NIKOLA TESLA.

In another column we print a review and estimate of the work of Nikola Tesla from the pen of Lieut. Patten, whose own work, to some extent along similar lines, well qualifies him for the undertaking. While much has been written of Tesla and his achievements, it has been almost invariably from a popular standpoint, and, as far as we know, this is the first attempt to give a critical estimate. The great beauty of the Tesla experiments, the novelty of the subjects dealt with, the charming literary style and picturesque personality of the gifted inventor himself—all those have distracted attention from the technical and commercial features which, under ordinary circumstances, are the grounds upon which judgment is based. Perhaps another reason is that only recently has the opportunity been afforded, through an exhaustive compilation of Tesla's writings, patents and of other material, to take a comprehensive view instead of only the partial one hitherto possible. One is naturally disappointed that nothing practical has as yet proceeded from the magnificent experimental investigations with which Tesla has dazzled the world, and, what is still more disappointing, that they hold out no definite hope of the realization of the great promise they were supposed to contain. On the other hand, it should be borne in mind that Tesla is not working as a commercial experimenter with only a view to the speedy coining of his results into dollars and cents. His attitude is more that of Faraday, who felt that the world would obtain most benefit from his genius if devoted to pure physical research, knowing that his discoveries would eventually have a

practical fruition. The whole hope of modern science may be said to lie in molecular physics, and it is through work like that of Hertz and Tesla that we will, if ever, penetrate its mysteries. While therefore the popular conception of Tesla as one working like Edison to achieve only practical results is wrong, the popular estimation in which he is held has nevertheless a real justification in his valuable labors, though these may not lead directly to the marvels expected.

WHAT DOES IT MEAN?

When such an eminent coterie of patriots as Governor Flower, Thomas C. Platt, Superintendent of New York State Canals Hamman et al., join forces in connection with an equivocal public measure, it is necessary for the public to be on its guard. The circumstances attending the granting of the recent canal electric franchise are so suspicious as to augur no good for the interests of the public or of the electrical enterprises with which the terms of the grant may interfere. The secrecy with which the contract was prepared and the haste of the Governor in signing it just as a bill was about to pass that would have taken away the power to make such a contract, have a significant bearing, which is rendered still more significant by such other names cropping up in connection with the matter as Hugh J. Grant, and Anthony Brady and Charles De Freest of Senator Murphy's entourage. If the question involved is merely the possession of a valuable franchise that will not conflict with present electrical interests, the matter is bad enough, as it concerns the gratuitous appropriation of what belongs to the public, and the monopoly of what should be left free for legitimate competition among all comers. If, however, it also involves—and this seems possible—the power to crush legitimate electrical interests now established along the route of the canal, the measure is little short of anarchy. That a government should thus place in the power of a clique the means to destroy private capital is monstrous, and that it should be done by what seems to be a low intrigue is a crime. It is but just to say that the officers of the Cataract General Electric Company claim that the State can at any time purchase the plant at an advance of 10 per cent., but it is also said that this proviso was left out or nullified in the franchise as signed. The scores of electric lighting companies along the line of the canal will hardly permit their interests to be jeopardized without an effort on their part to prevent it, and the outcome will doubtless settle the question whether the State can constitutionally make a free gift of its property for the purpose of setting up a monopoly to crush legitimate business enterprises, and incidentally whether the abuses of power condemned at Gravesend shall be permitted to flourish at Albany.

GENERAL ELECTRIC.

The annual report of the General Electric Company, which, with an analysis, will be found in the financial column of this week's issue, contains little that is reassuring. The best that can be said of it is that the statement is a frank one and does not attempt to bolster up false hopes. That the new directors will have to apply drastic measures before the company can be brought up to a point where it should be, is evident from the statement, and, we believe, expected by those most interested. One of the points that will have to be dealt with is the valuation of patents and franchises, which is placed at \$8,150,264.02. Of the hundreds of patents owned by the General Electric Company we can recall less than a half dozen that are generally considered to have any great value; these are the lamp patent, which expires in November; the three-wire system patent, the feeder-and-main patent, and the double carbon arc lamp patent. Of the others many doubtless have a considerable intrinsic value, but—and this is the only vital point to consider in connection with their valuation—do they act as a preventive

of competition to any important extent? There is an immense difference between a patent that involves a monopoly and one that can be merely quoted as a selling point. Of the assets \$4,264,814.21 consist of plant and real estate, and \$6,624,280.08 of stores, manufactures, the value of work in progress, and cash, or there are, in round numbers, \$10,889,000 of assets, representing values that are tangible and comparable to those of ordinary manufacturing concerns. Assets in stocks of manufacturing companies, such as the Brush, Fort Wayne and others, are \$2,767,470.58; in stocks and bonds of local companies, \$2,723,493.17; and in notes and accounts receivable (face value, \$14,984,697.42), \$9,525,303.63, or, in round numbers, \$15,000,000 of stocks, bonds, and accounts, making with the other amounts given above, \$34,000,000 in round numbers. The liabilities, aside from stock to the value of \$34,711,600, are \$11,216,849 in debenture bonds and accrued interest on same, mortgages, and notes and accounts payable. This showing, unfavorable as it is on its face, is still more so on account of the indefinite value of the items that go to make up notes and accounts receivable, and of the stocks and bonds. Schedules of the latter are published, which permits of the valuation being checked; the former have been scaled \$6,000,000, but taking into consideration the basis on which electrical business has been conducted, both on the part of the great companies and of the recipients of their favors, the real value of a great part of the debts that go to make up the \$9,500,000 referred to is an extremely uncertain quantity. What the future of the General Electric Company shall be will depend upon the action of the directors. If they adopt the frank policy which their officers followed in preparing their report, sturdily face the situation and then apply the radical remedies necessary, the company may be again started on the road to prosperity. If it lays aside the hopes bound up in patents, which, instead of protecting have been the source of enormous legal expenses, and places its business on the same commercial basis that its great rivals have adopted, it may be necessary to largely scale its stock, but in return prosperity will almost undoubtedly be assured. The General Electric Company has been the last to recognize the changed conditions from the days when manufacturing profits cut little figure in the calculations of electrical companies, and when it mattered little if a huge and picturesque official personnel and corresponding office expenses were out of all proportion with the profits earned. Such a method of doing business recalls Canrobert's celebrated saying at Balaclava, "C'est magnifique, mais ce n'est pas la guerre," and after its recent lesson we do not doubt but that the General Electric Company will now map out a policy which, though perhaps prosy, will be in accordance with true business principles. While the policy of the company has heretofore been such as to excite the most violent animosities and its total shipwreck would be applauded by many, the great part it has played in the development of the electrical industries will also be remembered and its rehabilitation welcomed by all whose path it has not crossed.

Subterranean London.

It gives an impressive idea what subterranean London is fast becoming, says the London "Daily News," to learn that on emerging from the river the new City and Waterloo line will, in its passage up Queen Victoria street, run for a part of the way underneath the low level main sewer, which in its turn runs along beneath the District Underground Railway. So that at this point in the city we shall have first a busy main thoroughfare, below that a steam railway, then a huge metropolitan sewer, then an electric railway, reaching its terminus at a depth of about 63 feet below the streets, and here it will communicate with another line—the Central London—which will lie at a depth of 80 feet.

Death of Paul Jablochhoff.

Paul Jablochhoff died at Saratoff, Russia, April 5. While M. Jablochhoff in recent years has had little influence on the industrial development of electricity, his work in the earlier years exercised a most potent influence, and as one of the pioneers his name ranks with Gramme and Siemens.

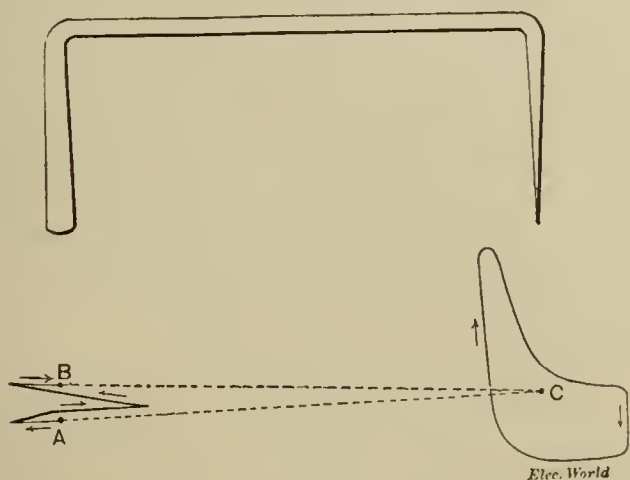
M. Jablochhoff was born at Serdobsch, Russia, Sept. 14, 1847. He belonged to a distinguished and well-to-do family, his father having been a member of the General Council of his province and his brother a distinguished military officer. Entering the military service he studied at the Russian Military Engineering and the Military Galvano-Technical schools, and in 1871 was appointed director general of the Moscow-Koursk telegraph lines on account of the particular aptitude he had shown for electricity.

His attention was first particularly drawn to arc lighting by the frequent failures of an arc light which he placed on the engine of the Czar's train as a safeguard during the commencement of the Nihilist propaganda in 1872. In 1875 he quitted the Imperial service, and the next year, having had placed at his service the Breguet workshops in Paris, after eight months' experimental work he produced the celebrated Jablochhoff candle, which may be said to have given the first great impetus to electric lighting through the then incomparable illumination it furnished to the Avenue de l'Opera of Paris. The Jablochhoff system soon acquired a world-wide fame, but after a few years was displaced by the modern arc lamp.

M. Jablochhoff at the same time took up the subject of alternating currents, and as early as 1878 showed a transformer system at the Paris Exhibition. He was also the pioneer in the use of condensers with alternating currents, and the original character of his genius is shown in many other inventions, such as that of a voltaic battery consuming coal, auto-accumulators, etc.

A Simple Instrument for Measuring Areas of Curves.

In a recent paper read at the London Physical Society by Prof. Henrici, he calls attention to the simple and ingenious "hatchet" integrator, which was invented long ago, but does not seem to be generally known. It is shaped like a staple, as shown in the adjoining cut, one limb terminating



A SIMPLE INTEGRATOR.

in a tracing point and the other in a curved blade like a hatchet. By moving the point from near the centre of mass of any closed curve, as *C* in the indicator diagram, up to the curve, around the curve once, and back to the starting point, the distance between *A* and *B*, the initial and final positions of the hatchet head, is a measure of the area of the curve. The instrument has been found very useful for indicator diagrams. No further information is given in the abstract in the London "Electrician," March 23, from which the accompanying cut is taken, but it appears that it is important not to have the length too short as compared with the size of the curve in order not to cause an error due to

the difference between the arc and its chord between *A* and *B*; it is well not to have the instrument too high, as it then becomes awkward to handle; care should doubtless also be taken to have the hatchet edge in a direct line with the point. No information is given regarding the calibration of the instrument, but we suggest that it can be calibrated readily by measuring the area of a circle or square, whose exact area and centre of mass are known, thus giving the constant; the difficulty seems to be in the estimation of the centre of mass of an irregular curve. A very simple form of this instrument can be made by opening the large blade of a penknife for the hatchet end and opening the small blade on the opposite end halfway, using that as the point. Perhaps further information could be found in the original paper, which was read on March 9.

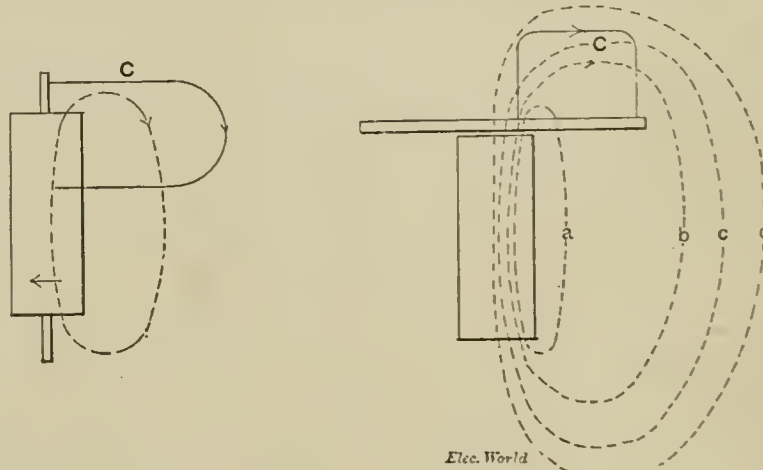
Unipolar Induction and Current without Difference of Potential.

BY A. G. WEBSTER.

There have recently appeared in *The Electrical World* several articles on two subjects that frequently appear in the guise of paradoxes in electricity and magnetism, and as the writers have not generally been contented with stating facts, but have felt constrained to "advance a theory" of their own, a few words more on the subject may not be out of place. It is my purpose to point out that the theories in question are unnecessary, and that some of the statements made are incorrect or without point.

The conditions necessary to the working of a so-called unipolar dynamo were clearly and correctly stated by Mr. Hering in his article of Jan. 13, but as he in the same article partially commits himself to one of the statements that I wish to criticise, namely, that lines of force from an electromagnet are stationary if the coil is stationary and revolve if the coil revolves, it will be well briefly to consider the simplest cases of so-called unipolar induction.

If we rotate a cylindrical permanent magnet about its axis (Fig. 1), and let the ends of a wire rub, one on the magnet



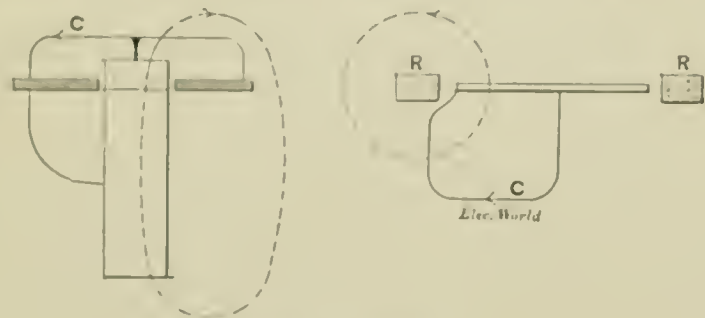
FIGS. 1 AND 2.

and the other on the axis, we get an induced current in the wire, in the direction shown by the arrowhead. In all the figures following, it will be supposed, when the contrary is not stated, that the rotation of the moving parts is in the direction of the hands of a watch lying flat on its back. The lines of magnetic force (drawn dotted), symmetrical in each case about a vertical axis, are supposed to go upward in the middle of the figure. The above is Faraday's original experiment. Let us now examine what role the rotation of the magnet plays. First, it is evident that it is merely relative motion of parts of the system that produces any effect. We shall therefore get the same current if the magnet remains at rest and the wire *C* rotates in the opposite direction about the axis. The cause of the induction is now, of course, to be seen in the continuous cutting by the moving conductor of the lines of force that cut it once, but not twice. The experiment may now be modified as in Fig. 2. A disc is fixed

to the end of the magnet, and against it rub the ends of the wire. As before, magnet and disc may remain fixed, and the wire may revolve. Now separate the disc from the magnet, and rotate it alone, the magnet and wire remaining stationary. The current is the same as before, showing that the rotation of the magnet has nothing to do with the matter. The induction may be considered to take place when the disc moves in the moving radius joining the ends of the wire, and depends on the number of tubes of force cutting the disc once, as does the line *b*. Lines which cut twice, like *a*, or which cut the wire twice, like *c*, or not at all, like *d*, contribute nothing. When the wire moves, the disc being stationary, the induction may be accounted for by the cutting by the wire, the same lines coming into play as before; hence the current is the same.

Now, thirdly, we may rotate the magnet, the disc and wire being stationary. Of course, we get no current. I say, of course; for, if there were any current produced, turning the magnet and disc in the same direction would produce a different current from that produced by turning the disc alone. This is, however, not the case.

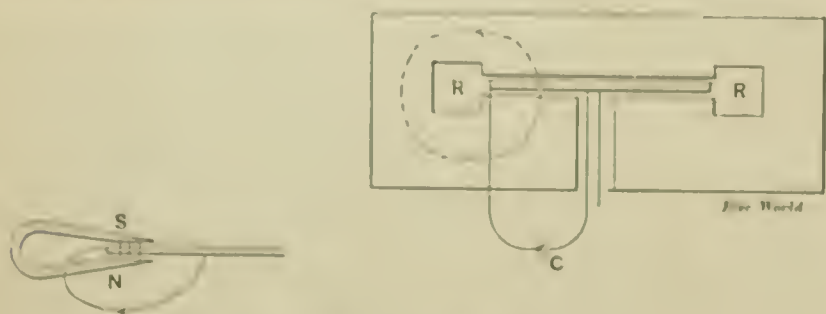
The above experiment is the converse of the Ampere-Faraday rotational experiment, shown in Fig. 3. Here the



FIGS. 3 AND 4.

wire *C*, traversed by a current, dips in a basin of mercury, corresponding to the disc above, and rotates about the axis of the magnet. If the wire be held still, the mercury revolves in the opposite direction. Rotating the magnet has no effect whatever on the motion. We accordingly see that the essential part of the phenomena of unipolar induction or rotation is two discontinuities in the motion of the conductor, or, in other words, two sliding contacts. It is the relative motion of the two parts of the conductor that figures in the phenomena, while the relative motion of the magnet does not enter into consideration at all. For instance, in the experiment last described, in one instance the magnet is at rest relatively to the wire *c*, in the other to the mercury or disc, the result being the same.

This effectually disposes of the question whether the field of a symmetrical magnet rotates with it or not by showing that it is a question devoid of sense, the answer being, to

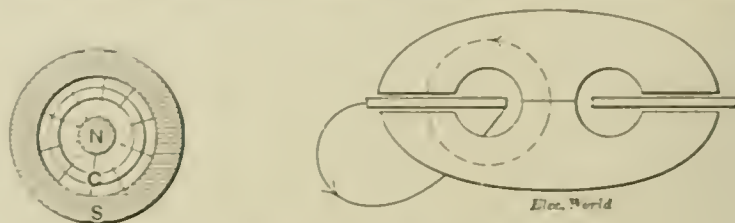


FIGS. 5 AND 6.

use a favorite word of Lord Kelvin's, purely nugatory; for, the field being unchanged by the rotation, we cannot determine whether it rotates or not. A further example of what takes place in Fig. 2 is found in Lorenz's method for the determination of resistance in absolute measure, where, as in Fig. 4, a disc rotates in the field of a ring coil, *R*, the current being taken off at the axis and the circumference. This

is the exact prototype of Forbes' "unipolar" dynamo, Fig. 5, except for the iron. The principle is identical with the original unipolar dynamo, Faraday's disc, Fig. 6, which, it will be observed, has two poles, like all unipolar dynamos. Fig. 4 may be called a non-polar dynamo.

This brings us to Mr. Bruce Ford's supposed mushroom dynamo (Fig. 7). The disc must now have a hole cut in it to prevent it from cutting the lines through the stem of the mushroom. This is merely Forbes' dynamo turned inside out, for if we cut the stem, make the disc without the hole, reduce its diameter and weld the edges of the mushrooms together, we get Forbes' machine. Fig. 7 is like the Siemens machine (Fig. 8), which has a tube instead of a disc



FIGS. 7 AND 8.

cut by lines of force proceeding radially from an enclosed pole, *N*, to an enveloping hollow pole, *S*. I hope I have now convinced Mr. Ford that, in Fig. 7, cutting mushrooms apart and revolving either or both will produce no effect, and that his theory is therefore superfluous. I have as yet said nothing about revolving the magnetizing coil, as it is *a fortiori* evident, from what has been said, that it makes no difference.

I now return to Mr. Hering, who, in the issue of Feb. 3, in answering a statement of Mr. A. Randolph, states that an unsymmetrical magnet in revolving does not necessarily carry its field with it, but the explanation of the working of the machine in question may be found in the strengthening of the fixed field (by the moving pole pieces). I confess that this seems to me to be a distinction without a difference. All that I have heretofore said relates to fields symmetrical about the axis of rotation. When, however, a piece of iron moves in a field of force, it is customary to speak of it as carrying its tubes of force with it, it being immaterial whether they are the same tubes in another place or whether the tubes in the other place have been strengthened by the iron which has come there. The idea of moving tubes of force has, however, been very fruitful, and in the hands of Poynting, Heaviside and Hertz has given us a convenient representation of the transfer of energy in space. It is noticeable that if we had had to do only with steady currents, the notion of moving tubes of force would never have arisen, as it would not had we had to do only with symmetrical fields, such as those above described.

(To be continued.)

India and the Electrical Conference.

When the committee which arranged the Electrical Conference at the World's Fair was discussing the matter, says the Madras "Times," it was proposed to put India on the list of invitations, but some member of the conference asked why "Indiana" should be specially represented and none of the other American States. Those present thinking India was short for "Indiana," accordingly struck it out of the list. That is how it came about that India was not asked to send a representative. Such is fame!

Telephone Communication in Different Cities.

From a German journal it appears that there are almost as many telephone subscribers in Berlin as there are in New York, Chicago and Philadelphia together; in London there are only about two-thirds as many as in New York.

The Advisability of Becoming an Electrical Engineer.

BY HENRY FLOY.

Not with the idea of figuring as a philanthropist, nor to discourage the ambition of future Edisons or Teslas, but because the future of any man is shaped largely by the selection of work made during his early years, and because there exists a misapprehension as to the opportunities open in electrical engineering, it has occurred to me that a brief statement of existing conditions, as I see them, might help to an intelligent decision those who are considering the advisability of becoming electricians.

The remarkable results effected through the agency of electricity, and the wonder which these results inspire in minds ignorant of the laws that govern electrical phenomena; the very rapid growth of the electrical business and the large amounts of money that used to be made in these lines, have all tended to produce a popularity for electrical engineering which at present is probably unequalled in any of the professional or technical callings.

Such expressions as "Electricity is in its infancy," "Electricity is to be the motive power of the age," etc., are quoted and requoted by the general public, not because they know anything as to the truth of the statement, but because it is the American nature to be tickled with novelties and to believe in anything that has the appearance of worth.

As a result of these conditions, there are at present a very large number of young men—and even some young women—who are planning to become electricians. Some of this number are preparing themselves more or less thoroughly by a course of training in classical or technical colleges—these I shall call "students"; the remainder—who may be called "artisans"—are working their way up from the practical or business end of the profession. When men of equal natural ability from the two classes come into competition, the former must eventually secure the higher positions, for the training secured in from three to six years of college curriculum cannot help but make them exact thinkers in addition to furnishing them a supply of theoretical knowledge which the "practical man" has failed to obtain.

Formerly there was considerable doubt as to the possibility of the "student" becoming a good all-around electrician, on account of the opinionated and conceited views apt to be held in regard to his own ability, which would make him unwilling to get down to the "dirty work." But this objection cannot be considered to hold now, as will be evident to any one who will take the trouble to visit electrical manufacturing establishments and see men of the highest training and ability, some of whom are already supplied with sufficient means to live comfortably the remainder of their lives, clothed in working jackets and performing tasks of the most menial character as patiently and as cheerfully as any of their less fortunate companions.

Immediately after graduation "students" are, of course, handicapped, because they lack practical experience, but after having obtained this, which they seem willing to do, it is but natural that they should outstrip men who have not received the advantages of a college training, and in very many cases, not even a high school education.

Possibly some may think that I overestimate the advantages to be derived from a college course, and therefore I refer directly to the catalogues of two of our leading universities, each representative of its class, to show what course of instruction a graduate from one of these universities has received.

Before admission to the course in electrical engineering at Princeton, it is required, after 1895, that the student shall be a graduate of the Academic Department, or shall have shown himself capable of such standing by examination.

This course is designed to extend over two years, and, according to the Princeton catalogue, covers the following:

Course of Study.—First year. The mathematical theory of electricity, Mascart and Joubert: *Treatise on Electricity*, volume I, with references to Maxwell, Cumming and other authors. General electricity, volume IV. of Wullner—*Experimental Physik*. These courses occupy eight hours a week throughout the year. Elementary electrical measurements, with references to Stewart and Gee, Kohlrausch, Slingo and Brooker, Gray, etc. Two days in the week are left free for this work. Strength of materials and mechanism, each two hours a week, and theory of machines for three hours a week for half the year, are taken with the senior class in the Civil Engineering Department.

Second year: The theory of electrical measurements, Fleming: *Alternate Current Transformer*. Four hours a week for half the year. Mascart and Joubert: *Treatise on Electricity*, volume II. Four hours a week for half the year. Theory of dynamo construction, Thompson: *Dynamo-Electrical Machinery*, with collateral lectures. Technical applications of electricity in telegraphy, electro-metallurgy and electro-chemistry, electric lighting and transmission of power. Four lectures a week throughout the year. Advanced electrical measurements and electrical testing.

In addition to these courses a meeting is held once a week, at which reports on the current electrical literature are made by the students.

As an example of a high-grade technical school which insists upon a thorough training in shop work and mechanic arts, in addition to the theoretical work, I cite Cornell University. This college well represents those schools which hold that training for both mathematical and electrical engineers should be very much the same, their idea being that an electrician should have a very thorough knowledge of mechanical and steam engineering in order to succeed in his own profession. The work during the freshman year at Cornell covers the following:

French or German, higher algebra, trigonometry, analytical geometry, chemistry, drawing and shop work.

For the sophomore year, differential and integral calculus, descriptive geometry, electricity and magnetism, acoustics and optics, chemical laboratory, drawing, designing and shop work.

For the junior year, mechanics and engineering, kinematics, drawing, machine design, materials of construction, physical and mechanical laboratory work, shop work.

For the fourth year a distinction is made between the electrical and mechanical courses. Those who wish to graduate as electrical engineers take physics, both lectures and laboratory work, which includes testing of instruments and determining of constants, the operation of dynamo machines and tests of same, photometry, efficiency tests of electric lamps, telegraph instruments, cables and a thesis which shall cover some practical and original work. Steam engineering, which includes lectures on steam boilers, steam engines, turbine water wheels, air compressors, hot air engines, etc., etc.; mechanical laboratory, with tests on steam engines, and application of Hirn's analysis; electrical engineering, which includes theory of the dynamo, etc., and shop work.

The preparation of the "artisan" for his work usually covers a fundamental public school training and in some cases a high school or even low grade polytechnic institute course, but the "artisan" usually enters upon his work when quite young, and by the time he reaches the age at which the "student" comes into competition with him, he has already made a good start in practical life and pretty thoroughly understands the operation of all machinery he is expected to handle. Most of his knowledge is picked up practically; that is, he learns from imitation, and though knowing "how" he does not always know "why." Some of these men endeavor to improve themselves, as far as their opportunity allows, by studying nights and attending some of the courses which are offered in cities for the instruction of just this class of men, but it takes a strong constitution and iron will to work faithfully during the day and study intelligently at night.

Prepared each in their own way, what are the conditions which the two classes of men above described may expect to meet when really ready for advancement along the line of their life work?

At present the electrical business is overstocked with men who are striving to make their mark in this profession. The cause of the overcrowding is due not only to the present de-

pression, which is affecting the electrical business, the same as an other mercantile interests, but more truly to the over-popularizing of this particular profession, and to the fact that the country needs but comparatively few electricians, in the full meaning of that term.

Though my statement that but few electricians are needed may at first sight be disputed, any one who will but consider the subject carefully will soon realize that such is the case, for there are, after all, but comparatively few electrical manufacturing companies in this country, and as their labor and their capital are invested in producing and not in discovery, their need is necessarily for business capability rather than inventive genius. Furthermore, those who are using electrical apparatus seldom have call for men that are highly trained theoretically, since most machinery is so manufactured as to need but little attention and such as may be given it by men who have had only practical experience.

In order to substantiate my statement as to the overcrowding of the electrical profession, I can say that at least one large manufacturing company in this country, during the present winter, has been receiving on an average thirty applications per week from high-grade college graduates who are desirous of entering their factory, although knowing before making application that they will be put at the coarsest and crudest work. The same company referred to has on file applications from perhaps 500 men who may fairly be classed as "artisans." Almost without exception, applications, whether from "students" or "artisans," are being refused, and in most prosperous times not over 20 or 30 per cent. of all "student" applications are accepted, while the "artisans" do not fare any better. The cause for this is found in the fact that unemployed "students" are so numerous that they can be had for the asking, and practically those of their number who can control some influence are more than sufficient to supply whatever demand manufacturing establishments may have for this class of men. Consequently, it must be recognized that the mere fact of having a thorough education cannot now insure one a salary of \$10 per week in the electrical business, unless the "student" has some influence which must be powerful enough to secure him a start and assist him to rise.

For the "artisan" the prospects are not even as bright as for the "student." The former, in many cases, is already in some paying position by having worked up to it in securing his knowledge of the business, but if turned out of employment he will find at present almost no chance of securing a new position in the electrical manufactories, unless exceptionally capable or having some friend influential enough to make an opening for him. This is true despite the fact that when possible the large manufacturing establishments are desirous of employing those who have had a large amount of practical experience, even though little theoretical knowledge.

With such conditions existing, what are the prospects for the future?

There are yearly graduating from what may be called "classical schools," such as Amherst, Dartmouth, Brown, Wesleyan, University of New York, Union, Rochester, various State universities, etc., an indefinite though moderately large body of students who intend entering electrical engineering as a profession. In addition to these men there is another class in the technical schools who are studying special courses leading to the degree of electrical engineer. The latter class is being more fully prepared for its work than the former, and these are the students more likely to secure any available positions; and yet considering them alone, we find that they are so numerous as to more than meet any demand that is likely to arise for electrical engineers in the near future.

The following list, secured from the officers or catalogues of the institutions named, shows the number of regular

students taking the course in electrical engineering for the college year 1893 and 1894 in some of our representative schools:

School.	Regular students.	Post graduates.
Mass. Institute of Technology.. (approx.)	240	(approx.) 22
Columbia	43	19
Cornell	322	41
Harvard-Lawrence Scientific School	56	..
Denigh	131	..
Ohio State University.....	121	..
Pittsford	22	..
University of Michigan.....	85	..
Worcester Polytechnic Institute. (approx.)	80	6
Yale-Snellfield Scientific School..	65	..

Thus, in the colleges named—and the list could be greatly extended—we find 1,175 undergraduates and 89 post-graduates, making a total of 1,264.

We may safely assume that none of the above young men expect to be satisfied with salaries of \$100 or \$150 per month for the remainder of their lives, and yet it would seem from present indications that many of these cannot do much better than this.

To the personal knowledge of the writer, there are men who graduated in 1891 from colleges of the best standing who are at present working for \$8 per week. These men are by no means incapable, but, lacking influence, have been unable to do much toward furthering their own interests. A graduate of four or five years' standing, that is, one who entered the field comparatively early, is getting \$3,000 per year, another \$2,400, and so on down. One student I know of who took both the graduate and undergraduate courses before leaving college in 1890, is said to be getting \$15,000, but such cases are very exceptional, and only the result of combined ability, opportunity and financial backing.

The son of a stockholder of one of the leading manufacturing companies of the country, who had graduated from a technical school of high standing, worked for about \$6 per week for eight months in the factory in which his father was interested, and then left, apparently discouraged at the outlook and the amount of drudgery that must be undergone.

It is a well-known fact that the General Electric Company is charging young men \$100 who enter their courses in the factory; consequently the "student" not only receives small salary, but in addition pays for "tuition," so that it is becoming to be recognized, though perhaps a surprise to some, that "student" labor, viz.: labor performed by college graduates, can be procured for less than that of ordinary workmen.

The young man who starts in a factory as a "student" is likely to be set sweeping floors, wiping off machinery, oiling shafts, or, if fortunate, winding coils, assembling machines, testing apparatus, etc., the changes from one class of work to another being not rapid and advancement to higher positions depending on the ability and perseverance of the individual man.

Many young men may look forward to filling the position of consulting engineer; that is, one who shall design and superintend the installation of plants, but such men are not in very great demand, since purchasers who intend to make installations of any size prefer to deal directly with the manufacturing companies, who, on their part, keep a force of salesmen and roadmen, and are thus able to meet the purchasing companies more than half way, so that ordinarily the independent consulting engineer is not required. Doing a large amount of this work and thoroughly understanding its various branches, the manufacturing companies require comparatively few men of this class just referred to, so that, though there is some chance for young electricians in these lines, it is not all that might be expected.

If it were possible to learn the history of consulting engineers for the past five years, I think it would be found that

most of them would advise against any young man going into this line of the electrical business. At least one company that I know of, though successful in the first few years of its existence, has gradually been doing less and less business, despite the fact that it has an already established reputation as first-class engineers.

The idea of being an electrical inventor has a charm for many young men, which will enable them to overcome many obstacles and endure much for the sake of "perfecting their ideas," but only last summer I heard Edison say, in substance, that the patent business was a poor one; that it did not pay for the inventor to spend his time defending patents from infringement; the thing for the inventor to do was to proceed with the manufacture of his inventions, and, by their cheapness and acceptability, hold the market against all later producers, but this means that the inventor shall have excellent business ability, a quality which, unfortunately, seldom seems to be combined with inventive genius.

The lighting stations of large size generally have a good man in charge, but these positions are usually not such as would satisfy the class of men I have in mind, and because the growth of this business is not likely to be either sudden or rapid, the opportunities it offers cannot be considered particularly brilliant.

At present the electric street railways do not seem to appreciate the need for highly trained men, and most of them are satisfied with their horse railway superintendents, who have picked up enough electrical knowledge to make the road run, sometimes paying a dividend, but more often not. Of course there is no knowing what the future may develop in this line. It is possible that the railroads may substitute the electric motor for the steam locomotive. If so, here will be a demand for high-grade electrical engineers.

Recently power transmission has been attracting a great deal of attention, and where the newer and more intricate systems are used, first-class electricians are necessary for the successful operation of the plant, and possibly in this line more than in any other there are prospects for the young engineer.

In an article as brief as this must necessarily be, it is impracticable to adequately cover the subject, but possibly the line of thought herein contained may prove suggestive to the prospective electricians to whom it may chance to come.

Electrical Legislation in New York.

Electrical legislation is beginning to be of importance in the eyes of the lawmakers. Attracted by the greatness of the plan for the utilization of the power of Niagara, which they unwittingly sanctioned, legislators, either for themselves or for others, are coming to the front with bills that mean, although they do not always say so, the generation of electric power.

This session four such measures have appeared. What is known as "The Genesee River dam scheme" was introduced by Senator Parsons and Assemblyman O'Grady. Under the plea of restoring to the owners of water power the water diverted for canal purposes, it provided for a State appropriation of \$250,000 to build a dam 130 feet high at Mt. Morris, near Rochester. It was shown in committee that a dam 85 feet high was all that was needed, and it was also pretty thoroughly revealed that at a cost to the State of millions of dollars the mill owners wanted to get this immense dam built to generate electric power. The bill was killed in the Assembly. It will probably be revived next year as a private enterprise.

Another scheme to get State aid to build a dam for power purposes on a similar plea is set forth in Assemblyman Hobbie's bill appropriating \$200,000 for the construction of "reservoirs" in the Adirondack region in the vicinity of

Carthage. No doubt the Champlain canal needs more water, but it is equally certain that the owners of water rights in Essex, Hamilton and Warren counties look upon the plan as one that will some day result in the furnishing of an enormous water power at their very doors. The bill is at present quietly sleeping in committee without any prospect of passing this session. It is estimated that the proposed "reservoirs" would cost about \$1,500,000.

Still another plan is revealed by the bill introduced by Senator Pound and Assemblyman Clark, which seeks to incorporate the Niagara, Lockport and Ontario Power Company. It is not a new scheme by any means, but has been revived, as have most such schemes, by the vast possibilities that seem to cluster around the great hydraulic plant at the Falls. It has the merit of being willing to start without State aid, and the men back of the enterprise say the proposed \$10,000,000 capital means business. The proposition is to take water from the Niagara River, near Tonawanda Creek. As yet the bill has made but little progress, and seems not likely to. It is said here that strenuous objections are being raised to allowing any more water to be taken from the Niagara River for power purposes.

Senator Donaldson's bill "To incorporate the Hudson River Transportation Company" has been widely discussed as another of these big electrical schemes, but even yet nobody is quite sure that the truth is known about it. With a capital capable of extension from \$500,000 to \$10,000,000, it incorporates comparatively unknown men with a blanket franchise to do anything from gridironing the State with wires, pipes or tunnels, to making, generating, supplying or storing gas, electricity, oil or water. This is asserted to be a scheme to pipe line water from up the State to the metropolis, but it is looked upon with so much suspicion that it will have to be very much modified, if it gets through at all.

With the purpose of establishing an electrical city at Waddington in St. Lawrence County, a bill has been introduced by Assemblyman Ainsworth that incorporates the St. Lawrence Electric Town Site Company. The capital is to be \$3,000,000, and one of those interested is Major G. B. Burbank, who was prominently identified with the construction of the Niagara Falls undertaking. It is understood that a 12-foot fall of water can be had at Waddington, which will be so handled as to generate at the outset 25,000 h. p. Papermaking, woodworking and general milling purposes will in time require the generation of at least 75,000 h. p. in this venture, the projectors hope. The charter provides fully for carrying out these plans.

At the instance of the so-called "canal men" a bill has been introduced repealing the second section of the act giving the Superintendent of Public Works authority to make such contracts as that which has been entered into between the Cataract General Electric Company and the State. The object of the bill is to keep all electrical corporations off the canal grounds, but many think that with this contract in existence it will simply entrench the Cataract company in power and leave the superintendent unable to give any competitor a trial. This bill is likely to pass, but not to become a law.

Generally speaking, the raft of other electrical legislation before the Legislature relates to telephones, electric railways and electric lighting. There is also one bill by Assemblyman Butts, which provides for the licensing of all persons installing or operating electrical plants. The executive officers of all towns or cities are to appoint boards of three examiners, no examiner is to be an employee of any electrical concern, their findings are not to conflict with the rules of the New York fire underwriters, their pay is to be fixed by the city or town, no applicant must be of less than three years' experience, failure to obey the law is a misdemeanor, and no insurance company may take risks on

property on which the law has been violated, under penalty of a fine equal to its assessed value.

The street railway bills come chiefly from the Brooklyn members. Senator Bradley and Assemblyman Wray jointly have a measure which provides that "all exposed wires used in operating by electricity as a motive power by railroad corporations and others shall be properly and efficiently insulated." It is to go into effect on July 1—it it passes. Admitting that the intentions of this measure are of the best, there is a world of humor in it for an electrician. Senator Owens varies the bill by an additional provision that the companies shall all forfeit their charters unless they do the insulating within six months. In conjunction with Assemblyman Scanlon, he also wants an extra man stationed on the front platform of each car, so as to provide against accidents. Senator Donaldson has a bill that makes the consent of two-thirds of the property owners on any street a necessity before any work can be done in the way of stringing or laying wires.

Telephone legislation, which is an old story, takes the form of bills to reduce the rates. There are a half dozen of these, but most of them are so plainly for "speculative" purposes that they need no notice. The bill advocated by the New York Board of Trade and Transportation is an innovation, in that it provides a board of State officers to fix the rates, which, however, are not to be over \$78 per year in cities of over a million inhabitants, \$66 in cities of half a million or under, \$48 in cities of a hundred thousand, \$36 for twenty thousand population and \$27 for less than eight thousand. No rate that provides a profit of more than 10 per cent. on the capital invested is to be allowed. This bill was practically killed by a statement that money was to be collected to defeat all those who voted against it. The others will never be heard from again this session. A measure also exists that allows the cable road to run wires through its conduits for the alleged purpose of signalling in cases of accident. Its passage is doubtful.

The several electric lighting bills chiefly empower electric railroads to go into the business of furnishing light or power in various places throughout the State, or empower village trustees to contract for the furnishing of such light. There is also one by Senator Owens, who does not want any company to charge over half a cent per hour for an incandescent light, nor more than 4 cents per hour for each arc light in any city of over 800,000 inhabitants. The fate of most of this legislation is uncertain, but the odds are decidedly against much of it getting out of committee.

Earth Forward and Return Circuit.

According to a daily contemporary, the Abbe Michel has succeeded in using two separate horizontal geological strata as a telephone circuit. The strata are conducting, and are separated by an intermediate stratum of comparatively insulating material. By coupling the transmitter to the surface stratum and a deep stratum, and similarly coupling the receiver, it was found that speaking could very well be carried on at a distance of 120 feet. Very rarely would the geological conditions permit of this arrangement being adopted; while in any case, of course, it would be impossible to have more than one system in the same locality.—London "Electrician."

Underground Wires in Philadelphia.

From the message of the mayor of Philadelphia it appears that 300 miles of underground telephone, telegraph and electric light wires have been added, that Broad street is relieved of overhead wires, and that they are being removed from Market street. The city now has 680 miles of underground wires in successful operation.

Nikola Tesla and His Work.

BY LIEUT. F. JARVIS PATTER.

Mr. Nikola Tesla has been prominent in the electrical field for more than ten years, and the creations that have sprung from his brain have made his name familiar to the general public. His work, however, has been of such an advanced order of electrical application that comparatively few have a clear idea as to just what he has accomplished.

Within the past three months a book has been published which tells the story and which is indeed a rather exceptional contribution to the electrical literature of the day, presenting, as it does, an elaborate description of all that Mr. Tesla has thus far given to the public in his patents and lectures.* It includes not only descriptions of his numerous inventions, but his personal writings upon the lines of thought and experiment he has advanced, and so affords the opportunity for a brief review of what he has done.

From both a literary and typographical standpoint the book is an excellent addition to the electrical library. It is tastily gotten up, and evinces care and literary skill in the editing; the illustrations, which are profuse, are good, and this is equally true of the frontispiece portrait of Mr. Tesla, which to many will largely enhance the value of the book.

With the exception of a short biographical sketch, Part I., comprising twenty-four chapters, is devoted to a rather exhaustive treatment of the many forms of rotary field motors that Mr. Tesla has from time to time invented. One of these chapters, which will meet the requirement of the average reader, is an abridgment of Mr. Tesla's well remembered lecture before the American Institute of Electrical Engineers in May, 1888, in which he gave for the first time the rotary field motor invention to the public. Most of the remaining chapters of part I. are detailed descriptions of different modifications of the general multiphased motor system, such as would likely occur to an active inventor anxious to bar with a profusion of patents every access to a broad system naturally open to many variations. In fact, many of these chapters are little else than mere transcripts from patent specifications.

Part II. is devoted to high frequency phenomena, a field of investigation that seems to be peculiarly Mr. Tesla's own. It opens with an interesting chapter that seems to be from the editor's pen, in which he gives his own resume and estimate of the matter set forth in Mr. Tesla's three lectures upon high frequency effects, lectures given in succession before the American Institute of Electrical Engineers, the Royal Institution in London, and the Franklin Institute in Philadelphia. These three lectures, reproduced verbatim and making as many long chapters, constitute, in fact, the main part of the work.

Part III., comprising seven short chapters, describes quite a variety of inventions of relatively minor importance, so far as Mr. Tesla's work is generally known, and which would probably never have seen publication beyond the patent specifications, from which they are evidently drawn, had not the exhaustive design of this book rendered their inclusion excusable. The inventions here mentioned include an arc lighting system of earlier days, some suggestions of how a unipolar machine might be built, a pyromagnetic generator, a thermomagnetic motor, an anti-sparking dynamo brush, and a method of regulation for constant current. These chapters are interesting mainly as showing how much a professed inventor must do that is not in the line of great achievement.

A short but interesting chapter describing Mr. Tesla's personal exhibit of apparatus at the World's Fair, and a brief reference to his latest surprise, the "electro-magnetic

*"Inventions, Researches and Writings of Nikola Tesla." Edited by Thomas Commerford Martin. New York. 1894. Price, \$4.00.

oscillator" for producing high frequency currents by mechanical means, ends the volume.

With the exception of a few chapters by the editor, the volume is a collection of Mr. Tesla's writings, and those who have followed his work closely will find in it little that is new. Much of the subject matter in Part I., devoted to polyphased currents, is taken in a sweeping manner from patent specifications, and as such will be new to some who little know, without such a review, how thoroughly Mr. Tesla looked after the possible variations of his broad invention. The various motors described are shown in their most elementary forms by mere diagrams of the operative circuits.

While these numerous variations of the same general idea are instructive as showing the growth of the invention in the inventor's mind, and the gradual development of the mere abstract idea to different practical forms, still, in all these descriptions there is little to be found that has any practical bearing or importance to-day. The engineer will find in these chapters little that he cares to remember for practical use or application, the advocate of controversy as to priority of invention will find ample data for reference, and the student of electrical science will find in them evidence of how little the most thoughtful inventor can foresee the features of his invention that will lead to most controversy and discussion, for nowhere in these earlier writings is any importance attached to the frequency of the alternating current used. Throughout the twenty-four chapters of Part I. the charming delusion prevails by inference that all these machines are as good at one frequency as at another. One might also draw the erroneous conclusion that polyphased currents were first discovered and used by Mr. Tesla; on the other hand, no one can doubt that the biphased and triphased rotary field machines were simultaneously worked out by him as early as 1887. He did not leave the triphased machine for a follower to invent.

Following the general treatment of multiphased machines come descriptions of various devices and makeshifts (no word seems more appropriate) for working these machines by a single alternating current. The rotary field motor operated by multiphased currents, as its every feature indicates it should be, is a unique and characteristic thing and should have been left to the field of operation that its inherent simplicity must sooner or later create for it. Its birth, however, was contemporaneous with that of single alternating current working, so the genius that first showed the rotary field machine in practice must pervert his invention to meet the requirements of a system to which it was entirely unsuited. The description of these many attempts adds but little to the value of the book.

In chapter XIV. is given a description of a single alternating current motor that does not depend upon the production of two currents from one, and another chapter shows a similar motor with a condenser in circuit, which points to Mr. Tesla as one of the earliest users of this device.

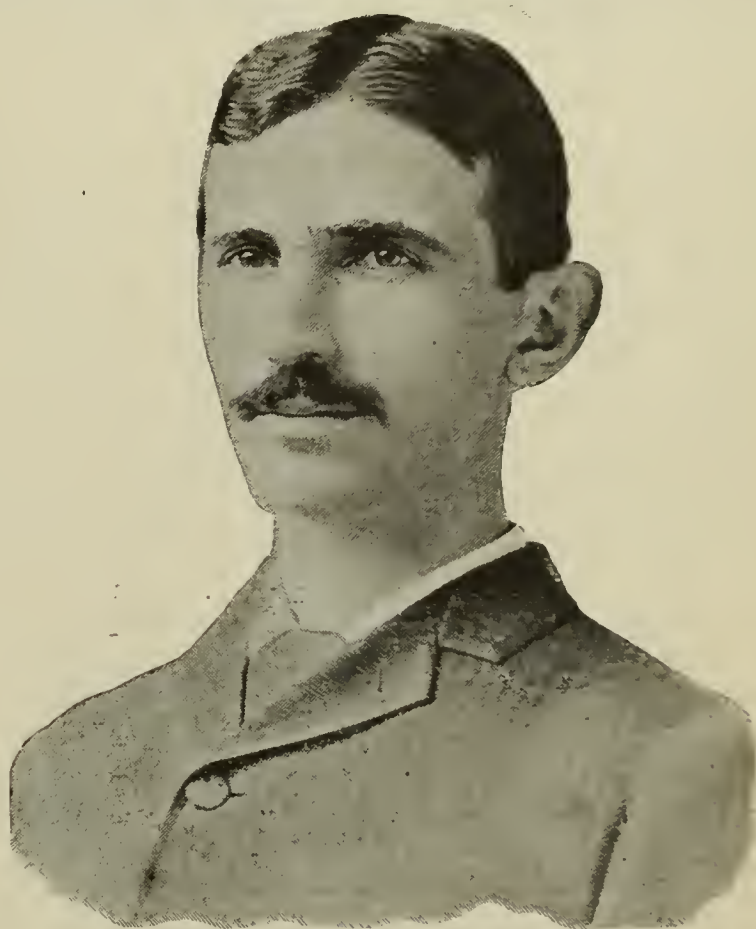
One cannot resist the conclusion, however, that this part of the work is a little padded with the only ostensible purpose of showing what a lot of inventions Mr. Tesla has made, and the reader is tempted to wish he had not invented so much.

In Part II., devoted to high frequency effects, we have to consider an entirely different order of work, which may be properly classed as pure science, for there is scarcely a practical effect described in the many pages given to the three lectures.

In this work the purpose in view has apparently been to establish by experimental process the identical character of light and some form of electrical manifestation of energy. In attempting this proof, Mr. Tesla has doubtless given new evidence in favor of the electro-magnetic theory of light, which theory, of course, preceded his work.

In his endeavor to obtain a very high frequency, Mr. Tesla doubtless started with the notion of setting matter into vibration at a rate approximating that of light, with the expectation that under such violent molecular agitation it would emit light. It is left to be inferred that so high a frequency is scarcely possible of attainment, while a much lower one under favorable conditions produces the desired effects. The investigation of these conditions constitutes a large part of the three lectures, which are sometimes tedious with exhaustive detail; though doubtless essential to a thorough investigation of the problem and invaluable as a guide to further work, these minutiae are not always interesting reading. This fact seems to be appreciated occasionally, and when it is we find a digression in the form of some purely speculative possibility—generally a suggested practical application of the effect under consideration. These are often so purely speculative in character as to be actually amusing.

Seriously speaking, the scientific world to-day believes in



NIKOLA TESLA.

the electro-magnetic theory of light which grows out of fundamental views enunciated by Faraday and elaborated in later years chiefly by Maxwell and Hertz. Mr. Tesla has not touched the mathematical side of this question, and so has added nothing to Maxwell's proof. Hertz established by experimental or physical demonstration the truth of Maxwell's deductions. So, if Mr. Tesla has added something to our scientific knowledge of this subject, it will consist in what he has added to the work of Hertz.

Broadly speaking, however, the Tesla experiments are the same in general results as those performed by Hertz, but are undertaken in a different and entirely original manner and are shown in far greater profusion and variety of effect. Indeed, Tesla's investigation of the electrostatic field, so far as variety of effect is concerned, would seem to leave but little to be desired. Tesla's labor in this direction was simply a long and painstaking investigation, the apparent purpose of which was really to determine what practical use, if any, can electrical science derive from the so-called Hertzian oscillations. If this question must be definitely answered by the Tesla experiments, we are compelled to say that no practical use for such phenomena has yet been shown.

The vacuum tube and light effects produced by rapid al-

ternations of an electro-magnetic or electrostatic field, and the transmission of energy along a single wire without a return lead, are beautiful, and mostly novel exhibitions of what can be done with electric energy under properly arranged conditions, but they are not of practical value in any use that has yet been made of them. They are simply advanced laboratory experiments of great scientific beauty and interest.

The introductory part of one lecture is given to a description of the apparatus used for producing the high frequency effects, and the precautions that must be taken in the arrangement of the parts are carefully pointed out with a view to help the experimenter who desires to follow this line of investigation.

Another is opened with a description of the best form of generator to be used, preference being given to a form of motor dynamo for transforming direct current into an alternating current of low voltage by a simple dynamo conversion. This low voltage alternating current is then changed to high tension by an ordinary converter, and this current, on being passed through the oscillatory transformer, has its frequency raised to something like a million a second.

Introducing another lecture, Mr. Tesla goes into a long digression upon the human eye that deals in nothing but generalities, having little or no bearing upon the subject.

The effects described in these three papers may be classed, for sake of arrangement, as phenomena produced by electrostatic force, dynamic electricity phenomena, and vacuum tube effects. We will consider some of these briefly.

Mr. Tesla claims that all electric and magnetic effects can be traced to the action of electrostatic molecular forces. In fact, he goes much further in one of his speculative digressions and refers everything among Nature's fanciful designs to the action of electrostatic force. His first claim finds some confirmation in a beautiful experiment he describes, in which he produces a veritable flame by the action of electrostatically charged molecules. A flame is thus produced by which, however, no material is consumed. He thinks this experiment gives us a further insight into the nature of an ordinary flame, which he attributes to the electrostatic effects produced by the chemical changes going on.

The experiments in which vacuum tubes are shown glowing brightly by simply being placed in a rapidly alternating electrostatic field are beautiful, but the practical application suggested—of lighting an apartment by simply creating an electrostatic field in the space between the walls and using detached vacuum tubes for lamps that will always be aglow when between the walls—is far from realization, and the reading public should not be left with the impression that anything of the sort has ever been accomplished.

Another very interesting experiment consists in the operation of lamps and motor devices by the discharge from condensers, and he points out methods of transforming or changing the voltage of direct as well as alternating currents by means of condensers, and expresses the hope in this connection of perfecting apparatus by which electricity of high tension may be obtained directly from heat energy itself. No suggestion is, however, given as to what the method is or how the transformation is to be effected. This hazy suggestiveness of great practical ends just in view but never reached becomes at times somewhat unsatisfactory.

Among the most beautiful of this array of experiments is one that illustrates the impedance of a rod or bar of practically no resistance when connected in a circuit to which a very high electromotive force and frequency is applied. Owing to the impedance the current may be shunted around it through a circuit of comparatively high resistance supplied with incandescent lamps that glow brilliantly when their terminals are connected to the bar at points only a few inches

apart. It is further shown in this experiment that there are points or nodes on the bar, from which no current can be taken in the manner described, while others differently situated give a high difference of potential, and so marked is this distribution that the points can be readily selected by an ordinary voltmeter or by the lamp circuit itself.

The most surprising of the new facts elicited from these investigations is that the shock due to these very high potential and high frequency discharges can be supported by the person without serious inconvenience. This Mr. Tesla attributes to the fact that the body offers a large cross-section to the high frequency current, which distributes itself uniformly, so that the current density is small at any point of the path. The inference also follows that these currents pass through the human body in much the same manner as a direct current passes through a good conductor. The E. M. F. used in this experiment was about 2×10^5 volts and the frequency near a million a second. With this enormous potential literally in hand Tesla grasps one pole of the high tension transformer and approaches the other to the opposite pole, on nearing which a brush discharge having the appearance of a flame passes from his hand to the free pole. Enlarging upon this phenomenon in his usual style he estimates that with a frequency of four million and an E. M. F. of 3×10^6 , his entire person would be enveloped in such a flame, but without danger.

In another beautiful experiment two straight wires are connected to the poles of the high tension transformer and stretched parallel to each other across the room, there being no cross connection between of any kind. When given the high tension current, these wires emit streams of light or brush discharges so profusely that light enough is produced to distinguish objects in the room. If these wires are bent into concentric circles, one inside the other in the same plane, the annular space between them is filled with streamers that make a sheet of light about a metre in area.

Perhaps the most interesting feature of these high frequency phenomena is their apparent capability of operating various sorts of electric devices—even motors of a certain description—and this with only a single wire leading to the source of energy. In one of these illustrations Mr. Tesla is led to say that he thinks it probable these experiments indicate the possibility of operating a motor at any point of the earth's surface from a central source with only an earth connection to the latter. This he hopes to accomplish by causing the electrical charge of the earth to oscillate and by the use of resonance a distant motor is made capable of picking out the current of different rate or frequency that is intended for its consumption or supply. It is probably suggestions of this character that have caused some readers to view Mr. Tesla's work as that of a visionary enthusiast.

It is more important, however, to determine just what Tesla has given in this discussion of high frequency phenomena that is of value—for its value is really quite independent of any views he may hold concerning the possible future applications of electricity.

He has built up a method of experimental investigation of physical phenomena, concerning which much remains to be learned. This method, with its vast array of beautiful experiment, is original and goes some steps beyond the point reached by previous work in this field, which may be defined as the experimental investigation of molecular physics. In all this there is little of practical interest to the electrical engineer. In going into this domain Mr. Tesla left what is commonly called electrical engineering behind and his work in this new field should therefore not be judged by its standards.

To the physicist Mr. Tesla stands a pioneer of a new and wide field of research.

To the electrical engineer he stands the inventor of the

rotary field machine, a brilliant and unique conception, which he soon left for the engineer to elaborate and figure out.

Before the general public he stands a phenomenal inventor from the Eastern World, from whom is expected little less than if he carried Aladdin's lamp in his hand, which, of course, is wrong, and an injustice both to the public and to Mr. Tesla.

Mr. Tesla is a hard and patient worker and has done enough for one decade in producing the rotary motor. He has doubtless much of importance in store for us, but the difference should never be lost sight of between the search for Nature's truths in the laboratory of the physicist and the reduction of the results attained, however great their promise, to a form suitable for commercial use.

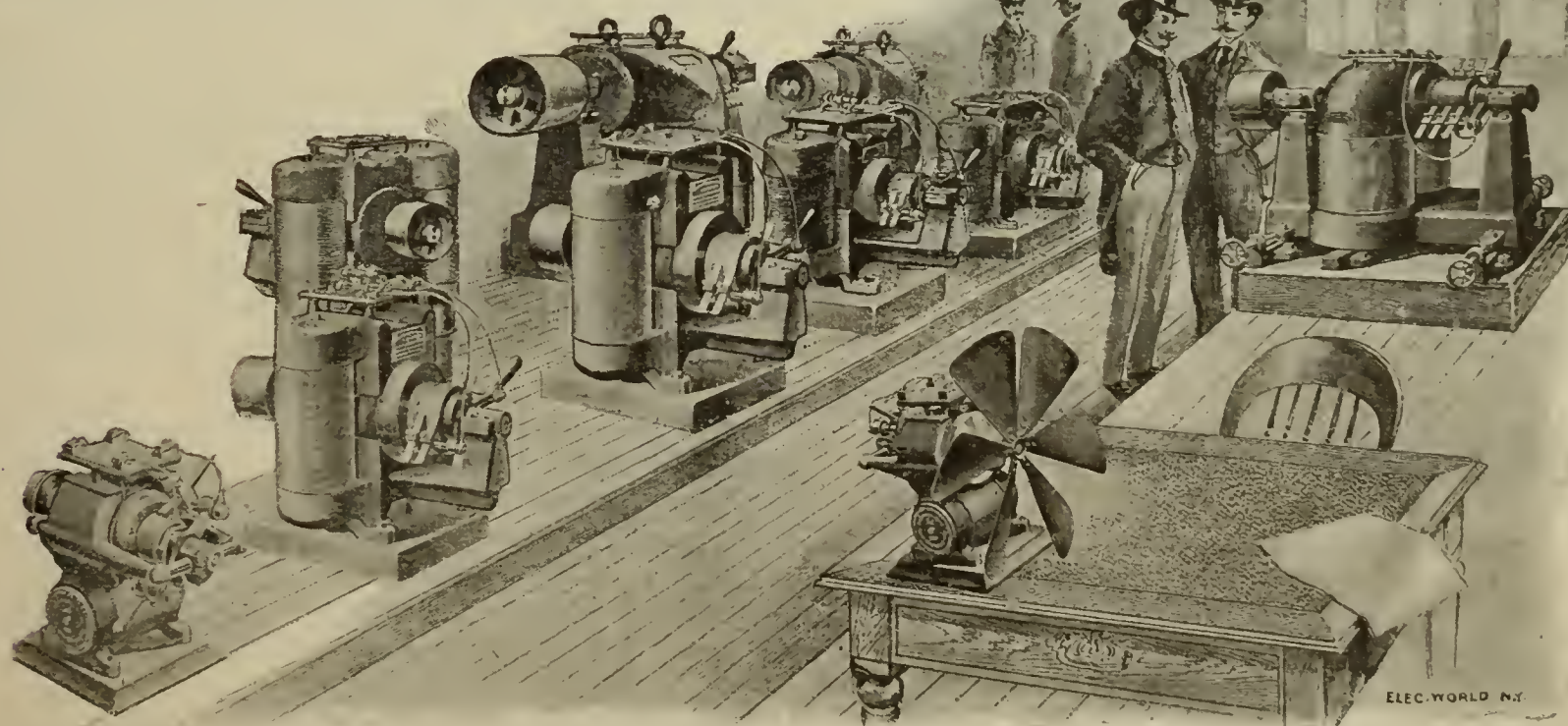
The Home of the Card Motor and Dynamo Company.



THE South and Southwest have long been recognized as among the important fields for the introduction of electric installations of all kinds, and the city of Cincinnati in particular is considered the central point of a vast territory; in fact, it is one of the leading cities of the country, electrically speaking. The success of the Card Motor and Dynamo Company, pre-eminently a Cincinnati enterprise, is but natural, therefore.

Some four years ago this company was started. Step by step it has steadily grown both in the extent of its plant and scope of its work. From a small shop on one of the unimportant streets of the city, it has become what is in many respects one of the most interesting factories yet constructed.

The factory fronts on Broadway, and extends down Hunt street a long distance. Practically all the lower floor is devoted to the factory. The Broadway front of this floor is used as a show room, where motors and dynamos of all types and sizes manufactured by the company are on exhibition. The offices, located immediately over the show room,



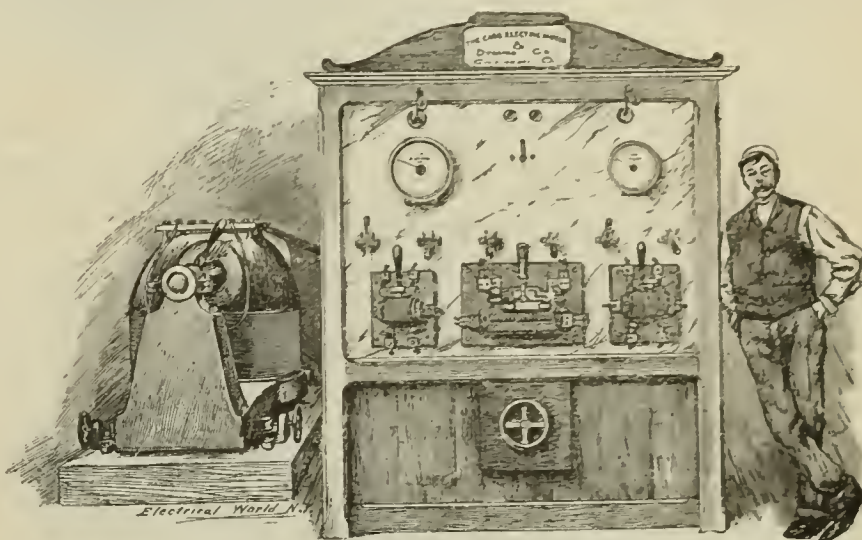
SHOW ROOM IN THE CARD FACTORY.

are commodious and attractive. The rest of this floor is devoted to a store room for material and supplies of all kinds.

It is on the first floor, where the Card machines are built, however, that the visitor finds most of interest. The entire power is supplied by a Card generator, situated alongside of the handsome marble switchboard shown in the cut. A steam engine runs this one generator, from which light for

the entire building and power for all the machines are obtained. The plant is so arranged that whenever it is necessary to work overtime the electric current is obtained from the central station, thereby saving the cost of running the steam plant.

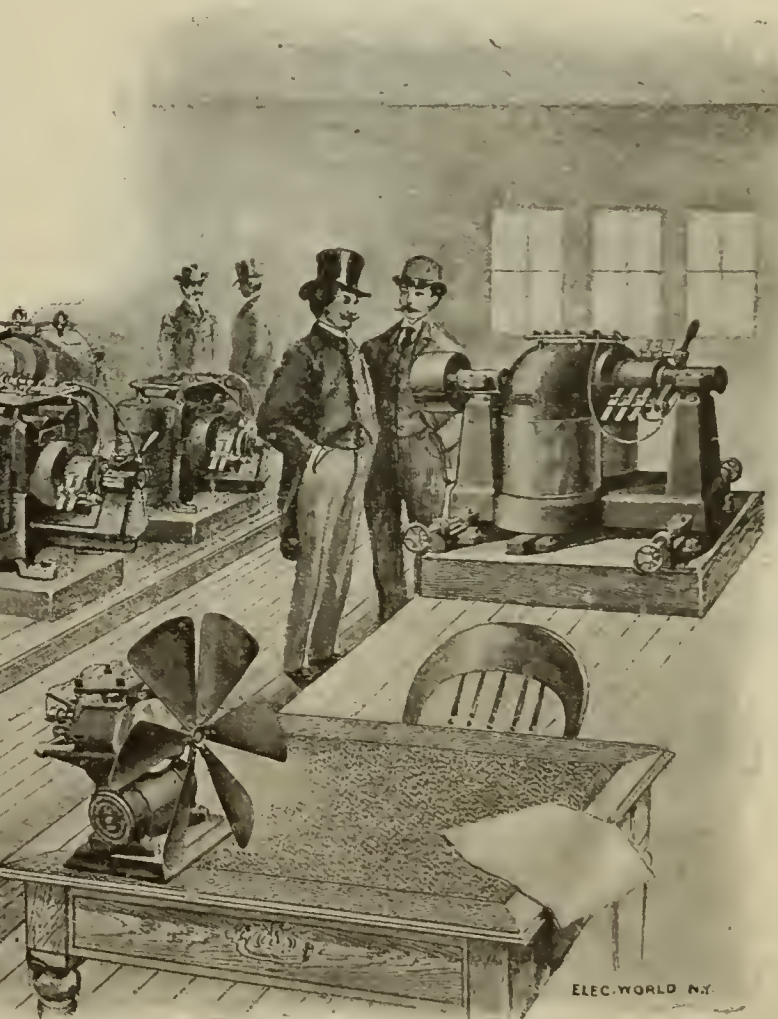
All of the machinery on the floor is operated by Card



SWITCHBOARD AND GENERATOR IN THE CARD FACTORY.

motor, either directly connected or belted to the machine. The accompanying illustration shows one of the large planers operated by a 3-h. p. motor suspended from the ceiling. With this arrangement any desired speed can be secured for the machine. It is at present run at two speeds, a slow forward movement and a quick return, an automatic controller serving to change the speed of the motor. This obviates the necessity of any extra shafting or gears to secure the same result, and almost doubles the capacity of the machine.

In another sketch is shown a drill press directly connected

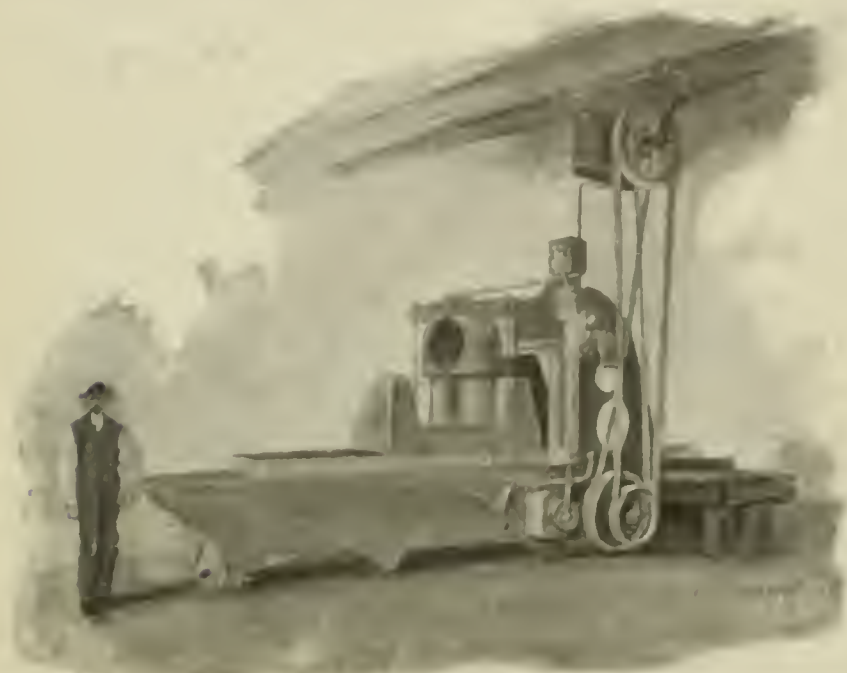


to a Card motor. Connected in this way, it will readily be seen what an advantage is secured by having a reversing power. The machine can be adjusted for any work obtainable from such tools, with the increased advantage of a variable and reversible speed.

The lathes, and there are many of them, are all operated with motors of the Card type, so that it may be said that

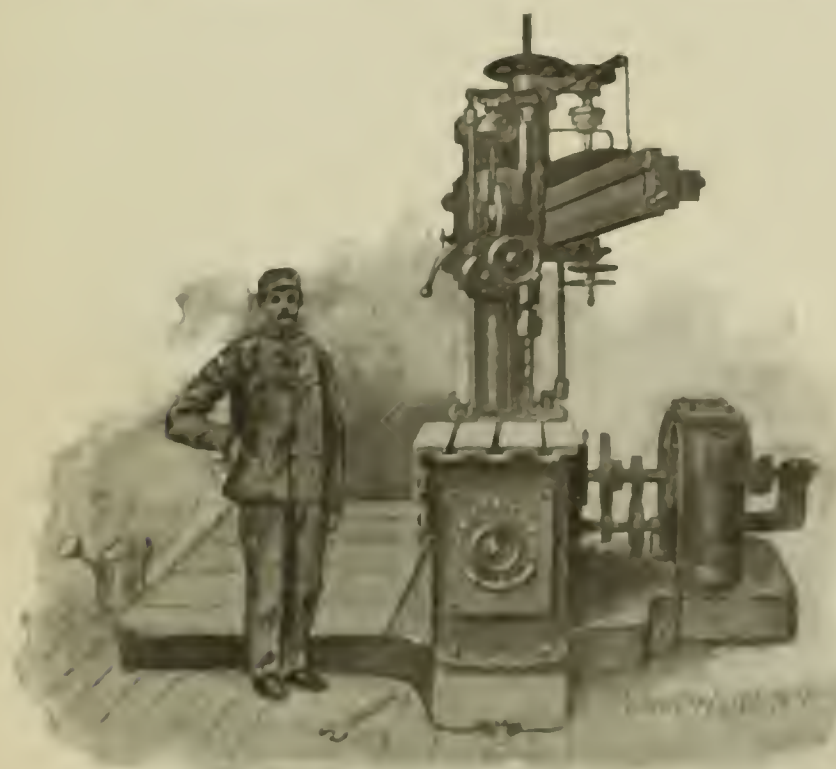
Card motors and dynamos are manufactured by themselves.

The Card Motor and Dynamo Company now manufactures motors and dynamos of all sizes, paying particular at-



PLANER DRIVEN BY ELECTRIC MOTOR.

tention to the operation of machinery with motors. From its own experience, it claims to show a saving of 35 per cent. in the cost of operation, and that the performance of a machine so constructed is highly satisfactory in every sense.



ELECTRICALLY OPERATED DRILL PRESS

Recently the company has taken up the manufacture of street railway apparatus, and it anticipates an extensive business in this line.

Electric Light Prospects in Messina.*

BY CHARLES M. CAUGHY

The present contract for illuminating this city by gas expired on the 28th of March, but owing to a deadlock in the municipal council, the Ministry appointed a commissary, who will act until the organization of a new body in June, and no action will be taken until then.

The only illuminating plant in Messina is the gas works, absolutely owned and operated by an English company, under a concession from Victor Emmanuel in 1861, and which has been once renewed. The light furnished and the prices charged are both causes of great dissatisfaction.

The power is only eight candles, and it costs about \$1.02

*Advance copy of Report of U. S. Consul at Messina.

gold for 1,000 cubic feet. It appears to me that there is here a great opportunity for any enterprising electric light company, for in Italy, as well as in the United States, the people are only too willing to adopt the latest and best illuminant.

For the installation of a plant for lighting stores and dwellings and the furnishing of motive power the prospects are equally favorable. The "locus habitandi" in Messina, as in the majority of other European cities, is the apartment, or what we know as the "flat." The walls here are never less than two, sometimes three, feet thick, and built of stone, so that the introduction of gaspipes on any floor except the first, where the connection is made from the street, is attended with so much labor and expense that very few houses except those recently built, into which it was carried during construction, are so equipped.

No local obstacles confront the introduction through the smallest of apertures, under window frames, etc., of the tiny electric wire, which can be carried, upon arms projecting from the houses, that privilege being now enjoyed by the telephone company, so that one of the largest factors in construction expense, the buying and planting of poles, is avoided.

As to motive power, there is one applicant already in the field willing to adopt it as soon as it is installed, and that is the Tramway Company, which runs its lines from Messina to Faro Point, a distance of 9 miles, and to Barcelona, a distance of 30 miles. It is now operated by dummy engines.

I realize that the first questions that will arise are, what will be the cost of constructing a plant, and what will coal cost?

When I say that the average price for unskilled labor is 35 cents and skilled 45 cents per diem, that the laying of stone, including cost of material, is 50 per cent. cheaper than brick; that lumber is no more expensive than in the United States; that land is remarkably cheap, and that Cardiff coal costs, delivered on the wharf, \$4 per ton, I think the questions are satisfactorily answered.

Before writing this report, I made a thorough canvass of the business men of the city, and they, without exception, promised their most earnest co-operation, both with their influence and their purses, to make the installation of an electric plant in Messina a success.

With the day of deliverance from the thralldom of a gigantic monopoly at hand, the advent of any Moses will be hailed with joy, but if he come from the West, with which the commercial interests of the Messinese are so closely allied, he will receive the heartiest of welcomes.

Let me say to those companies who may see fit to enter into competition to do so in propria persona, so to speak, by sending a well equipped representative to look over the grounds, and to be on hand to meet any emergency, or to answer any question that may arise.

To enter into correspondence and overwhelm those in authority with circulars, indorsements, etc., printed in a language that to most of them is unintelligible, is a sheer waste of printer's ink, stationery and stamps.

The fastest steamers of the Hamburg American line leave New York every two weeks, and land their passengers in Naples in ten days, from which place it is only a night's sail to Messina.

A personal representation will, I am sure, be productive of good results, while correspondence will only tend to fill the waste basket.

I do not wish for one moment to be understood as saying that the installation will be an over easy task to accomplish, for this gas company is in no wise different from like corporations in the United States, and no doubt will make a bitter fight, but in this case the intruder will find helping hands awaiting him from a long oppressed people, who will only too gladly array themselves on the side of progress.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE
PRINCIPAL FOREIGN

ELECTRICAL JOURNALS.
BY CARL HERING.

NOTE.—Owing to the crowded condition of this department the following changes will be made, the object being to enable more space and attention to be given to abstracts of articles and papers of a more important nature. Almost every issue of each of the foreign journals contains descriptions and data, often with illustrations and tables, of local central stations and isolated plants; unless they appear to be of special interest they will not be noticed hereafter. References to descriptions of steam and gas engines, boilers, fuels, etc., and all other subjects not belonging under the heading of electricity and magnetism, will in general be omitted. The Swiss monthly "Journal Telegraphique" (in the French language) contains probably the best telegraph and telephone statistics of the world, and as this Journal is doubtless accessible to those specially interested in this subject, references to such statistics and descriptions in that Journal will hereafter be omitted. Serials in the nature of a treatise on a subject will be noticed only once; this will apply also to papers which are continued in several issues and which are merely referred to in these columns as distinguished from being abstracted. When the same paper or article is reprinted or abstracted in several journals, only the first appearance will be noticed, except if the original is in a foreign language and the reprint is an English translation, in which case the references to the translation will also be given, as usual. Very good abstracts, generally longer than can be given here, are published in the monthly journal of the Institution of Electrical Engineers (London), and in the Proceedings of the Institution of Civil Engineers (London), which abstracts will be noticed only in case the original article has not been mentioned in these columns.—C. H.

ELECTRO-PHYSICS.

Cathode Rays.—The Lond. "Elec.," March 23, contains an article by Prof. Fitzgerald, in which he reviews briefly a recent paper by Mr. Lenard in "Wied. Ann.," No. 2, 1894, on "Cathode Rays in Gases Under Atmospheric Pressure and in Extreme Vacua"; it is followed by a translation of the complete paper, together with a number of illustrations. The subject of the investigation is the action that takes place in the so-called dark space surrounding the negative pole in a Geissler tube; these rays are capable of penetrating thin metallic partitions; in Mr. Lenard's apparatus he seals a small hole or window in a vacuum tube with a thin piece of aluminium foil, through which the cathode rays are passed normally, producing a faint glow outside of the window visible to a distance of 5 centimetres; substances which become phosphorescent in ordinary vacuum tubes glow brightly in the air to distances up to 8 centimetres from the window; he concludes that cathode rays are a phenomenon in the ether and are independent of the presence of matter; the paper is of considerable interest, and does not admit of being abstracted.

Electric Transference of Heat.—In an editorial in the Lond. "Elec. Rev.," March 23, attention is called to the fact that the difference of potential between a conducting body and iron depends on whether the latter is magnetic or non-magnetic, and calls attention to a recent Academy paper by Mr. Houllevigne, in which he examines this phenomenon; the paper is briefly described, but the explanation is not quite clear; it appears that a magnet placed in the neighborhood of one of the junctions of a copper iron couple modifies the difference of potential; as no current can be produced, there being no energy consumed, the variation of the E. M. F. must be compensated in the rest of the circuit, which compensation occurs in the magnetic parts and is assumed to be in the nature of a continuous variation of the potential between the sections which are unequally magnetized, a conclusion which has been tested experimentally in that paper.

Compensating Electromotive Forces.—An Academy paper by Mr. Schuerr on "Means for Compensating the Electro-

motive Forces of a Cell," is abstracted in "L'Elec.," March 17; the object is to find if it is possible, with the aid of other local couples, to compensate for the various E. M. Fs. of a cell.

Capacity of Leyden Jars in Series.—The Lond. "Elec. Rev.," March 23, explains the apparent disagreement between several writers.

Condenser.—A theoretical discussion from the Italian by Mr. Lori of a condenser made of cylinders which are not coaxial, is given in "La Lum. Elec.," March 24.

MAGNETISM.

Magnetization of Soft Iron.—A translation of Mr. Joubin's paper, mentioned in the Digest Feb. 24, is published in the "Phil. Mag." for March.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Testing Iron of Transformers.—In an article by Mr. Feldmann, in the Lond. "Elec.," March 23, he gives the following formulas for the eddy current loss per cubic centimetre, as determined from Fleming's values:

$$\left(\frac{b p \mathfrak{D}}{2.5 \times 10^6}\right)^2 \text{ watts for sheets,}$$

$$\left(\frac{b p \mathfrak{D}}{4 \times 10^6}\right)^2 \text{ watts for wires,}$$

in which b is the thickness or diameter in millimetres, p the frequency, and $\mathfrak{D}$ the maximum induction. These he verifies experimentally by calculations from different sets of tests, giving the results in a number of tables; he believes the method to be one for workshop use; he thus shows good reason for believing that the formulas at present in use agree with results of observation. Editorially a source of error not alluded to in this paper is pointed out—it is questioned whether it can safely be assumed that the reading of a Cardew voltmeter is a measure of the maximum voltage; in the above case this appears to have been so, but it is recommended not to assume this in every case without some experimental determinations of the shape of the wave.

Testing Iron.—A correspondent in the Lond. "Elec.," March 23, asks how Mr. Parsons in his method, explained in the Digest last week, obtains equal induction in the two samples; as he explained it, a core of laminated brass would appear to be excellent material for a transformer.

Brilliance of a Candle Flame.—According to a paper by Mr. Glau, from "Wied. Ann.," mentioned in the Lond. "Elec.," March 23, the luminosity of a candle can be calculated directly from its flame; he found that the height of the flame was not the only factor determining the brightness; also that a stearine candle 5.88 centimetres in circumference had a higher luminosity (candle power?) than another 6.49 centimetres in circumference; he found that the ratio of the volume of the flame to the illuminating power was very nearly constant, the difference between the calculated and the observed results being never greater than 3 per cent.; from this it follows that equal volumes of the bright flame of any two candles give out the same light; editorially, it is stated that the mean projected area of the luminous part of a standard candle flame is about half a

square inch and the brilliancy is therefore 2 candle power per square inch.

Voltmeter.—The "Elek. Zeit.," March 22, gives a short illustrated description of an improved gas voltameter intended for currents up to 0.2 ampere; the hydrogen alone is measured, as the absorption of the oxygen by the liquid introduces errors; the accuracy is said to be very great, the difference between the measurements made by it and by the silver voltameter being only 0.05 per cent.

Recording Voltmeter.—A translation of the description of the Raps instrument, mentioned in the Digest Jan. 27, is given in abstract in the Lond. "Elec.," March 23, including four of the most important illustrations.

Influence Machines.—The two forms of the improved machines of Mr. Bonetti are illustrated and described in "L'Elec." March 17; it will be remembered that there are no sectors in these machines and that the number of brushes is increased, by which modifications the output of the machine is considerably increased, but it is no longer self-exciting. The "Bul. de la Soc. Int." for February contains a description of this machine by Dr. d'Arsonval, but without an illustration.

Simple Thomson Galvanometer.—A very simple form is described and illustrated in the "Elek. Zeit.," March 8, which may be used with the reflected beam or telescope.

DYNAMOS AND MOTORS.

Electric Motor in Aeronautics.—In an editorial in the Lond. "Elec. Rev.," March 23, belief is expressed that electricity offers the most promising prospects of immediate results, the electric motor being the easiest of all to develop the required degree of lightness and power; attempts to provide steam or explosive motors will prove costly if not futile; "a minimum of 10 pounds weight per horse power, and at most 15 pounds, has been calculated as necessary" (whether this means that 10 to 15 pounds is the maximum or greatest weight which a motor and source of power may have per horse power hour is not quite clear); reference is made to obtaining the current from a sort of trolley wire, a device mentioned in the Digest some time ago; Trouve has succeeded in developing energy in a small motor at the rate of 1 h. p. for each 7 pounds (but it does not state the total weight or total horse power); neither gas nor steam motors have done any better.

Alternator.—It is explained in the Lond. "Elec.," March 23, that the ring in the alternator, described in the Digest March 31, is not a solid casting of steel, as was stated in that article, but that it is built up of sheet iron; in a test of a 275 kw. alternator the loss was 6,000 watts for hysteresis and Foucault currents.

ARC AND INCANDESCENT LIGHTS.

Theory of Electrical Projectors.—The articles by Mr. Blondel, abstracted in the Digest Dec. 3, 1893, and Jan. 6, 1894, have been published by Lahure, of Paris, in a more extended form as a pamphlet; a long list of articles and works on this subject is given in an appendix.

TRANSMISSION OF POWER

Series Transmission of Power.—In the "Elek. Zeit.," March 8, Mr. Schultz, after mentioning the advantages of series traction, among which are the greater torque and the fixed positions of the brushes, describes several small installations in Germany, which have been in operation for some time; in all of these there is but one generator and one motor; it seems that telegraphic communication is necessary for signaling from the motor to the generator; for starting the motor, the motor and generator are connected in circuit, and the generator is then started; notwithstanding considerable loss in the line there is practically no variation in speed for very great differences of load; with a 50-volt loss on a 600-volt circuit, the efficiency with a 24-h. p.

installation is 75 per cent. In another the motor is at a pumping station 1,000 feet distant, and is operated entirely from the generator end, there being no attendant at the motor; in another case the series motor is at times coupled in parallel with a steam engine, a combination which is said to work very satisfactorily; a further advantage of the series machines is that the neutral zone of the armature does not shift with varying loads.

ELECTRIC RAILWAYS.

Board of Trade Regulations.—The London journals of March 23 publish the regulations which the Board of Trade has decided to prescribe regarding tramways worked by electricity; the proposed regulations were published some time ago, the present form being the final modification. The Lond. "Elec." and the Lond. "Elec. Eng." also publish the proposed regulations for the electric underground railways in metal lined tunnels. Both of these sets of regulations are too long to be given here and are not of a nature to admit of being abstracted. Editorially, the Lond. "Elec." states that in scarcely a single instance can the interests of electric traction be said to have suffered by the amendments made to the proposed rules; the general effect of the regulations is to compel the use of feeders; the maximum earth current is increased from 2 amperes to 10 per line, and a current equal to 5 per cent. of the total output of the station is permitted as an alternative; one main purpose of the regulation is to insure that if any leakage passes through the earth it shall enter gas and water pipes and not leave them, except through proper metallic conductors, thus avoiding corrosion; an important concession is the allowance of 15 per cent. increase in the fall of potential in regulation instead of 5 volts. The rules are also discussed editorially in the Lond. "Elec. Eng.," where the opinion is expressed that electric traction interests have no ground for objecting to the rules as they now stand.

High Speed Railway.—A recent paper by Prof. Ziperowsky on the proposed Vienna-Budapest line is abstracted briefly in the "Elek. Zeit.," March 8. He claims that speeds of 120 to 150 miles per hour are practicable, but limits himself to a speed of 72 miles, the total distance being 167 miles; with a single track and a single passing point at the middle of the route, a train can be dispatched in each direction every one and a half hours; with three such passing places, the number of trains is doubled; with four motor cars running continuously 1,000 h. p. will be required, produced by two stations of 300 h. p. each; for the transmission he suggests 10,000 volts, which are transformed at 50 stations to the 500-volt line current. The present scheme is a modification of the one described in The Electrical World Oct. 10, 1891, and appears to be a more possible one.

The article mentioned in the Digest Feb. 24 is contained more at length in the "Bul. de la Soc. Int." for February.

Waterloo and City Railway.—According to the Lond. "Elec. Eng.," March 23, the construction of this railway is about to be begun; it will be about a mile and a half long, connecting the Waterloo station with a point in the eastern centre of London; the description is confined entirely to the civil engineering features; it will be somewhat like the City and South London underground railway, an important difference being that the tunnels will be 12 feet in diameter in place of 10; each car will carry 50 passengers, and each train will be composed of seven cars; where it crosses under the river it will be 60 feet below high water; one terminal will be 63 feet deep and the other 55 feet; it is estimated to cost two and a half million dollars.

Conductor Rail System.—According to the Lond. "Elec.," March 23, a line will be run in Lyons connecting the centre of the town with the Exhibition, in which a conductor rail is used, connected in circuit by magnets laid underground;

the system is that of Claret & Vulleumier, and is said to have been used successfully at Clermont; no further information is given.

Electric Tricycle.—The Carli vehicle is illustrated and described in "La Nature," March 10; it contains a battery of 10 cells, each of a capacity of 100 ampere hours, making a total of two kilowatt hours; a cell weighs 11 pounds, contains 5 horizontal plates and can be discharged at 5 amperes; the total weight is 352 pounds; the motor takes 550 watts; it can therefore run for four or five hours and can also be used to recharge the accumulators; he charges the accumulators with very small currents during a long time, which enables him to use primary batteries; for starting or for a sudden demand for power, there are a set of rubber springs, which can be stretched by hand or during a run, and which are applied by means of a catch; their force is sufficient for running about 150 feet.

Electric Omnibus.—"Ind. and Iron," March 16, contains an illustrated description, the illustrations of which, however, show only the exterior, of the omnibuses which are to be run in London by means of storage batteries; little data are given.

Cars Driven by Gas.—The Lond. "Elec.," March 23, quotes from a German gas journal, in which Prof. Gostkowski claims that a gas car is 24 per cent. cheaper to run than an electric car; that the latter, with overhead wires, has a past, while the gas car has a future; no further information is given.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Parallel Working of Long Lines.—The discussion of Mr. Mordey's paper (see Digest, March 31) is published in the Lond. "Elec.," March 23. Mr. Raworth claimed that the peculiar phenomenon which Prof. Forbes pointed out was not an alternating current effect at all, nor was any electricity involved in it; under the circumstances nothing could happen but hunting; the same thing would have happened if the two engines had been connected by a thin rubber belt over the two flywheels, in which case the slack would have occurred at the top and bottom in regular pulsations. Mr. Sparks said that the synchronizing current depended wholly on the inertia of the moving parts, and that if the speed varied very much during the revolution a very large current was found necessary. Mr. Kapp criticised the analogy with flexible teeth; regarding the V curves (see Digest April 1, 1893), he said they were exceedingly useful if drawn in their entirety; if, in a transmission plant, the resistance of any circuit was small and the self-induction large, the left branch of the V became vertical and then turned over, while the right branch sloped out to a great extent, so far that the machine could not take the great current indicated, on account of heating; in a transmission plant it would be better to excite a little above the point which Mr. Mordey rightly considered the best theoretical point, namely, the bottom of the V; the curves were taken while the machines were running idle and did not represent the true shape, which would be more round at the bottom and the arms would be more curved; if the resistance is small and the self-induction large, it would be advisable to excite the motors higher than the generator in order that they might work at that branch of the curve which sloped indefinitely. He called attention to the fact that in most installations there must be a margin of power which might be gotten by exciting the motor more than the generator, always supposing the line resistance to be low; he mentions an installation in which he had specified three cranks and in which the expansion of each cylinder was adjusted separately. Prof. S. Thompson called attention to a possible importance of a common steam supply to the engines when alternators were running in parallel.

Compound Alternators in Parallel.—In the Lond. "Elec.," March 23, Mr. Mix calls attention to a recent incorrect statement that the Thomson-Houston compound alternators will not work in parallel; in the station at St. Brieuc, two 70-kilowatt alternators over-compounded for 25 per cent. are coupled in parallel regularly and in the most satisfactory manner; they are driven from the same line of shafting; in one case, due to an accident, in which two wires were crossed, the machines were paralleled for three months when they were 180 degrees out of phase, but they immediately came into phase with only a slight flicker of the lights; in another case the exciting current of one dynamo was diminished to a minimum and the other increased to a maximum, and there was not the slightest tendency of the machines to get out of phase; the same was true when the compoundage was changed in one or the other.

Hydro-Electric Installation.—In the Lond. "Elec. Eng.," March 23, is given a brief description taken from the Lond. "Engineer," of the installation at Antwerp, based on the Van Rysselberghe system; as has already been described in these columns, it consists in the transmission of energy in the form of water under pressure and the transformation into electric energy at various distribution centres in the city; the pressure used is 52 1-2 atmospheres; the length of the distributing pipes will be about 7 1-2 miles, and there will be 10 district stations, each embracing a radius of 1,640 feet; very little is said of the electrical features.

Bockenheim.—A translation of the description of the polyphase installation mentioned some time ago in these columns is given in abstract in the Lond. "Elec. Eng.," March 23.

Electric Motors in Berlin.—A list of the motors, classified according to their purpose, is given in the "Elek. Zeit.," March 8; out of a total of 386 motors, representing 1,085 h. p., 98 are used for ventilation, 74 for printing machines, and 51 for elevators.

Balancing a Three-Wire Station with Only One Machine.—The correspondence on this subject is continued by Mr. Gibson in the Lond. "Elec. Rev.," March 23; he claims that the example of Mr. Thursfield is an extremely rare case, and does not see anything worth considering as a serious practical objection; he works out an example.

Laval Steam Turbine Dynamo.—"Ind. and Iron," March 23, gives a short illustrated description of the 5.5-h. p. combined turbine and Oerlikon dynamo; the speed is reduced from 30,000 to 3,000, the drop in speed is only 4 per cent. from no load to full load, a three-hour test showed a consumption of 570 pounds of steam, equal to about 34.5 pounds per horse power hour.

Accounts.—In London "Lightning," March 15, is given a method of keeping central station accounts; a schedule is given for weekly reports.

Switch for Circuits Containing Self-Induction.—Mr. Mueller, in the "Elek. Zeit.," March 8, gives a well-illustrated description of a switch for disconnecting circuits containing a great self-induction, as, for instance, the field circuit of a dynamo; the principle of the switch is that just prior to opening the circuit an inductionless resistance is connected as a shunt to the self-induction circuit, so that the extra current is discharged through this resistance; by properly proportioning this shunt resistance, the intensity of this extra current can be limited as desired; if, for instance, it is made double that of the self-induction resistance, the induced voltage at the opening of the circuit will never increase to more than double its normal value; in closing the switch this shunt resistance is first opened; all these operations are accomplished by a single switch lever; one of these shunt resistances will suffice for a number of circuits, and it may be made small, as the current lasts but a few seconds.

Incandescent Lamp Drop Suspension.—A new form is illustrated in the "Elek. Zeit.," March 8, for an adjustable balance fixture, in which the difficulties with the securing of the cords and their insulation over the rollers are said to have been overcome.

Socket.—An improvement in the Edison socket is described and illustrated in the "Elek. Anz.," March 9.

WIRES, WIRING AND CONDUITS.

Underground Mains.—In a paper by Mr. Clirehugh, reprinted in the Lond. "Elec. Eng.," March 16, and abstracted in the "Electrician," March 16, he discusses chiefly the various insulating materials. Gutta-percha is not suitable; india rubber he recommends very highly; for making joints with pure rubber he recommends that after 20 or 30 are ready an experienced vulcanizer should be employed to vulcanize them; the only objections to india rubber are its high price and the difficulties of making joints; he warns engineers against purchasing low priced rubber cables; the bittite used by the Callender company is believed to be bitumen refined to purity and vulcanized; the jointing is very simple; he gives no opinions regarding it; it is used chiefly for low tension currents. A table is given showing the cost per yard for a number of different systems, but being in English prices it is of little interest to Americans. Regarding another class of cables, in which the insulating material must be protected by a metallic envelope, he is decidedly of the opinion that such cables answer equally well if treated with sufficient care, the price being lower than that of rubber. He believes it is better not to insist on too high an insulation, but to insist on its being uniform, high insulation being often obtained at the expense of the life; such cables should be tested after immersion with at least double the voltage for which they are intended; such cables should be taped or braided when drawn into pipes and if heavy should be lubricated, for which there is nothing better than soft soap; a good temporary way of sealing the end of a cable is to tape it with dry cotton tape and plunge it into hot pitch; the difficulties in connection with such cables are largely overrated, and with good care they are as good as india rubber cables, the jointing being simpler; he thinks paper insulation has an advantage in the cleanliness of the jointing; its power for resisting disruptive discharges is very high, 1-4 of an inch being sufficient to stand 20,000 volts, which he thinks no other dielectric will stand; regarding the Brooks oil insulation resistance, which he describes, he points out the difficulty in getting the oil out to make a joint; it might be suitable for feeders, but not for distributing mains. Armored cables are not as cheap as is often supposed; they may be good for outlying districts, but there are many objections to their use, the principal one being the difficulty in fault finding; in conclusion he describes the Crompton system of uninsulated mains.

Underground Mains.—A paper by Mr. Rider is reprinted in the Lond. "Elec. Eng." and "Elec. Rev.," March 16, and abstracted in the Lond. "Elec.," March 16; he discusses the subject in general, giving, however, nothing new. On the distributing mains from the feeding point to the houses there should not be a loss of more than 2 per cent.; in an ordinary business street the feeding points should not be more than 750 feet apart; in no case should a feeder supply more than one feeding centre, as it would then be impossible to regulate for the loss in the feeder; each feeder should be regulated independently; a drop of 10 to 20 per cent. may be allowed for the feeders; he recommends a combined system for feeders, in which some lines are buried permanently and other portions are drawn in through tubes; regarding alternating current lines he states that there is only one perfect cure for the induction of the wires on each other, and that is to make them concentric, he thinks too little attention has been given this and that there is a great unknown

waste of power in such systems, being equal, he believes, to the magnetizing current losses of the transformers; he shows from some recent specifications how little this subject is understood even by capable firms; in a cable made by Siemens, three separately insulated conductors are twisted together, and then covered with lead and armored; the effect of the twisting is the same as making them concentric, while the making of joints becomes much simpler; he mentions a system in which there are only two primary wires, but three secondary wires, forming a three-wire system, the middle wire being connected to the middle of the secondary; bare wire conductors should be used only for continuous low tension currents, for if used with alternating currents it is practically impossible to avoid induction effects; the insulation resistance in these, he says, is often a minus quantity.

The discussion of the above two papers is published in the Lond. "Elec.," March 23. Mr. Wordingham thought the difficulty of vulcanizing joints had been exaggerated, as there was very little difficulty in vulcanizing joints properly. Mr. Mountain thought cables which were insulated with bitumen, paper or fibre might be very good for low tension mains, but were unsuitable for high tension works unless laid with great care and great expense; if cables were laid in ground where there were traces of ashes he had found considerable trouble. Mr. Taylor also thought the difficulty of making rubber joints had been overestimated. The discussion is given somewhat more in detail in the Lond. "Elec. Eng.," March 23.

Conductors for Mines.—The Lond. "Elec.," March 23, translates a paper by Mr. Libert from a Belgian journal, describing cables for mines in which firedamp exists and where it is necessary to avoid the possibility of a spark. Concentric conductors, when well insulated and covered with a strong armor, may suffice for most cases; the safety might be increased by running them in iron pipes to avoid crushing. He describes the Atkinson, Charleton and the Noblet cables, in which instead of a simple protection, arrangements are devised by which the sparks are produced in closed chambers; in the latter, which he describes and illustrates more at length, and which he appears to recommend, there is a central auxiliary wire traversed by a current in a different direction from that of the concentric main conductor; each cable is divided into sections and connected by sliding caps, such that when the cable is stretched, the auxiliary wire is broken first, and by means of electromagnets in circuit, the main current is immediately disconnected; in case of the cables being crushed, the auxiliary and main wires come in contact, which causes a current to pass through the electromagnets, resulting in the opening of the circuit; two illustrations are given of this cable.

Fusible Cut-Outs.—In the second part of Mr. Anney's article in "L'Ind. Elec.," March 10 (the first part of which was abstracted in the Digest March 31), he discusses fuses which are contained in glass tubes mounted at the ends with metallic caps, contacts being made with spring clamps; for 1 to 2 amperes extremely fine silver wire is used, for 5 amperes a copper wire between Nos. 32 and 33 B. & S. gauge, and for any multiples of 5 a corresponding number of these wires are used in multiple; the advantage over lead is that the mass of metal is much less, producing less of a shock on fusion. Regarding the material for the base of such fuses he states that wood is out of the question, slate absorbs moisture and is apt to contain conducting substances, hard rubber changes its shape and carbonizes under the influence of the heat, vulcanized fibre absorbs moisture, glass is very good but is difficult to manufacture, marble is an excellent material if there are no veins through it, faience has the advantage of being cheap, but is too porous, being apt to absorb moisture, and the glaze with which it is covered decomposes by the heat of the fuse; porcelain, he

says, is the only material which most nearly meets all the required conditions.

Steamship Lighting.—In the Lond. "Elec. Rev.," March 23, Mr. Mavor explains that Mr. Kennedy confuses single wiring with concentric wiring and that he recommends the latter.

Bronze Wires in Telegraphy.—The "Elek. Zeit.," March 22, contains an article by Mr. Mueller, forming a part of the discussion on this subject.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Simultaneous Telegraphing and Telephoning.—In the "Elek. Zeit.," March 8, Mr. Christianie discusses the well-known method in which the relays are wound with a double winding, thus having the additional property of an induction coil, so that both telegraph and telephone currents can be sent through it; he states that many difficulties are involved in such a system, even though the principle is very simple, but it can be used to advantage for telephoning in the unavoidable intervals between telegraphic dispatches; the complete connections for such a system are given.

Telegraphing Without Wires.—In "Cosmos," March 3, Mr. Michel illustrates and describes a method in which both circuits are through the ground, being through different strata of the earth, having a more or less good insulating stratum between them; he has been able to speak for a distance of about 400 feet, while telegraphic signals can be sent through 1,500 to 3,000 feet.

Telephone in Germany.—A long paper by Mr. Muench, describing the evolution of the telephone system in Germany, is reprinted in full in the "Elek. Zeit.," March 22. From the statistics which he gives, it appears that Berlin has the greatest number of subscribers of any city in the world, there being 20,949, next come Chicago with 9,684 and then New York 9,066, Hamburg 8,303 and London 6,700.

Telephone Switchboard.—The Mix and Genest switchboard, which was adopted several years ago by the German Government, is described quite fully, with the aid of thirteen illustrations, in the "Elek. Zeit.," March 22; an abstract would be of very little use; the illustrations are very clear; it will be remembered that this system was adopted after careful comparison with the others in use and is praised very highly. Several systems and details of other switchboards are given in "La Lum Elec.," March 24.

Communication with Lightships.—According to the Lond. "Elec." and "Elec. Eng.," March 23, the first permanent lightship cable has been successfully laid and communication established with the Kentish Knock Lightship.

Multiple Telegraphy.—The "Bul. de la Soc. Int." for February contains a very long illustrated paper by Mr. Baudot (whose system is used largely in France).

Controlling Signals.—A well illustrated paper by Mr. Prasch on a new method is published in the "Zeit. fuer Elek.," March 15.

ELECTRO-CHEMISTRY.

Electric Preparation of Tungsten.—According to the Lond. "Elec. Rev.," March 23, the Krieg process consists essentially in preparing the chloride by using electrodes composed of scheelite or wolfram and carbon for the production of an arc in the presence of chlorine; the chlorides are extracted in the form of sublimates, from which tungstic acid is prepared by treatment with hydrochloric acid, which decomposes the tungstic chloride and other metallic chlorides; the tungstic acid is freed from silica by means of "electrization," and is finally made into electrodes with carbon and reduced to metal in a closed electric furnace.

Rhodium.—According to London "Lightning," March 15, recent experiments have shown that rhodium is ad-

mirably adapted for electroplating copper and iron, the former taking the metal more easily and the latter acting better when oxidized; a suitable bath consists of 100 grams of rhodium sulphate dissolved in one litre of water, to which is added 100 g. of ammonium fluosilicate, 100 g. of ammonium chloride and 50 g. of ammonium cyanide.

Separation of Cerium.—An electrical process for separating cerium from lanthanum and didymium is briefly described in Lond. "Lightning," March 15.

Steel Plating.—A process of plating copper and zinc plates for printing, with iron, in order to increase the number of impressions which can be taken from them, is described in "L'Elec.," March 17.

Circulation of the Electrolyte.—In London "Lightning," March 15, Mr. Gibbings states that he has found it extremely important to provide for an absolute steady circulation of the electrolyte in the deposition of copper, and calls attention to the importance of such circulation in accumulators; he claims to have devised an apparatus for providing such circulation, but does not describe it.

Purification of Sewage.—The Hermite process is discussed in "Ind. and Iron," March 23, where attention is called to impurities in the air in the sewers which may not be purified by the liquid; also that materials like paper absorb considerable of the chlorine without being disintegrated, thus representing a considerable amount of useless work. "Ind. and Iron," March 16, gives a number of illustrations of the plant and details as installed in the city of Nice; the description contains nothing new.

In the abstract in the Digest, March 31, the statement that the positive terminals were made of "rods of brass wrapped with platinum gauze" should read "rods of glass," etc.

Theryc-Oblasser Accumulator.—In the Lond. "Elec. Rev.," March 23, Mr. Everard gives the results of a test, giving 33 ampere hours and 64 watt hours per kilogramme of plates, the total discharge being 156 ampere hours, the total weight of plates 6 kilogrammes and the discharge rate 7.1-2 amperes per square foot of positive surface.

Accumulator.—A modified form of Plante accumulator is described and illustrated in "L'Elec.," March 17; the plates are made of pieces resembling an ordinary comb, the teeth of which fit into each other.

Plane of Polarization.—The Lond. "Elec. Eng.," March 23, abstracts briefly an article by Mr. Humburg, from a German chemical paper on the "Electromagnetic Rotation of the Plane of Polarization of Acids."

Polarization of a Thin Metal Partition.—The second paper of Mr. Daniel is published in the "Phil. Mag." for March.

Chemical Action of a Reversed Electrolysis.—The Lond. "Elec. Rev.," March 23, discusses the subject briefly, with special reference to Prof. Armstrong's views.

MISCELLANEOUS.

Electricity in Animal Life.—A paper by Mr. Solvay on electricity in the phenomena of animal life is begun in "La Lum. Elec.," March 17.

Phonograph and Microphone in Medical Studies.—The Lond. "Elec. Eng.," March 9, calls attention to a recent paper by Dr. Macintire, in which he expresses the belief that the phonograph will soon be used in medical teaching; he has been able to record a number of cough and heart sounds; he exhibited microphones for enabling a number of students to listen to the sounds of a body which may be in a hospital at a distance.

Educational.—Under the heading of "A Technical Utopia," the Lond. "Elec. Rev.," March 23, describes the Currie Engineering School, which it praises very highly; three full pages of illustrations accompany the article. The same

number contains a short description of the Telegraphists' School of Science. The course at the Institute at Frankfurt, Germany, is given in the "Elek. Zeit.," March 8. The course of the Mechanics' School of Electricity in Vienna is given in the "Zeit. fuer Elek.," March 15.

Thermo-Pile.—The present form of the Guelcher thermo-pile, as now made in London, is described and illustrated in the Lond. "Elec. Eng.," March 23; it is claimed that with 66 elements, having an internal resistance of 0.65 ohm, a current of 3 amperes at 4 volts is obtained when the external and internal resistance are equal, the consumption of gas not exceeding 0.064 cubic foot per hour, which corresponds to about 10 1-2 cubic feet per kilowatt hour of useful energy, bringing the cost down to an exceedingly low amount.

Tempering.—As the edge of knives and scissors should be hard and the rest of the blade sufficiently soft to be elastic, the "Elek. Anz.," March 22, suggests that the Lagrange & Holo process for tempering might be used to advantage, only the edge of the blade being immersed in the liquid and brought to a red heat.

Biographical.—A biographical sketch of Hiram S. Maxim is published in "Ind. and Iron," March 23.

The General Electric Company at the Midwinter Fair.

The representation made by the General Electric Company at the Midwinter Fair, while, of course, considerably less important than that made by them at Chicago, from the point of view of mere quantity, is still the most important among the electrical exhibits which are now supposed to be delighting our Western brothers by the Golden Gate. The display of its purely mechanical exhibit is made in the Palace of Mechanical Arts, and the space allotted is occupied by many of the later types of its machinery, apparatus and instruments, the major portion being devoted to a fine exhibit of electrical mining and power transmission apparatus.

The chief use of electricity on the Pacific coast is to transmit power to the cities and towns for railway and lighting work, and to the mining centres for the operation of the different electrical mining apparatus, such as drills, crushers, pumps, etc. The field of power transmission is very wide in the states west of the Rockies, where coal is extremely costly, but where, on the other hand, there are many available water-powers which are fast being utilized.

Among other apparatus the General Electric Company exhibits the following:

A three-phase rotary four-pole transformer similar in design to those now in use at Redlands, Cal., and to those which will be used at Niagara Falls. It resembles a continuous current transformer in which the primary and secondary are wound on the same armature. It is wound for a potential of 200 volts at the receiving or motor brushes, while the potential of the three-phase current is 500 volts.

The most important feature is a complete three-phase power transmission plant. The generator is of 35 kw. capacity, and is driven by means of belting by a 35 kw. bipolar motor. The current of the generator is led to a switchboard containing the usual set of instruments, such as Thomson-Houston indicators, recording wattmeters, switches and fuses, and the "line" is carried on oil insulators, after having been transformed in the step-up transformers from a potential of 300 to one of 6,000 volts, to the switchboard of the receiving station. Step-down transformers are there employed, which reduce the voltage to 300, under which pressure the current is delivered to a 10-h. p. three-phase motor, which is belted to what is generally termed a "drill" generator, a dynamo having rotary brushes, used to operate percussion drills. The drill exhibited is of the General Electric percussion drill type. Connection is made by

means of a cable armored for its better protection in mine work.

A 10-h. p. mining locomotive, 24-inch gauge, and equipped with two 500-volt iron-clad motors, also forms part of the exhibit. This locomotive is well adapted for mine work, as it is built very low, for entrance into low gangways. The seat for the motorman is in front, and all operations, such as starting, stopping, reversing, applying sand to the rails, etc., can be quickly done, the handles on the levers for these operations being all within easy reach. Two 16-c. p. lamps in a reflector form the headlight.

Portable mining outfits are also shown, one consisting of a special motor running a swivelled diamond drill by means of bevel gears, which can be thrown out of mesh so that a friction clutch allowing of connection of the motor to a hoist can be thrown in, the motor serving for the two different operations. On the same truck with this apparatus is also mounted a 3-kw. Edison motor, connected to a triple Gould pump.

There are also set up and in operation a rotary pump, driven by means of a rigid coupling from a 3-kw. Edison motor mounted on the same base, the pump delivering about 300 gallons a minute; another portable pump outfit, consisting of a 3-kw. T.-H. motor connected by two intermediate gears (the pinions being of rawhide) to a Gould triplex pump, delivering about 100 gallons a minute, the whole being mounted on a truck; a 10-h. p. sinking pump for deep mine work, perfectly water-tight. All these pumps are working with very little noise and vibration.

A board filled, in regular style, with instruments, such as wattmeters, indicators, fuse blocks, railway supplies, etc., a few fan motors, which attempt to make things lively by means of colored ribbons attached to their frames and floating in the air currents produced; a 24-inch projector, marine type; four large ball clusters on poles, containing each forty 16-c. p. lamps and two cubes of fifty-four 16-c. p. each, complete the exhibit so far as the Exposition space proper for the company is concerned.

A 200-kw. railway generator furnishes current for cornice lighting, the lamps being connected five in series, as well as for the motor of the tower elevators. This is driven by a double piston valve engine of the Joshua Hendy Machine Works, San Francisco, cylinders 14 inches by 18 inches, belt connected. This dynamo is on the opposite side of Machinery Hall, near the boiler house, where are also eight Thomson-Houston arc light machines, each of 50 lights. These are driven, four each, from two counter-shafts which in turn are belted, one to a Buckeye automatic cut-off slide valve engine of 200-h. p., 140 revolutions; cylinders 14 inches by 24 inches (the speed being controlled by the isochronal regulator); the other one to a 150-h. p. Russell engine of 100 revolutions, cylinder 13 inches by 20 inches, and fitted with the Russell automatic cut-off slide valve and flywheel governor.

The Annex shelters a 50-kw. Edison dynamo, supplying current for the electric fountain and the searchlight on top of the electric tower. This machine is belted to a 250-h. p. tandem I. F. Thompson slide valve engine, manufactured by the Golden State and Miners' Iron Works, of San Francisco. Nearby is a 6,000-light alternator, driven through the intervening medium of a countershaft from a 500-h. p. Corliss engine of 80 revolutions per minute, and cylinder 22 inches by 48 inches.

The searchlight on top of the electric tower is that which was exhibited at Chicago. It is a 60-inch projector with a Mangin spherical mirror, and is one of the largest in the world. The fountain is one of those which played at the World's Fair, and has been fully described in these columns. In its new position it is much better situated for display, and is not subjected to the violent competition of surrounding white buildings and blaze of light.

A Non-Arcing Railway Lightning Arrester.

The fundamental principles of the Wurts non-arcing lightning arrester, manufactured by the Westinghouse Electric and Manufacturing Company, are based upon the following facts:

1. That a static discharge will leap over a non-conducting surface, such as glass, wood, marble, etc., more easily than through an equal air space. If a pencil mark be drawn over this non-conducting surface the discharge will take place still more readily.

2. That a dynamo arc in order to be maintained must be fed by the fumes or vapors of its electrodes—conversely, therefore, that in order to avoid the formation of a dynamo arc between electrodes means must be taken to prevent the formation of these conducting fumes.

An electric spark which springs across an air gap does not pass like ordinary moving matter, gently pushing the air aside. Its passage is so instantaneous that the air is shattered, so to speak; the spark crashes its way through the air like a bullet through a pane of glass. If, however, the air be previously split—electrically split—the spark will pass with ease. A pencil mark over ground glass or a charred groove in a wooden surface forms an electrical crack or entering wedge through the air so that an electric discharge finds a much easier path over this surface and through this electrical crack than it does when it is forced to bore its own way through the air medium.

In the non-arcing railway lightning arrester the discharge



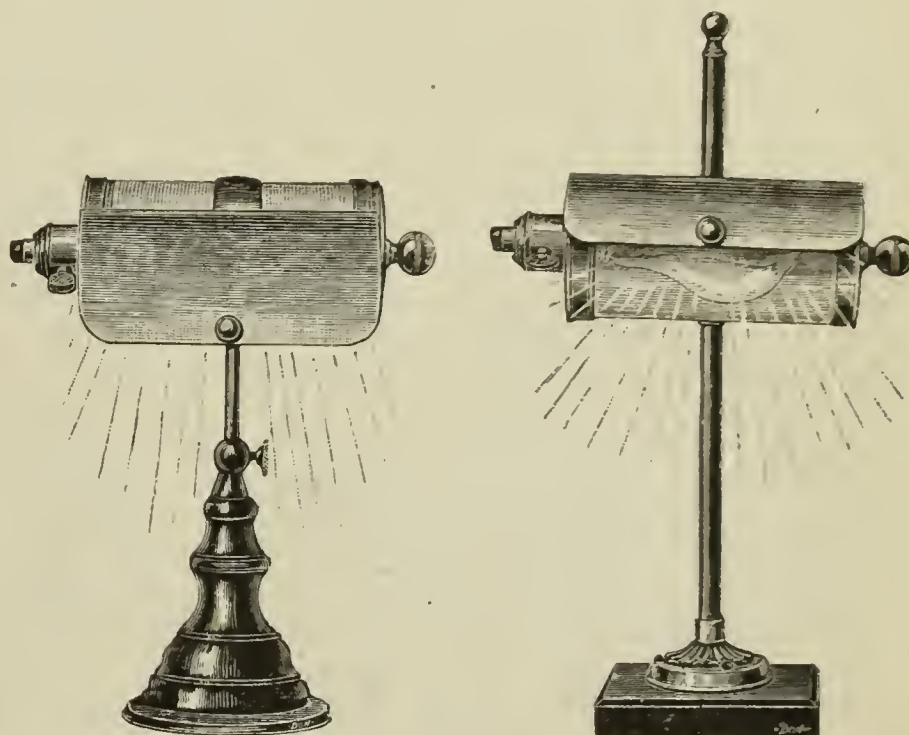
RAILWAY LIGHTNING ARRESTER.

is caused to pass between two brass electrodes separated by half an inch and over narrow grooves burned into a block of lignum vitae. It must not be understood that this charred surface in any way acts as a conductor in the ordinary sense of the word. The discharge takes place not by conduction, but by disruption, leaping between the electrodes and over the charred surface, the latter acting simply as an electrical crack through the air and thus greatly assisting the passage of the electrical discharge; neither does this charred surface leak dynamo current, for the ohmic resistance between the electrodes is more than 50,000 ohms. If now a solid lignum vitae block be firmly screwed down over the charred grooves and metal electrodes it will be impossible for conducting vapors to form and the device is at once a non-arcing lightning arrester.

The arrester, which is herewith illustrated, has been thoroughly tested, we are informed, during the past season in the western sections of this country, which are noted for their frequent and violent thunderstorms, and in every instance has proved all that is claimed for it.

New Form of Desk Light.

Since placing the Kinsman desk light on the market, which was designed for roll top desks, the manufacturers, McLeod, Ward & Co., 91 Liberty street, New York, have had numerous inquiries for lights of this style for other purposes, and have found it necessary to make a portable lamp for flat desks, etc. The illustrations herewith show two styles, Fig. 1 being of a somewhat more ornamental style than Fig. 2, although both present a very neat appearance. Both shades can be raised and lowered as desired in a

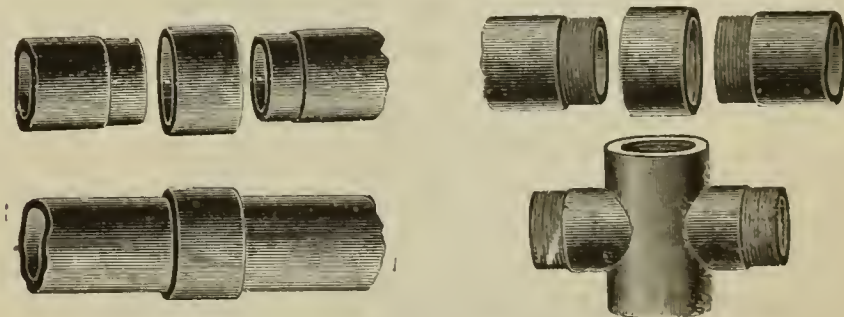


FIGS. 1 AND 2.—DESK LIGHTS.

similar manner to the ordinary portable. No. 1 is shown with the eye shade down, the rays of light being thrown directly underneath, while No. 2 is shown with the eye shade up, the rays of light from it being thereby thrown horizontally and perpendicularly. This eye shade is adjustable the same as in the desk light, the glass cylinder being revolved by a slight touch for the purpose of modifying the light, two-thirds of the glass being ground and one-third clear.

A New Conduit.

A fibre conduit for underground electrical purposes is being placed on the market by the Fibre Conduit Company, 45 Broadway, New York, and extensive preparations have been made for its manufacture on a large scale in view of the tendency, accelerated by the action of municipal governments, toward placing all electrical wires underground. The



FIBRE CONDUIT FITTINGS.

conduit is made of wood fibre, treated with an insulating and preserving compound, which produces a hard and solid substance, and is made into tubes by a machine designed for the purpose by Prof. Henry Fairbanks and Mr. Howard Parker, of St. Johnsbury, Vt. The tubes are completely saturated with the treating mixture, which has been prepared under the direction of eminent chemists. The fin-

ished pipe, in 5-foot lengths, is uniform in thickness, with smooth surfaces, and is made in a number of standard sizes, with the necessary regulation fittings (several of which we illustrate), section boxes, etc. Two standard joints are made, one a socket and the other a screw joint, and also, when required, a special socket joint which is wholly in the pipe, thus not increasing the outside diameter.

The weight of the finished product is less than one-third that of iron pipe of the same size. It is claimed that the conduit is practically imperishable when laid in the ground. As it is non-absorbent, it is not affected by acids or alkalis and does not contract or expand with varying temperature; it is, therefore, free from the splitting and checking, corrosion and disintegration, which injure wood and iron. Being a non-conductor, there is none of the electrolytic action, which, in many cases, affects metal pipe so seriously.

The material is tough, elastic and strong. Standard 3-inch pipe will safely bear a crushing weight between two plane surfaces of 800 pounds per lineal foot, and it will stand a pressure of 450 pounds at the centre of a 5-foot length supported at both ends. Its bursting strength is over 125 pounds per square inch. As to insulation, we are informed that conduits seven-sixteenths of an inch thick have been tested on a 20,000-volt alternating current without any perceptible effect. Moisture does not condense on the surface, as in metal pipes, and it is claimed that bare copper can be used in the conduit to great advantage and with any working voltage. It is easily cut with ordinary tools, and joints, fittings, etc., may be introduced at any point. The joints are both strong and tight, unlike those of some other electrical conduits.

A mill for the manufacture of the above conduit has lately been constructed at Orangeburg, N. Y. The factory is located on the West Shore, Erie, and Ontario and Western railroads, and has, therefore, fine shipping facilities, while the buildings are equipped with all the modern appliances and machinery run by electric power.

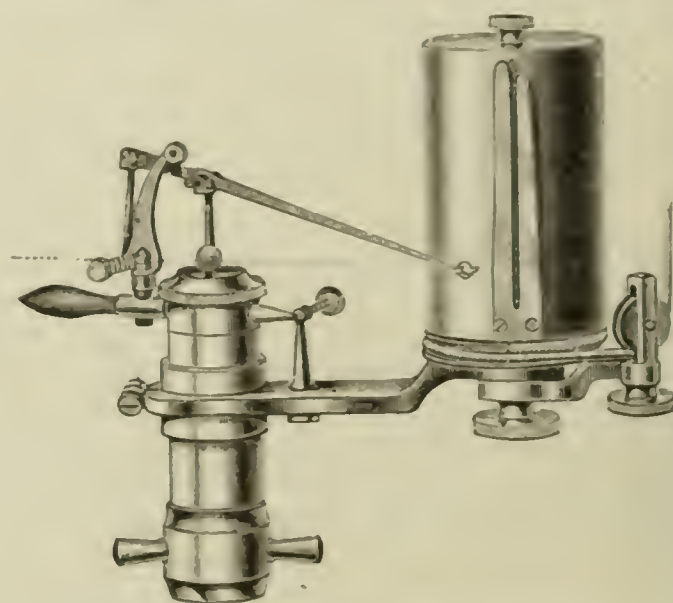
Improved Straight Line Indicator.

The peculiarity of the indicator illustrated, manufactured by the Hine & Robertson Company, 68 Cortlandt street, New York, lies in the simplicity of its parallel motion device, and in the auxiliary spring that allows it but one working surface, thus preventing the appearance of any backlash. These two features admit of lightness of the moving parts throughout and the placing of the guiding mechanism near the fulcrum, so that it may have little movement, thus reducing the momentum of the moving parts to such an extent that it is no longer a disturbing element at high speeds. The auxiliary spring prevents any looseness appearing, and thus impairing the accuracy of the indicator.

The guiding mechanism consists simply of a small cam fastened to the pencil arm, the face of the cam being held by the spiral spring, at *E*, against the roller. This roller has a fixed bearing on the upright, between the connecting rod and vibrating link, as may be seen from the same figure. The cam rocks upon the roller, and is so shaped as to cause the pencil point to move in a straight line. The guiding mechanism, it will be seen, is placed so near the fulcrum as to obviate a high surface velocity of the cam, and the moving parts simply rock back and forth upon each other, turning almost upon the same point of contact while taking a card of average height. This will give a perfectly straight line throughout the whole range of its movement. It will be noticed by reference to the cut that the two links will be parallel with each other at all points of the stroke, and that the lower pivots of these links will be always in a straight line with the pencil point, thus forming an exact pantograph, without depending on the piston rod for a guide. It will also be seen that the movement

of the pencil coincides with that of the piston at all times, a point of very great importance, which every intending purchaser should carefully consider.

The drum is made as light as possible, with a bearing at both ends, the drum spring being ground concave on the sides to avoid all frictional resistance in the drum. The drum spring can be set to any tension desired by first removing the drum, unscrewing the milled nut upon it, and loosening the thumb nut inside, when the spring may be tightened by turning the milled disc to any position. The groove for the cord is so arranged that there is but one turn of the cord on the drum, preventing the distortion when



STRAIGHT LINE INDICATOR.

the cord runs double. The springs are provided with heads that take a firm hold on the outer coils, leaving nothing but the free coils to do the work. These coils are ground in such a manner that the spring will stand compression to the fullest extent without showing any tendency to bind sideways. The piston rod is made hollow, and threaded to receive a swivel rod so that this pencil can be adjusted to any height on the drum.

A Wireman's Soldering Stick.

A convenience that will be appreciated by wiremen has been recently placed on the market by the Electric Appliance Company, Chicago, consisting of a soldering compound put up in the form of a round stick 6 inches long and 1 inch in diameter, and having about the consistency of sealing wax when cold. In making a joint, the Allen soldering stick, as it is called, is merely rubbed on the hot wire, when it melts, producing a bright surface, to which the solder adheres with great readiness. The advantage over soldering fluids in handling is obvious, as well as the gain in time, and the makers claim that, unlike many fluids, the compound will not corrode the joint or affect the surrounding insulation.

The great waste in soldering fluids from the manner in which they are often applied, and from the frequent overturning of bottles, and the deleterious action that often results, are all obviated by this new convenience.

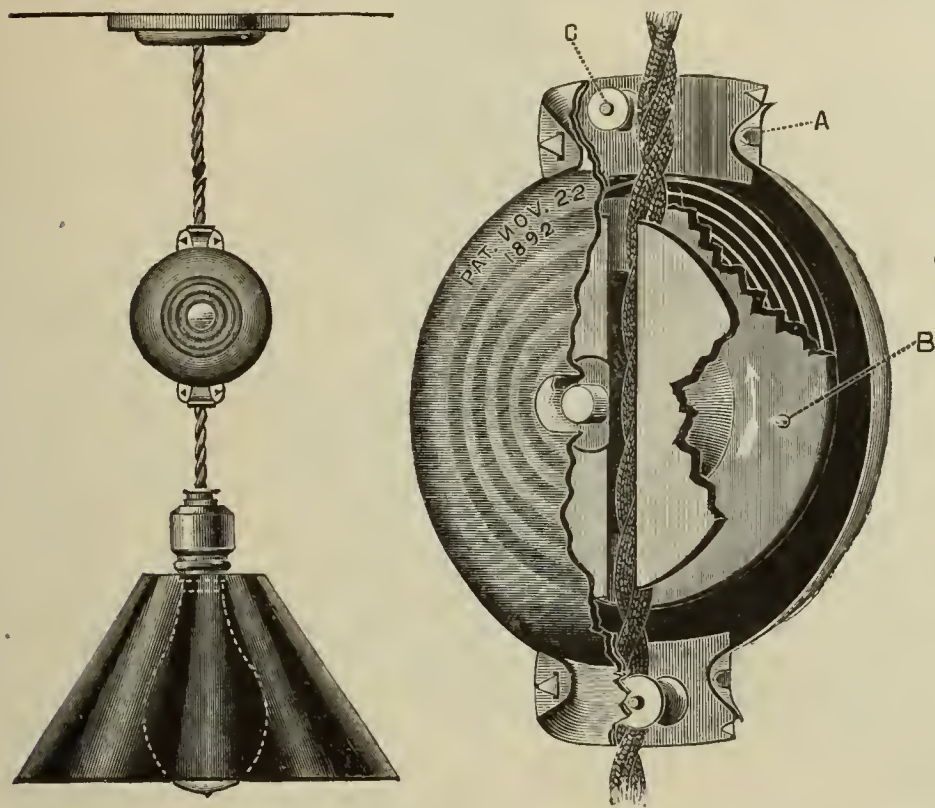
A Correction.

In an article on the Thomson recording wattmeter for arc circuits, printed in our issue of March 17, it was stated that the safety cut-out "is designed to close immediately on trouble occurring within the meter." This should have read "The cut-out is designed to close in case of any trouble on the circuit which the meter is measuring. On closing, this device cuts out both the meter and the lamps upon it and serves not only as a protection to the meter, but to the lamps which it is measuring. A rise in potential around the lamps,

which are being measured, sufficient to cause trouble will throw this cut-out into action and absolutely preclude any danger to the meter or its circuit."

Incandescent Lamp Adjuster.

The pendent lamp adjuster we illustrate, manufactured by Stephen Porter & Co., 384 Atlantic avenue, Boston, and

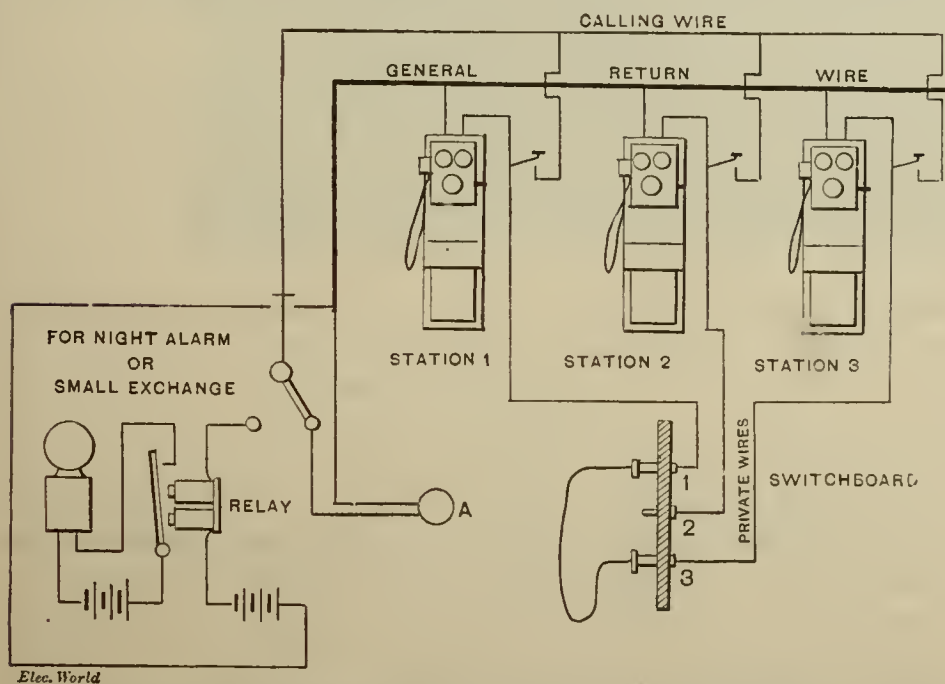


PENDENT LAMP ADJUSTER.

for which George L. Colgate, 136 Liberty street, New York, is selling agent, depends for its action on a spring instead of on that of a differential pulley, as with other forms of adjusters, thus reducing the wear on the conductor incident to the use of the latter. To attach the adjuster, one-half of the shell is removed and the conductor pressed into the slot shown. The shell is then replaced and secured by binding down firmly the four points, *A*. To adjust, if necessary, the spindle is turned back or forward the necessary number of turns and held in its new position by the pin *B* until the shell is replaced, when the pin is removed. Readjustment is only necessary in special cases, as the spring is properly adjusted at the factory for ordinary applications.

National Telephone System.

We recently described the little compound receiver tele-



NATIONAL TELEPHONE EXCHANGE SYSTEM.

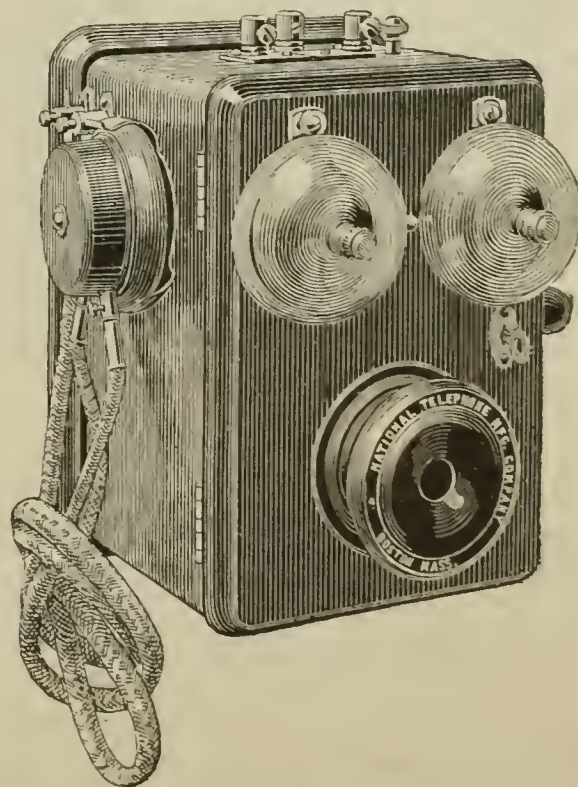
placed on the market by that company, comprising a receiver, transmitter and magneto bell, all in one box.

We also illustrate the telephone exchange system of the same company. One wire, as shown, is carried from the switchboard to each subscriber; a general return wire and calling wire, connected to the operator at *A*, gridirons the exchange territory, each subscriber tapping on to both of them. If the person at station No. 1, for example, wishes to talk to station No. 3, he takes the receiver from the holder, places it to his ear and pulls down the cord at the bottom of the bell box; this connects him with the calling wire leading to *A*, where the operator complies with the order to connect to No. 3 by making the necessary connection on the switchboard. When the cord in the station box is released by the operator a sharp click is heard, which is a signal that the call has been heard and the desired connection made. No. 1 can then ring up and talk direct to No. 3, the operator being cut out and unable to hear the conversation. While a grounded circuit can be used, the metallic circuit shown is, of course, far superior.

The Queen-LeChatelier Pyrometer.

Modern investigation and many of our modern industries demand an instrument for the accurate measurement of very high temperatures. A vast amount of experimental work in this line has been done by physicists and metallurgists in the past, their most noteworthy results having been achieved by the employment of the air or gas thermometer, which depends for its action upon the expansion of air instead of mercury, as in the ordinary forms of thermometers. The bulbs of these thermometers they constructed of materials like glass or platinum, whose melting points are very high. In the more recent experiments, however, porcelain bulbs were used. These air thermometers are not convenient or practical instruments, requiring, as they do, a great deal of subsidiary apparatus and the application of many corrections to the readings. With them, however, eminent scientists have done us invaluable service by establishing many fixed temperatures, such as the melting points of various metals. These may safely be relied upon in graduating other forms of pyrometers.

M. Le Chatelier, in constructing his pyrometer, has made use of these known melting points. It is based upon the principle of measuring the electric current generated by the heating of a thermo-electric junction. As modified by



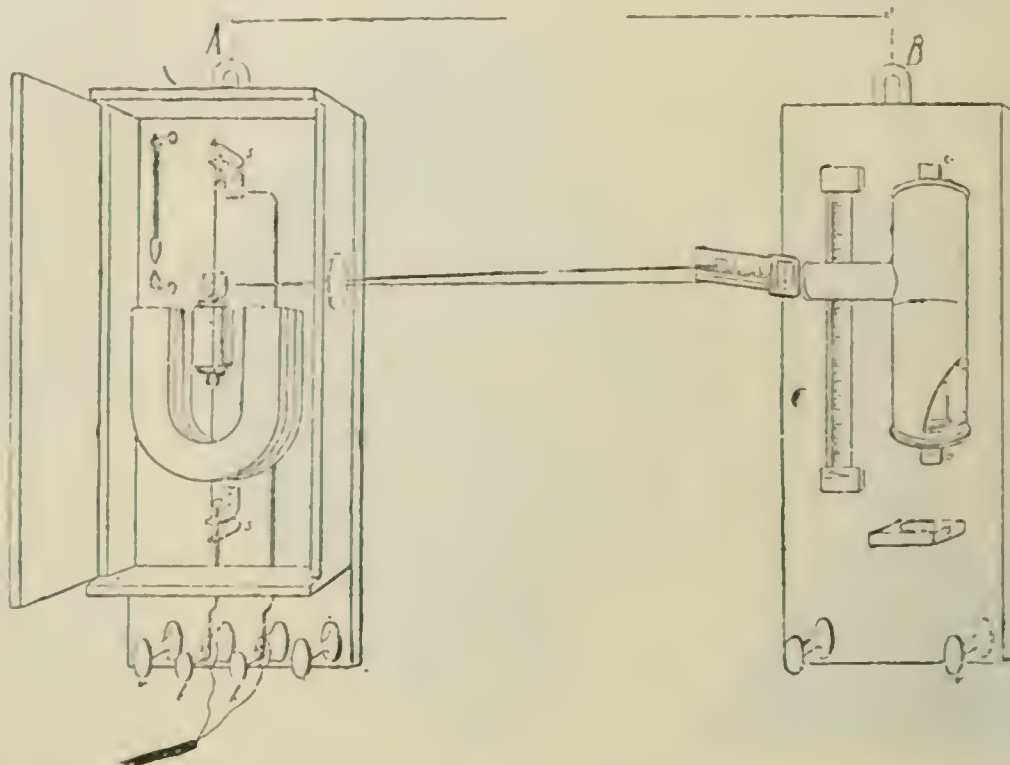
COMBINATION RECEIVER, TRANSMITTER AND MAGNETO BELL.

phone of the National Telephone Manufacturing Company, Boston, and illustrate herewith a new combination just

Queen & Co., it consists of a thermo-electric couple and a d'Arsonval galvanometer. The wires which compose the

couple are one of pure platinum, and the other platinum alloyed with 10 per cent. rhodium, both of which are perfectly homogeneous. For use, the couple, which has been first connected with the galvanometer, is inserted into a furnace or oven, when immediately a current is produced and measured on the galvanometer scale, from which the temperature is readily deduced.

The following advantages are claimed for this pyrometer:



FIGS. 1 AND 2.—IMPROVED PYROMETER.

First—It is adapted for a very large range of temperature, i. e., from 200 degrees to 3,000 degrees Fahr., but is intended more specially for high temperatures, such as are met with in the manufacture of metals, chemicals, porcelain ware, etc. Second—It is almost instantaneous in its indications, five seconds being sufficient time to subject the couple to any stationary temperature; or the couple may, if desired, be left permanently in the furnace or oven, indicating at all times the temperature, and thus enabling the operator to keep an hourly record of same. Third—The metals which compose the couple are not affected by gases, and hence will not become oxidized or react chemically on each other at high temperatures; nor are they altered in their thermo-electric properties by rough usage or bonds.

From the above statements it will be readily seen that the instrument is of great accuracy and durability. The measurement of the temperature is made by means of a d'Arsonval galvanometer, contained in two wooden boxes, which are screwed against a central wall or slab with handle, for portability, as shown in Fig. 1. Fig. 2 shows the two boxes unscrewed from the central slab and placed in their respective positions against the wall. Box A contains the galvanometer proper, and is also provided with set screws and a small plumb bob, so that it may be set vertically. Box B contains the lamp, having a lens and window with cross-hairs for throwing an image upon the galvanometer mirror in box A, which in turn reflects it back upon the scale in box B. Box B has also two set screws for adjusting it vertically. The two boxes are set one metre apart.

The current set up by the thermo-electric couple (no battery is used) enters the galvanometer through the two binding posts, box A, and the deflection caused by it is shown upon the scale, box B. This scale is graduated in millimetres, and it is necessary, therefore, that a curve be made reducing these millimetres to degrees Fahrenheit or Centigrade. This curve is very simply made from known melting points given herewith: Water boils, 212° Fahr.; lead melts, 617° Fahr.; zinc melts, 770° Fahr.; gold melts, 1,013° Fahr.; palladium melts, 2,732° Fahr.

Trolley Tower Wagon.

The convenience of an adjustable wagon tower, which can also be dropped out of the way in driving through the streets, is apparent, and is very efficiently attained by the one we illustrate, manufactured by S. E. Hartman, Worcester, Mass. The tower can be attached to any express wagon, or is supplied with a special wagon. The latter has a seat

hinged to turn over forward out of the way and is provided with a tool box; there is one elliptic spring forward, and the wagon has low wheels in order to permit a short turn, and two heavy elliptic springs behind to steady the tower. One



TROLLEY TOWER WAGON.

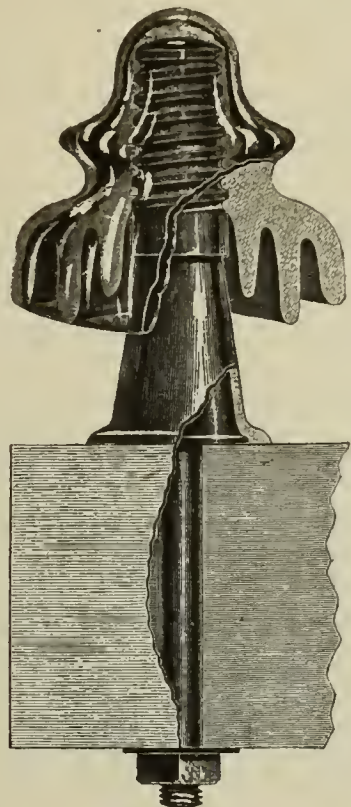
man can easily adjust the tower to any height by means of a crank or wrench attached to a worm gear.

Electric Fishing.

A French electrician, M. Trouve, applies an incandescent lamp to catching fish. A net is sunk in the water, with an electric lamp attached, and the fish collect to bask in the rays of the new illuminant. Round the edge of the net is a pneumatic tire, which is silently inflated and rises to the surface while the fish are wondering whether the brilliant glass bulb is a new kind of luminous jelly fish. M. Trouve's ingenious idea seems hardly sportsmanlike, but it at least avoids frightening the fish and destroying the spawn—the chief drawbacks to net fishing.—London "Lightning."

Indestructible Insulator Pin and Triple Petticoat Insulator.

The insulator pin we illustrate possesses the advantage of being indestructible, easily attached, and instead of splitting the cross-arm, as does the ordinary driven wood pin, rather tends to preserve it. These pins will stand a strain of 1,800



INSULATOR AND PIN.

pounds, while oak and locust pins break at 700 and 900 pounds respectively. The triple petticoat insulator shown, manufactured by the same firm, Fred. M. Locke & Co.,

the supersession of older haulage methods by the electric mine locomotive in a coal mine in Pennsylvania and emphasizes the vast advantage which its use confers.

The mine in question is the Bear Run mine of the Blossburg Coal Company, near Landrus, Tioga county. The locomotives, of which there are two, are of the T. M. M., that is, "two motor mining" type, each of 30 h. p., manufactured by the General Electric Company. They are propelled by two W. P. 30 motors, one being geared to each axle. Current is brought to the motors by a specially designed trolley arm, on which the trolley wheel is swivelled to permit of its adjustment to the various irregularities of the wire line. The trolley arm can be set in sockets on either side of the locomotive, which may thus be run into headings on either side of the main haulageway, which is lighted by incandescent lamps, placed at the entrance to each cross-head, 100 yards apart. The dimensions of the machines are: Horse power, 30; speed, 6 miles per hour; draw-bar pull, 1,500 pounds; gauge, 36 inches; wheel base, 30 inches; diameter of wheels, 28 inches; width over all, 48 inches; length over all, 9 feet 6 inches; height above rail, 31 inches; weight, 7,500 pounds.

The current is furnished by a General Electric D 62, 75-h. p. generator, driven by a Harrisburg Ideal 80-h. p. engine.

The maximum load which these locomotives have been called upon to handle is 32 loaded mine wagons, each weighing 3,200 pounds, and the way has at one part a 3 per cent. grade. The daily haul of these locomotives is about 650 tons.

The entire plant has been pronounced eminently satisfactory, the locomotives having shown capabilities beyond the specification or the General company's guarantee. Their presence in the mine has done away with the slow-going.



MINE HAULAGE LOCOMOTIVE.

Victor, N. Y., is especially suited where high insulation is necessary, as it has an unusual length of insulating surface. This insulator has been largely used on high tension lines (up to 10,000 volts) and another style is made which, it is claimed, can be used with voltages up to 35,000.

Electric Mine Haulage Plant.

Concrete examples of the adoption of electricity to the exclusion of all other methods are generally more convincing in their import to the public mind than mere hearsay or description. The illustration shows a striking example of

limited mule, and induced great economy. The small height of the machines above the rail level allows them to go into places impossible to any mule, and their ease of control and operation is such as to render them invaluable.

Davis' Wiring Tables.

In the 500-volt table of "Davis Standard Tables for Electric Wiremen," the amperes at the head of the columns should be doubled, reading 4, 8, 12, 16, etc., instead of 2, 4, 6, 8, etc., as at present. This correction will be made in all copies hereafter sent out.

Financial Intelligence.

The Electrical Stock Market.

New York, April 9, 1894.

SECOND ANNUAL REPORT OF THE GENERAL ELECTRIC COMPANY.—The second annual report to the stockholders was presented by President C. A. Coffin at the meeting at Schenectady, N. Y., on April 2, 1894, and is as follows:

Before considering the present condition of your company, your directors deem it proper to revert to its situation a year ago. It is believed that by so doing, a clearer statement of the existing condition of your company can be had.

Your company represents a practical union of the Edison Electric Light Company, the Edison General Electric Company, the Thomson-Houston Electric Company and the Thomson-Houston International Electric Company.

To acquire these companies, your company issued the following securities (except as to \$100,000 of its common stock, which was issued for cash):

Common stock.....	\$30,459,700
Preferred stock	4,251,900
	\$34,711,600
Subsequently it sold for cash its 5 per cent. debenture bonds amounting to.....	10,000,000
Total	\$44,711,600

Of this amount \$8,159,264.02 was shown in the last report as representing the cost to the General Electric Company of the Edison and Thomson-Houston patents and contract rights, and your interest in the patents of the Brush, Fort Wayne and other allied companies.

On Jan. 31, 1893, your other assets were examined and valued, and a report on the condition of your company was made to the stockholders at their annual meeting in April last. This examination was conducted under rigid instructions from your board of directors, that material on hand, stocks, bonds, customers' notes and accounts, etc., should be carefully scrutinized, and should be valued on a most conservative basis. The complex organization then existing (referred to further on in this report), and the fact that the amalgamation of the various interests represented by your company had been so recent, made the task an especially difficult one at that, but the statement made by those directly responsible to the board was, that the instructions of the directors had been strictly carried out.

Your company had inherited stocks of manufactured goods in the principal cities in which district offices were located, from Boston in the East, and Atlanta in the South, to San Francisco and Portland in the West. Notes and accounts receivable, stocks, bonds and other assets were similarly distributed. Each district office had exclusive charge of, and was presumably familiar with, the value of its own assets, and was largely independent of the general office. This defective system, since abolished, rendered it exceedingly difficult to arrive at correct conclusions, and notwithstanding the efforts of the officers, it led to grave mistakes in the estimates of value of accounts, securities and inventories of merchandise.

The Edison company, to a small extent, and the Thomson-Houston company (the organization of which was mainly adopted by your company), to a greater extent had been in the habit of doing more or less exploiting work, resulting in the acquisition of stocks and bonds of local lighting and railway companies. The Thomson-Houston company had generally been very successful in marketing these securities at profitable figures. By the facilities which it had thus been able to afford to local enterprises, it was enabled to expand its business. Your company at the time of its organization assumed a large number of such transactions, which were in progress or contracted for. The general policy of your board, however, since the organization of your company, has been to curtail transactions involving the acceptance of stocks or bonds for anything other than license rights, except where for some special reason it has been deemed advisable to accept them, as in settlement of disputed or doubtful accounts.

Among the most important transactions of the character above referred to were those with newly organized companies, and this class of business had been very extensive in the South and West. The financial and industrial collapse in these sections in the spring and summer of 1893 affected your company severely, and very many accounts, notes and investments, assumed as good a year ago, must now be recognized as of diminished value. The same is especially true as to the Northwest, where your company's output was sold through the Northwest General Electric Company, formerly known as the Northwest Thomson-Houston Company.

As you are aware, the Thomson-Houston company has large interests in various construction and manufacturing companies, notably the above mentioned Northwest company, the Fort Wayne Electric Company, the Brush Electric Company and others, the whole standing on its books at about \$5,500,000. At

the time of the last annual report, statements were obtained from the officers of such companies, and it was estimated that something less than one-half of this investment was represented by patent rights, and something over one-half by other assets. Unknown to your board of directors, some of these companies became unduly expanded during the winter and spring of 1892-3, and the stringency which began in April and culminated last autumn, caused them to suffer greatly. Your directors have reduced your entire holdings of Fort Wayne and Northwest stocks to a valuation of \$1 each, exclusive of the amount carried in patents.

After protracted negotiations, the Northwest company has been put in liquidation, and the territory controlled by it has reverted to your contracted.

It is needless to say that the past year has been a most trying one to all corporations. It has been especially so to companies like your own, dealing with local enterprises situated in all parts of the United States, and largely dependent on normal conditions for their success and development. During the summer of 1893 even old and strong customers were obliged to ask for leniency in paying their accounts and notes. Under these circumstances your company found itself with its own obligations to meet, but unable at that time to collect the money with which to meet them. The difficulties thus presented were carefully considered by your board, and were met by selling to a syndicate certain of the company's assets, consisting of claims against, and stocks and bonds of, local lighting and railway companies, the same being of a class of which your company sold several million dollars in 1892, and which your directors, in their last report, said they intended to continue to sell from time to time as heretofore "through ordinary channels." The channels through which your company usually made such sales having become unavailable, owing to the panic, your directors adopted a plan used on several occasions in the earlier days of the Thomson-Houston Company, and made the sale of assets above described to a syndicate which paid over \$4,000,000 in cash. Although the transaction involved a large shrinkage from book valuations, the sale was at a price high under the conditions then prevailing. Few of the securities sold were listed on any exchange or commonly dealt in, and it was not possible to effect a ready sale, except in bulk, to a syndicate. These assets were placed in a trust known as "The Street Railway and Illuminating Properties." After the financial stringency had subsided, the right to subscribe to them was offered to the stockholders of your company.

The depreciation in value of the assets thus sold applies equally to those still on hand. Holders of stocks and bonds of almost every kind find them quoted to-day much lower than a year ago, and this company, as a holder of electrical stocks and bonds, is no exception to the rule. In fact, the shrinkage in values in electrical securities has been greater than in most others. The last year has been characterized by shrinkage in every direction, and your company has suffered severely from it.

Since the combination of the Edison and Thomson-Houston companies, in 1892, your directors have been earnestly endeavoring to simplify your organization. As a result of the union, your company suddenly came into control of some twenty companies, all engaged in active exploitations and having their own separate boards of directors and independent managements, with separate accounts and liabilities. At first your board had little success in its efforts to centralize and simplify the organization, but the events of the last summer emphasized the necessity of radical changes so unmistakably as to secure the co-operation necessary to effect the desired results. The "district offices" are practically abolished, except as mere sales offices. The business management of the company has been concentrated at its principal office at Schenectady, and its whole organization has been greatly simplified. All accounts are kept there, and all sales and credits are supervised there. So far as practicable, your manufacturing business has been, and will be, concentrated at Schenectady; and the operations of its other factories are now directed from there. During the short time since this change was effected, many advantages have accrued to the company from this concentration of the selling, accounting, manufacturing and engineering departments of the company.

Besides the shrinkage in the inventory value of the securities of local and other companies hereinbefore mentioned, as sold and on hand, there is a shrinkage in the inventory value of apparatus and material at factories and storerooms, and of machinery and fixtures at storerooms amounting to \$2,382,012.94. This shrinkage is partly due to the fall in value of material manufactured and in process of manufacture, and partly to the development in electrical science, which has been so great during the last year or two that apparatus which at the time of the last inventory was looked upon as commercial, has been superseded by entirely new and superior types. Consequently the older apparatus has become unsalable, or of slow sale, and most of it has been reduced to "scrap" value, and the remainder to much less than cost.

FINANCES.

On July 31, 1893, the direct and indirect obligations of the company (including the Edison, Thomson-Houston and International companies), exclusive of the debenture bonds, were:

Direct obligations:	
Notes payable	\$4,446,000
Dividend	609,000
Accounts payable and accrued interest.....	1,579,000
Total direct obligations.....	\$6,634,000
Less cash on hand.....	1,294,000
Net amount of direct obligations.....	\$5,340,000
Indirect obligations:	
Paper discounted under endorsement.....	\$3,394,000
Net amount of direct and indirect obligations,	
July 31, 1893.....	\$8,734,000
On Jan. 31, 1894, these matters stood as follows:	
Direct obligations:	
Notes payable.....	\$744,000
Accounts payable, accrued interest, etc.....	406,000
Total direct obligations.....	\$1,150,000
Less cash on hand.....	591,000
Net amount of direct obligations.....	\$559,000
Indirect obligations:	
Paper discounted under endorsement, guaran-	
tee, etc.....	\$1,425,000
Net amount of direct and indirect obligations,	
Jan. 31, 1894.....	\$1,984,000
Reduction of debt in six months.....	\$6,750,000
Of which there was received from street railway	
and illuminating properties.....	\$4,050,000
Reduction of debt from other sources (principally	
collections of notes and accounts receivable).....	\$2,700,000

This reduction does not disclose all the improvement of the last six months. The indirect obligations of the company, arising from its endorsement of discounted notes receivable, were six months ago almost as embarrassing as its direct debt, as the larger part of them had to be provided for by your company at maturity, their makers being unable to take care of them. To-day no paper is under discount, except such as it is believed will be paid by the makers; consequently the indirect obligations of the company are nominal rather than real.

At the date of this report, the direct obligations have been reduced to about \$750,000, which are partly offset by about \$400,000 cash on hand, and the paper under discount is reduced to about \$750,000.

In addition to the above, there are still outstanding some important guarantees given two years ago by the Thomson-Houston company to the United States Securities Company, whereby in one form and another it is claimed that the Thomson-Houston company (and, practically, the General Electric Company) is bound to take back from the Securities company certain bonds of local companies at a valuation of \$702,000. This liability has been in part arranged for by substitution of other securities, and it is not thought that such guarantees will involve any considerable cash outlay, although their ultimate adjustment may result in some loss.

Your directors believe that the notes and accounts receivable, and such stocks, bonds, etc., as it is undesirable for the company to hold permanently, can, with some delay and patience, be collected and marketed to such an extent as shall not only liquidate the small amount of remaining obligations, but shall also supply all necessary working capital. Earnest attention is being given to the sale of these assets.

While the liquidation of the debt has been going on, the company has also readjusted its basis for sales, either to cash or to short credits to desirable customers. In view of the extreme depression and the uncertainty as to the early future, your directors have not felt justified in any other course than that of adhering strictly to sales on this basis. It is believed that your company has lost little legitimate business in consequence of its curtailment of credit to customers. It intends to confine its business to this basis, and to accept smaller profits.

Your directors do not believe that it will be possible for some time to come to do as large a business as was done by the company prior to the panic, although a gradual improvement has been apparent during the last two months. The street railway business, which to a considerable extent was formerly done through syndicates and promoters, many of whom have become embarrassed, promises to be smaller than during the previous year. Arc lighting business is also reduced, largely because of the inability of local companies to secure capital with which to extend their business for the purpose of carrying out municipal contracts. The business of the company, with respect to incandescent lighting, which is, to a great degree, performed by strong and conservatively managed local companies, is in a more healthy condition, and has not suffered so severely. The business in plants for the distribution of electrical power is promising, and many important installations are in progress. The application of electricity to various mining purposes, such as hauling, hoisting, drilling, etc., is increasing. The future in this

respect is promising. The increase in the number of local lighting and railway companies is shown by the following table:

	Feb. 1, 1892.	1893.	1894.
Total number of local companies operating incandescent and arc lights.....	1,158	1,277	1,479
Total number of railway companies.....	214	435	541

LICENSEE COMPANIES.

The substantial and permanent character of the business of local illuminating companies, distributing light and power by the methods and protected by the patents controlled by your company, is more widely recognized year by year. The true interests of this company lie in advancing the interests of its licensees in every possible way, and to this end prices of apparatus have been reduced during the past year, and the licensees will continue to receive, from time to time, the benefit of further reductions in cost of manufacture.

PATENTS.

Substantial progress has been made during the year in the prosecution of suits against infringers of many of the more important patents belonging to the company. The "feeder and main" patent, which is of fundamental importance, particularly for low tension lighting plants, has been sustained by the Circuit Court for the District of New Jersey.

The litigation on the incandescent lamp patent has been generally successful, although the most strenuous efforts have been made by infringers to defeat the patent or to devise some form of lamp that would be outside of it. In two instances we have met with reverses in this litigation, which have proved to be comparatively unimportant. In these instances we are advised there is a strong probability that we shall ultimately prevail. The efforts to evade the patent by so-called "lamp repairs," and by injecting a harmless amount of inert gas into the bulb, have been defeated.

Our counsel are hopeful that the courts will so construe the law that the lamp patent will run for the full term for which it was granted, in spite of the fact that the situation is somewhat complicated by foreign patents. If we succeed in maintaining this position, the patent will be of substantial value to the company for some years.

Owing to the inevitable delays of litigation, the important cases on patents for railway work, upon which we place great reliance, have not yet come to hearing. It is expected that many of these cases will be determined during the coming year.

No final decision has been rendered against the company on any patent. During the past year several such suits against the company have been decided in its favor, notably the suit on the patent for the hydro-carbon treatment of the filament of incandescent lamps, which has been disposed of in our favor by the decision of the United States Circuit Court of Appeals.

Upon the whole, the patent situation seems to be promising, and we believe that at the next annual meeting we shall be in a position to report substantial progress.

All expenditures for patents and patent rights during the year under review, and all expenses of patent litigation, have been charged to operating expenses.

STATEMENT OF ACCOUNTS.

There are submitted herewith:

Consolidated balance sheet of the General Electric Company, includes the underlying companies, viz.: The Edison Electric Light Company, the Edison General Electric Company, the Thomson-Houston Electric Company and the Thomson-Houston International Electric Company, as of Jan. 31, 1894:

Statement of profit and loss account as of same date.

List of stocks and bonds owned.

In explanation of the items in the balance sheet, your directors deem it proper to state as follows:

Manufacturing Plants.

In the last annual reports, pages 8 and 9, the Edison General Electric Company's plants at Schenectady and Harrison were carried at.....	\$2,677,548.09
The Thomson-Houston company's plant at Lynn was carried at	1,240,066.77
In addition there were sundry small machines and tools included in the report in the Lynn factory's inventory account	40,913.35

Making the total manufacturing plants on Jan. 31, 1893 \$3,958,528.21

During the year the sum of \$884,659.11 has been expended in additions to the manufacturing plants and their equipment. On the other hand, the sum of \$902,058.34 has been written off the profit and loss for depreciation, leaving the cost of such plants on the books \$3,941,128.98, which is \$17,399.23 less than they were carried at Jan. 31, 1893.

Stocks and Bonds of Manufacturing Companies.

This is an investment account in the stocks and bonds of various companies, and it is believed to be conservatively valued. Details will be found in Schedule A.

Stocks and Bonds of Local Companies.

A list of such stocks and bonds owned by the company is annexed hereto (Schedules B and C), and, as will be noticed in the profit and loss statement, a great shrinkage has been made in

the valuation of the securities shown in said schedules, in order to reduce their book value to what is believed to be within their real value.

Inventory and Consignments.

The supplies of raw material, manufactured goods and goods in course of manufacture, at the factories, have been carefully inventoried, item by item, and a reduction of \$1,217,142.81 has been made from the sum at which they were previously carried. The supplies of finished apparatus in the different local sales-rooms of the company and on consignment have been dealt with in the same manner, and the sum of \$940,365.03 has been charged off on them.

Notes and Accounts.

As to the notes and accounts receivable (of over 6,000 customers) there is, in many instances, among those whose duty it is to pass upon their value, a wide difference of opinion. They have been classified item by item, and your board has taken them at the lowest suggested valuation. The amount includes \$2,531,609.88 due by the Fort Wayne, Northwest and other allied interests.

Work in Progress.

This represents the amount charged up against installations in progress, and is believed to be valued safely.

ORGANIZATION.

Numerous vacancies, principally due to resignations, have occurred in your official organization during the year, and have been filled as indicated in the list of officers, which accompanies this report. The selections to fill such vacancies have, in every instance, been made in recognition of general merit and of fitness especially displayed during the strain of the last eight months.

During the year, the entire internal organization of your company has been readjusted, and the number of departments has been reduced. This has resulted in a large saving of expense and increased efficiency. Your board now feels that the personnel of your organization is adjusted in a manner where few changes among subordinates are likely to be made in the early future, and a general appreciation of this fact will lead to more efficient work than was possible during the transition period.

C. A. COFFIN.

CONSOLIDATED BALANCE SHEET.*—JAN. 31, 1894.

Assets.	
Patents and franchises.....	\$8,159,264.02
Manufacturing plants.....	3,941,128.98
Real estate (not including factories):	
Edison Building, N. Y. City.....	\$412,356.13
Less mortgage thereon.....	200,000.00
	212,356.13
Other real estate.....	111,329.10
	323,685.23
Stocks of manufacturing co.'s (Schedule A)	2,767,470.58
Stocks and bonds of local co.'s (Schedules B and C).....	2,723,493.17
	5,490,963.75
Cash	591,143.88
Notes and accounts receivable (face value \$14,984,697.42)	8,934,159.75
	9,525,303.63
Inventories:	
At factories.....	3,349,042.94
At sales offices (including consignments)...	1,485,749.68
	4,834,792.62
Work in progress.....	1,198,343.58
Profit and loss.....	12,454,967.42
	\$45,928,449.23
Liabilities.	
Capital stock:	
Common	\$30,469,700.00
Preferred	4,251,900.00
	\$34,721,600.00
Five per cent. gold coupon debenture bonds	10,000,000.00
Mortgages	26,200.00
Accrued interest on debenture bonds.....	\$3,733.32
Notes payable	744,341.81
Accounts payable.....	323,084.82
	1,159,759.45
Sundry credits	39,889.78
	\$45,928,449.23

CONSOLIDATED STATEMENT OF PROFIT AND LOSS*—JAN. 31, 1894.

Dr.	
Interest on debenture bonds.....	\$499,893.62
Dividends	1,655,180.50
Taxes	195,457.31
World's Fair expenses.....	241,877.52
	\$2,592,378.95

*General Electric Company, Edison Electric Light Company, Edison General Electric Company, Thomson-Houston Electric Company and Thomson-Houston International Electric Company.

Amounts now charged off:

On patents.....	733,870.75
On notes and accounts receivable and on stocks and bonds, sold and on hand.....	10,444,318.78
On manufacturing plants.....	902,058.34
On inventories and consignments.....	2,157,507.84
On machinery, tools, instruments and fixtures—other than at factory.....	224,505.10
On sundry losses.....	125,205.31
	\$17,179,845.07

Cr.

General Electric Company's surplus, Jan. 31, 1893.....	\$1,024,954.59
Manufacturing and selling profits after deducting general expenses.....	3,189,884.37
Dividends and interest on stock and bonds owned.....	433,293.06
Interest, discount and exchange.....	76,745.63
Debit balance carried forward.....	12,454,967.42
	\$17,179,845.07

J. P. ORD, Second Vice President.

GENERAL ELECTRIC has been the subject of a vast deal of comment. The directors made public this week the result of operations for the year ending Jan. 31, 1894, and the showing presented is as bad as was expected. The stock declined several points on the first announcement of the annual report, but there has been a sharp recovery on the further appreciation of the fact that the bad results had been discounted weeks ago, and the change of quotations for the week is hardly appreciable. The most gratifying feature of the report is the frankness with which the management lays before the security holders the condition of the property. There has been no attempt to cloak over any of the distressing details of mismanagement and misfortune that have brought the General Electric Company to its present sad condition. The upshot of the year's operation is the conversion of a surplus of \$1,024,954, reported on Jan. 31, 1893, into a profit and loss debit a year later of \$12,454,967, this amount representing the impairment of the capital. It is impossible to accurately or fully present here all the features of the report, so full is it of matters of the highest import to the security holders. An analysis of the income account shows that the net manufacturing and selling profits were \$3,189,884, which is less than the profits for the eight months ending Jan. 31, 1893. The total net receipts were \$3,699,923, while the disbursements for interest and dividend payments, taxes and World's Fair expenses were \$2,592,379, leaving an apparent balance of \$1,107,554. The dividends paid included one semi-annual distribution of 3½ per cent. on the preferred stock, and two quarterly payments of 2 per cent. each on the common stock. The report of the company notes at the start that grave mistakes arose in the beginning, owing to the complicated organization of the company, in the estimates of the values of accounts, securities and inventories of merchandise submitted at the last annual meeting. These mistakes arose through the multiplicity of district offices, which have since been practically abolished, except as mere sales offices. The management has also curtailed the old time practice of accepting stocks and bonds for anything but license rights. The report's most interesting details relate to the scaling down of assets and the reduction of debt. These are matters of the most vital value to the company's solvency, and the stockholders are made acquainted at full length with the condition of affairs. As illustrating the working down of assets, it is well to quote a paragraph from the report: "The Thomson-Houston company had large interests in various companies, notably the Northwest company, Fort Wayne Electric Company, the Brush Electric Company and others, the whole standing on the books at about \$5,500,000. Unknown to your board of directors, some of the companies became unduly expanded during the winter and spring of 1892-93, and the stringency, which began in April and culminated last autumn, caused them to suffer greatly. Your directors have reduced your entire holdings of Fort Wayne and Northwest stocks to a valuation of \$1 each, exclusive of the amount carried in patents." The depreciation in value of the assets sold to "The Street Railway and Illuminating Properties," as well as those on hand, is treated in detail in the report above, the result being that \$14,587,466 stands charged off on the profit and loss account. The course of the floating debt was the important factor bearing on the company's solvency during last year's trying periods, and there is interest in the history of its funding and reduction. On Jan. 31, 1893, the direct obligations of the company (including the Edison, Thomson-Houston and International companies), exclusive of the debenture bonds, were \$4,782,763 net, after deducting \$3,871,034 cash on hand from the total of \$8,653,797. On July 31, 1893, the account of direct obligations, as stated in the report, stood: Notes payable, \$4,446,000; dividend, \$609,000; accounts payable and accrued interest, \$1,579,000; total, \$6,634,000; less cash on hand, \$1,294,000; net amount of \$5,340,000. Evidently the company had paid out its cash and reduced its indebtedness accordingly, the increase of net debt being practically the amount of the August dividend—the last paid on the common stock. On Jan. 31, 1894, these mat-

ters stood as follows: Notes payable, \$774,000; accounts payable, accrued interest, etc., \$406,000; total direct obligations, \$1,150,000; less cash on hand, \$591,000; net amount of direct obligations, \$559,000. The floating debt was thus reduced in six months \$4,781,000, of which \$4,050,000 were derived from the sale of securities to the Street Railway and Illuminating Properties and \$731,000 from the collection of notes and accounts receivable. The indirect obligations, arising from the endorsement of discounted notes receivable are now \$1,425,000, a reduction during six months of \$1,969,000. It is impossible to make a comparison of the balance sheet just issued with the one presented a year ago. In the first place the 1892 balance sheet was for only eight months, while the 1893 figures are for twelve months. But the change of items is so radical as to prevent an itemized comparison. Thus "Patents and Franchises" and "Manufacturing Plants," valued respectively at \$8,159,265 and \$3,941,129, do not appear at all in last year's balance sheet, while "Stocks of Underlying Companies," which stood in last year's statement at over \$18,000,000, do not appear this year. There are other equally important changes. The valuation of \$8,159,265 put on patents and franchises is the subject of much criticism, most experts declaring that, by reason of ability of the company's competitors to do business under other patents, these figures are much too high. Again, business, to judge from the profits reputed, must have been done often at a loss. Only a little over 8 per cent. was earned on the two classes of stock, and this is a very small margin of profit for a big manufacturing concern to operate on. Much speculation is indulged in as to the book value of General Electric. This is mere guesswork, as the value of such a stock as General Electric depends a good deal more on its earning capacity than on the assets. If the company can, in the worst year on record, earn over \$2,250,000 above fixed charges, it ought to soon reach a period when it can again distribute profits among stockholders. The facts are now known, and, as the General Electric Company is now financially easy, its prospects are much improved. The annual meeting is next Tuesday, and, as outlined in these columns last week, the present management is likely to hold over. Apropos of reports concerning new business, it was learned to-day that since Jan. 1 the General Electric Company has done a cash business of over \$350,000, or about \$23,000 a week. This last week alone the railway department closed a contract for \$116,000 cash.

WESTINGHOUSE ELECTRIC stocks have had another spurt on the publication of figures relating to the annual report. It is stated that it will show net earnings above all expenses, dividends and charges of \$1,790,000. This is an increase over the previous year of \$630,000. The floating debt has been reduced since Jan. 15 from \$1,140,000 to \$750,000. The surplus of the company will show an amount of quick assets equal to the sum at which the patents of the company are carried on the books.

EDISON ELECTRIC ILLUMINATING, of New York, 5 per cent. first mortgage gold bonds have had a substantial rise this week. The syndicate, including Drexel, Morgan & Co., A. A. H. Boissevain and others that recently started to market a block of \$750,000 of the authorized issue of these bonds, has closed out the entire amount, and the syndicate has disbanded. These bonds are convertible till July, 1895, into stock now paying 6 per cent. dividends, and are redeemable at 110 after 1900. After 75 per cent. of the issue is converted, the company can require the conversion of the remainder. It is stated that the earnings of the company for the quarter ended March 31 are the largest in the history of that company for that quarter. The usual quarterly dividend of 1½ per cent. will be declared next week.

WESTERN UNION TELEGRAPH stock continues strong. There is a tremendous short interest in the stock, and if they are once forced starting to cover, the prediction of the bulls that 90 will be soon crossed, is likely of fulfillment. The bears still talk of decreased earnings, and will not show 5 per cent. earned on the stock this year. They even say that the dividend will be passed during 1894. On the other hand, Mr. George Gould advises some of his best personal friends to go long of "Telegraph" and to buy it on every opportunity. All the selling down so far has failed to dislodge long holdings.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES has again retired 2,050 shares of the preferred stock, under its latest call, at an average price of 97.54. Since last summer the company has retired 8,664 shares of its 45,000 shares of preferred stock—500 shares at an average price of \$82.94, 843 shares at \$82.90, 1,320 shares at \$83.28, 2,354 shares at \$84.94, 1,597 shares at \$93.92 and 2,050 shares at \$97.54. Par is 100, and the shares cost the syndicate subscribers 90, with a bonus of common stock, to the same amount as the preferred. This common stock is now quoted at 20 bid, 21 asked. The trustees propose to liquidate all the property in their possession as the opportunity offers, and after the \$4,500,000 preferred stock has all been purchased or drawn and cancelled, further receipts will be divided to the common stock as fast as received. The sale last summer to this company by the General Electric Company of \$12,000,000 in order to raise \$4,050,000 with which to meet floating and avoid bankruptcy, is treated upon in the annual report of the General Electric Company with some detail. The success of the trustees in cancelling preferred makes it a pity that the General Electric Company should have had to so sacrifice its valuable treasury assets.

AMERICAN BELL TELEPHONE quotations continue to be benefited by the splendid showing of the annual statement made public last week. The reports of new competition seem to have lost all effect.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York.....	50	20	35
Detroit Electrical Works.....	10	2	3
Cleveland General Electric Co.....	—	85	90
East River Electric Light.....	100	—	65
Electric Con. & Supply Co., pref.....	15	15	16
Electric Con. & Supply Co., com.....	15	15	17½
Edison Electric Ill., New York.....	100	102½	103½
Edison Electric Ill., 1sts.....	—	107¼	107½
Edison Electric Ill., Brooklyn.....	100	103	104½
Edison Electric Ill., Boston.....	100	115	120
Edison Electric Ill., Chicago.....	100	125	130
Edison Electric Ill., Philadelphia.....	100	130	132
Edison Electric Light of Europe.....	—	—	3
Edison Bonds.....	—	80	85
Ore Milling.....	—	10	11
Fort Wayne Electric.....	—	4½	6½
General Electric Company.....	100	41¾	42
General Electric Company, deb. 5's.....	—	85	86
Interior Conduit and Ins. Co.....	100	35	50
Mount Morris Electric.....	—	—	65
Westinghouse Consolidated.....	50	33	34
Westinghouse Consolidated, pref.....	50	49¾	50
Western Union Telegraph.....	—	85¼	85¾
American Bell Telephone.....	—	188	189

*Ex. dividend.

New Incorporations.

THE ELECTRIC BELT AND APPLIANCE COMPANY, Chicago, Ill., capital stock \$500,000, has been formed to manufacture and deal in electric belts, etc. J. H. Fitch, H. L. Dietz and S. H. Trade are interested.

THE CITIZENS' ELECTRIC LIGHT AND POWER COMPANY, Hudson, N. Y., capital stock \$10,000, has been formed to do an electric light, heat and power business. S. D. Lake, A. J. Rowles and E. J. Hodge, of Hudson, are interested.

THE PLANTE COMPANY, Jersey City, N. J., capital stock \$1,000,000, has been formed to sell, maintain and construct electrical power plants, etc. R. McA. Lloyd, H. G. Ward, New York, and L. McKim Garrison, Orange, N. J., are the promoters.

THE HOUTZDALE AND SUBURBAN ELECTRIC RAILWAY, Hazleton, Pa., capital stock \$100,000, has been formed to build and operate an electric railway in Clearfield County. The incorporators are A. Markle, J. E. Giles and E. S. Doud, of that town.

SCOTT & CO., New York City, capital stock \$3,000, has been formed to manufacture electrical apparatus. C. P. Scott, 189 West 134th street; B. F. Hamilton, 227 West 135th street, and F. W. Harrington, 204 W. 133d street, New York, are the incorporators.

THE DEAN ELECTRIC MANUFACTURING AND SUPPLY COMPANY, Des Moines, Iowa, capital stock \$50,000, has been formed to buy, sell and manufacture electrical and mechanical devices. J. E. Brunner and W. S. Bales, of Des Moines, are interested.

THE SACHS ELECTRIC COMPANY, New York, capital stock \$20,000, has been formed to manufacture and deal in electrical appliances. T. L. Peter, 30 Pine street; C. T. Haviland, 29 Broadway, and Francis Forbes, 137 Broadway, New York, are the promoters.

THE BANSOR ELECTRIC LIGHT, HEAT AND POWER COMPANY, Bansor, Pa., capital stock \$30,000, has been formed to generate electricity and steam, and to supply light, heat and power, etc. D. Ruddleison, Milton Flory and B. F. Miller are the promoters.

THE BLUESTONE ELECTRIC LIGHT COMPANY, Coopers, W. Va., maximum capital stock \$50,000, has been formed to operate and maintain electric light and power plants, etc. The promoters are J. Cooper, Coopers; B. Moore and J. P. Bowen, Brewell, W. Va.

THE PHILIPSBURG AND SUBURBAN ELECTRIC RAILWAY, Hazleton, Pa., capital stock \$100,000, has been formed to construct and operate an electric railway in Clearfield and Centre counties. A. Markle, J. E. Giles and E. S. Doud, of Hazleton, are the promoters.

THE AKRON STREET RAILWAY COMPANY, Akron, Ohio, capital stock \$700,000, has been formed to build and operate railways and to supply electricity for light, heat and power. J. F. Seiberling, I. M. Miller, W. H. Carter, L. C. Miles and F. A. Seiberling are interested.

THE IDEAL LIGHT AND POWER COMPANY, Chicago, Ill., capital stock \$10,000, has been formed to build and maintain an electric light plant for generating and supplying electricity for light and power, etc. W. E. McKee, J. H. Garrett and J. B. Morgan are the promoters.

THE FOX RIVER ELECTRIC RAILWAY COMPANY, Green Bay, Wis., capital stock \$100,000, has been formed to build and operate an electric railway between Green Bay, Howard, De Pere and Allouez, Brown County, Wis. J. H. Elmon, A. Spuhler and F. A. Hallman are interested parties.

THE LIGHT, HEAT AND POWER COMPANY OF FISHKILL AND MATTEAWAN, Fishkill Landing, N. Y., capital stock \$40,000, has been formed to supply electricity and gas. W. D.

Haven, Trenton, N. J.; W. R. Seefeld and W. W. Wilkworth, Fishkill Landing, N. Y., are the promoters.

THE DONLON AND MILLER MANUFACTURING COMPANY, Brooklyn, N. Y., capital stock \$50,000, has been formed to manufacture electric and gas fixtures. John Donlon, 107 Adams street; A. S. Miller, 212 Clinton street, and John F. Miller, 212 Clinton street, Brooklyn, are interested.

THE INTERNATIONAL SUPPLY MANUFACTURING COMPANY, Detroit, Mich., capital stock \$50,000, has been formed to manufacture and deal in electrical machinery and supplies. A. H. Davis, C. G. Willoughby, O. W. Harris, W. M. Durand and H. Jones, Detroit, Mich., are the organizers.

THE ROYAL ARC COMPANY, Citizens' Bank Building, Elizabeth, N. J., capital stock \$5,000,000, has been formed to manufacture and deal in apparatus for producing electric light. A. Bellamy, A. H. Patterson, W. W. Dixon, New York, and F. C. Marsh, Elizabeth, N. J., are the promoters.

THE OKLAHOMA GAS AND ELECTRIC COMPANY, Denver, Col., capital stock \$100,000, has been formed to construct and maintain a plant for furnishing electric light to Oklahoma. S. J. Price, J. G. Fikes, W. H. Barr, F. E. Workman, Oklahoma City, and J. W. Rice, Salina, Kan., are the promoters.

THE ELECTRIC BOAT COMPANY, Chicago, Ill., capital stock \$100,000, has been formed to manufacture and sell Sillsbury electric motors and other electrical boat propelling apparatus, primary and storage batteries, etc. C. D. Wright, L. D. Wright and John Templeton are interested.

THE MUTUAL TELEPHONE EXCHANGE CONSTRUCTION COMPANY, Rahway, N. J., capital stock \$50,000, has been formed to construct and maintain overland, underground and submarine telegraph and telephone lines, also exchanges, and to manufacture and sell electrical apparatus and appliances of all kinds. G. Crawford, W. A. Hammett, H. W. Pope, New York; J. M. Shaw, West Brighton, S. I., and D. S. Robeson, Rahway, N. J., are the incorporators.

THE FAIRFIELD COPPER COMPANY, Jersey City, N. J., capital stock \$5,000, has been formed to carry on the business of bessemerizing and refining copper and other metals by means of electricity, etc. T. K. Egbert, Pattenberg, N. J.; G. Lowther, Riverdale, Conn.; H. Hanson, L. J. Merkel, New York City; J. H. Cameron, Fall River, Mass.; E. I. Smith, Ansonia, Conn.; O. G. Jennings, Fairfield, Conn., and Charles H. Brush, Brooklyn, N. Y., are the organizers.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
41 Park Row, New York, April 9, 1894.

THE NEW YORK BOARD OF ELECTRICAL CONTROL has had its term extended three years from Nov. 1, 1894.

THE FIBRE CONDUIT COMPANY, now at 45 Broadway, New York, will move into new offices in the Home Life Insurance Company Building, 267 Broadway, on May 1.

THE KNAPP ELECTRIC AND NOVELTY COMPANY, 54 Warren street, reports a larger inquiry for battery motors than last year, and expects a substantial increase in sales as soon as

MR. M. W. DEWEY, inventor of the Dewey electric car heater, and now consulting engineer of the American Electric Heating Company, of Boston, Mass., was in town for a few days last week.

MR. C. T. SNIEDKOR, inventor of the celebrated brand of Salamander wire, sailed for Europe April 4, on the Teutonic, on business in connection with the various European agencies of his wire.

NETTEL, O'CONNOR & CO., INC., have closed contracts with the Union Railway Company for building its 145th street trolley road, the first to be built in New York City, and for the Mount Vernon lines.

MR. W. H. FLEMING has severed his connection with the International Trading and Electric Company. The Manhattan General Construction Company of 30 Broadway, New York, and 706 Monadnock Building, Chicago, has made arrangements with him to act as selling agents for his patent woven wire gauze dynamo brush.

H. R. COHO & CO. report that they intend, in addition to handling the Mather Company's apparatus, to make a specialty of small plants for country residences. There seems to be a great demand for plants, including gas engines, storage batteries and dynamos, and we feel that Messrs. Coho & Co. should have a great success in this line.

THE BUCKEYE ENGINE COMPANY on April 1 will remove its office from 18 Cortlandt street to larger and more commodious offices at 39 and 41 Cortlandt street. The Buckeye company calls attention to the fact that in addition to its regular line of plain tandem compound, cross compound and triple expansion horizontal engines, it now makes vertical compound engines for electric

light and railway service ranging from 150 h. p. to 1,200 h. p. and over, and specially adapted for direct connecting dynamos.

MESSRS. J. JONES & SON have bought from the receiver the entire stock on hand of the late corporation of Alexander, Barney & Chapin, and will move their offices from 39 Vesey street to the quarters now occupied by the A. B. C. Company, at 67 Cortlandt street. It is understood that by paying spot cash Messrs. Jones & Son got the stock at an exceedingly low price. As will be noted from an announcement in last week's issue, the firm offers the goods to the trade at a discount of from 25 to 50 per cent. below market price, and offers to send upon application a printed list of the stock on hand. Messrs. J. Jones & Son are to be congratulated on their enterprise in this matter. Mr. Jones was for many years a member of the firm of Pearce & Jones, and he and his son, Mr. James Jones, Jr., comprise the firm of J. Jones & Son.

THE BROOKLYN BOARD OF ALDERMEN has approved of the report of the lamps and gas committee, giving the contracts for furnishing the lighting of the streets to the Edison, Citizens' and Municipal companies. By the terms of the resolution adopted the Edison company will soon be in a position to control a major part of the street lighting. Hitherto this company has been out in the cold, so far as city patronage was concerned, and the two other companies, which are controlled by Democratic politicians, had virtually a monopoly of the business. The lamps and gas committee also reported in favor of giving a franchise to the State Electric Light and Power Company, which had been vainly seeking this privilege from the two preceding boards. Alderman Cohn said that President Noah L. Cocheu had been credited with making statements seriously reflecting on the integrity and good faith of some members of the board, and he suggested that before the franchise was granted an investigation of the charges should be made. After some discussion the president of the board was directed to appoint a committee of seven to make an investigation.

THE MERCANTILE ELECTRIC COMPANY has filed a certificate of incorporation. Its purpose is to construct and maintain lines of telegraph and telephone, and its line is to run from 120 Broadway, through Broadway to the Battery, through Pine street to Nassau, to William street, through Nassau to Broad street to the East River, through William street to Hanover square, through Wall street to Pearl street, through Pearl street to Cedar street, through Cedar street to Broadway, connecting with the United States Sub-Treasury and various other buildings, with a central office at 120 Broadway, and through such other streets of the city as the needs of the business may require. The capital stock of the company is \$5,000. The directors of the company are Henry A. Hurlbut, Lyman Rhoades, Henry S. Terbell, George W. Phillips, Louis Fitzgerald, Thomas D. Jordan and William Giblin. Mr. Lyman Rhoades says that the incorporators of the company did not mean that it was going to enter business as a competitor of the Metropolitan Telephone and Telegraph Company. The reason that directors of the Equitable Assurance Society appeared as incorporators was simply that these gentlemen were associated with him in other business ventures. The Mercantile Electric Company has long done a private business, although not incorporated, Mr. Rhoades added, and it has used overhead wires mainly. It is incorporated now because it desires to go into the subways, and cannot do so without incorporating as an electric company. It will do a small special business, the same as it always has, and that is all.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., April 7, 1894.

THE ELECTRIC GAS LIGHTING COMPANY, 195 Devonshire street, Boston, Mass., has been appointed New England agent for the sale of "Kette" wires and cables.

SALAMANDER WIRE, with its remarkable fireproof qualities, continues to attract wide attention. The Boston and Maine depot, of Boston, which is said to have the largest isolated lighting plant in New England, is wired with Salamander wire.

BOSTON, MASS.—Sealed proposals will be received to May 2, at noon, by the fire commissioners of Boston, at their office on Bristol street, for furnishing the machinery of the operating room of the new central station of the fire alarm system, as per details to be had of Robert G. Fitch, chairman.

Pittsburgh Notes.

PITTSBURGH, April 7, 1894.

THE ALLEGHENY AND KISKEMINETAS RAILROAD COMPANY has presented a petition to councils in Allegheny City asking for a right of way to build a railroad from Allegheny to Tarentum, a distance of 12 miles.

THE BESSEMER LIGHT, HEAT AND POWER COMPANY of Bradock, Pa., has been chartered with a capital of \$10,000. The

directors are Josiah Barrett, Allegheny; James P. McKelvy, Brad-dock, and Charles E. Ellis, Swissvale.

IN WASHINGTON, PA., a local telephone company has been organized to compete with the Central District and Printing Telegraph Company, and the result has already shown itself in a reduction of from \$60 to \$35 by the old company.

THE ELECTRIC STREET RAILWAY at Washington, Pa., has been sold by the sheriff for \$10,900. The capital stock of the company was \$50,000, and the cost of building the line exceeded that amount. The property will now go into other hands and will be extended. New Westinghouse machinery will be put in the power house.

AT A RECENT FIRE in Brownsville, a neighboring borough of this city, it was discovered that the horses which usually pulled the fire engine and hose carriage could not be found. To overcome the difficulty these vehicles were attached to a motor car of the Suburban electric line, with the result that the distance to the scene of the fire, two miles and a half, was covered in eight minutes. The fire was gotten under control before much damage had been done. It is now suggested to do away with the horses altogether.

MR. LEON LE PONTOIS, of the Westinghouse Electric and Manufacturing Company, gave a lecture April 4 at the Keystone Electrical College, in this city. Mr. Pontois explained to his audience the generation of current, giving practical demonstrations of the fact that whenever a conductor is moved in the magnetic field, the peculiar molecular movement, known as the electrical current, must take place. He based his statements on the theory that electricity and magnetism, like light and heat, are the results of a peculiar vibration of matter. He said that in the study of electrical phenomena, it is better to rise above the plane of mathematics into that of pure reason, for the one only shows the mechanical relation of one thing to another, whilst the reason enters into the cause of things. Mr. Pontois attempted to demonstrate that atomic vibration is a necessary consequence of the force which keeps together all celestial bodies. All dynamos are based on the principle discovered by Faraday, that electric currents are generated in a conductor by moving them in a magnetic field. Therefore, if the reason why such phenomena are produced is clearly shown, the study of all kinds of dynamos and motors becomes very simple. Mr. Pontois intends to give a series of lectures explaining in detail the construction, operation and management of electrical apparatus.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD
936 Monadnock Building Chicago April 7, 1894.

MR. GEORGE A. MCKINLOCK, president of the Central Electric Company, has gone to Old Point Comfort, Va., for a couple of weeks' rest and recreation.

MR. W. H. SILLS, 86 Lake street, Chicago, Ill., has taken the Western agency for the sale of mica and "Micanite," manufactured by Eugene Munsell & Co., New York.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY'S factory, on Clinton street, presents a scene of unusual activity now-a-days. The company has its hands full taking care of the orders that come from all sections of the continent for its new telephone.

THE LINK-BELT MACHINERY COMPANY has recently taken a most conspicuous position in the ranks of manufacturers supplying apparatus to the electrical industry. It is now handling the Caldwell standard water tube safety boiler, the Ewart guaranteed friction clutch and their famous link-belt machinery.

THE GREAT WESTERN MANUFACTURING COMPANY reports its weekly sales of Clark wires and cables larger than ever. Its works at Duluth are crowded with orders for all kinds of electrical apparatus now on the catalogue of this enterprising firm. Manager H. K. Gillman has recently returned from a long Southern business trip.

LINCOLN & CO. is the name which now adorns the door of 934, the Monadnock. On the card handed out by Mr. Lincoln, late of Goodhue & Lincoln, the object of this new firm is stated as that of "high class electrical goods" and "manufacturers' agent." Mr. Lincoln is one of the popular young men of the West, and his future seems promising.

THE WALLACE ELECTRIC COMPANY, an announcement of which appeared in a recent issue, has completed its new catalogue, which shows that it will handle some of the best known specialties on the market. On May 1 this company will occupy a commodious store at 307 Dearborn street. Both Messrs. Wallace and Hine are very busy now-a-days.

THE INDEPENDENT ELECTRIC COMPANY, successors to the Sperry Mining Machine Company, is now meeting with deserved success in its efforts to introduce electrical machinery into mining operations. It has recently received some very flattering testimonials, and, what is more satisfactory, a number of very nice orders for apparatus of this kind.

THE METROPOLITAN ELECTRIC COMPANY seems to be about as busy as any firm in the West, and has all the business

it can handle. Its lines of specialties are exceptionally well liked by central station and street railway managers, and its headquarters on Fifth avenue are thoroughly equipped to handle the enormous business that seems ever on the increase.

THE CENTRAL ELECTRIC COMPANY, which recently surprised Chicago, and pleased its many friends by leasing the magnificent quarters lately occupied by the General Electric Company, on Adams street, is busy preparing to occupy them by the first of the month. Here it will occupy three floors, and will carry the largest stock of electrical supplies handled in Chicago. This company is just at present particularly active in the introduction of its high grade of interior wiring specialties, believing that the best interests of the fraternity will be subserved by the people themselves setting the standard for excellence, without being forced to do so by the insurance authorities. Its metal-sheathed bushings are meeting with a great success. On all lines which it handles business is reported remarkably good.

News of the Week.

Telegraph and Telephone.

WASHINGTON, PA.—The Washington Telephone Company has been chartered. The incorporators are T. F. Birch, John R. Kuntz and W. C. Bryson, of Washington.

CAMERON, MO.—The Slater & Davis Telephone Company has offered to put in an automatic telephone service as soon as 20 subscribers are secured, the charges to be \$18 per year.

BLOOMINGTON, ILL.—A local telephone company has been organized under the name of the Home Telephone Company, to build up a system to compete with the Bell company.

BUFFALO, N. Y.—T. J. Hurley, representing the International Telephone Company, which is headed by S. B. Elkins and others, has offered to install a telephone system at \$36 per year for subscribers.

AUGUSTA, GA.—Manager McDonald, of the Telephone Exchange, is in receipt of instructions to at once begin work on rebuilding the exchange plant. District Foreman James A. Owens, of Atlanta, will have charge of the work.

PAWNEE CITY, NEB.—Frank E. Griffing, instructor in telegraphy at the Nebraska Wesleyan University, Lincoln, is urging the adoption of a telephone system, and will endeavor to have a meeting of business men to consider the project.

THE ALBANY TELEPHONE BILL.—The only incident of importance at the hearing on March 28 was an attack by some members of the committee on Secretary Gardner, of the New York Board of Trade, for proposing to raise money and organize in order to defeat legislators favoring the Bell Telephone Company. The counsel of the latter company denied that the telephone rate in New York is \$240 per year.

Electric Light and Power.

SAUNDERSVILLE, GA.—Citizens are asking for an electric lighting plant.

CENTREVILLE, MICH.—Taxpayers have voted to issue \$20,000 in bonds for an electric lighting plant.

MONTCLAIR, N. J.—The matter of an electric lighting plant has been referred to the law committee.

FLORENCE, COL.—The Council has granted a franchise for electric lights to S. F. Rathvon, of Denver.

FERTILE, MINN.—The village has voted to issue bonds for water-works and an electric lighting plant.

COLUMBIA, OHIO.—Citizens will vote in April on the matter of bond issue for an electric lighting plant.

BALTIMORE, MD.—The Legislature has refused to grant permission to Baltimore to erect a municipal plant.

SHELDON, ILL.—The village will vote on the question of issuing \$6,000 in bonds for an electric lighting plant.

BLOOMDALE, OHIO.—C. B. Battrell and H. M. Hosler will soon begin work erecting an electric light plant.

HAMBURG, N. Y.—The Town Council has refused to increase the pay for electric light from \$60 to \$80 per annum.

NEWPORT, KY.—It is said that the electric light companies of Dayton, Covington and Newport will be consolidated.

CANAL FULTON, STARK COUNTY, OHIO.—Business men of Canal Fulton are agitating for an electric lighting plant.

BAINBRIDGE, N. Y.—An effort is being made to introduce electric lighting by the incandescent system into Bainbridge.

READING, PA.—An ordinance was introduced into the Council for a bond issue of \$125,000 for an electric lighting plant, to be decided by special election June 12, but the matter has been referred to a special committee.

WAVERLY, OHIO.—Authority has been given the town to issue \$15,000 in bonds for the erection of an electric lighting plant.

SHELDON, ILL.—The question of bonding the town for a \$5,000 electric light plant will be voted on at the coming village election.

SAN ANTONIO, TEX.—The City Council has granted a franchise to F. J. O'Belne to construct and operate an electric light plant.

BURLINGTON, VT.—The power house for electric light, near Winooski, has been badly damaged by fire, and Burlington is in darkness.

GEORGETOWN, OHIO.—A bill is before the Legislature authorizing Georgetown, Ohio, to issue \$10,000 in bonds for an electric light plant.

ATLANTIC HIGHLANDS, N. J.—The application of George H. Stout, Jr., for a franchise for electric lighting, was laid on the table indefinitely.

ERIE, PA.—The ordinance granting a franchise to the Merchants and Manufacturers' Electric Light and Power Company has been passed finally.

JACKSONVILLE, FLA., intends installing a city lighting plant of its own, and will sell bonds for this purpose in April, the weather gets warmer.

CASSOPOLIS, MICH.—The Village Board has granted an electric light franchise to the Cassopolis Light and Power Company for a period of twenty-five years.

NEWCOMERSTOWN, OHIO.—The House has passed Mr. Tracy's bill, authorizing an issue of \$15,000 in bonds by Newcomerstown to erect an electric lighting plant.

The Electric Railway.

HOT SPRINGS, S. D.—A franchise has been granted to J. M. Metcalf for an electric street railway.

ALLENTOWN, PA.—The Traction Company lines will be extended from Allentown to Easton, a distance of 15 miles.

SIoux CITY, IOWA.—The Consolidation Company has bought the cable line, and will at once equip it with electricity.

BRIDGETON, N. J.—The large new brick car house of the South Jersey Traction Company has been blown down and a number of cars wrecked.

LEWISTON, ME.—The City Council will give a hearing April 12 to the petition of the horse railway company to change its motive power to electricity.

ROME, N. Y.—Officials of the Rome Street Railway Company are investigating into the matter of changing their motive power, but nothing definite has been done.

ALBION, N. Y.—It is stated that the Albion and Oak Orchard Railroad will be built standard gauge, with electric power for passenger traffic and steam for freight.

MIDDLETOWN, CONN.—The Council has granted permission to the street railway company to use the trolley system. J. M. Douglas is president of the company.

PORTSMOUTH, VA.—A syndicate of local capitalists has bought the Portsmouth Street Railway, and they will improve and extend the line, put on new cars, rails, etc.

READING, PA.—The Reading and Southwestern Railway has asked for permission to occupy certain additional streets, and the matter has been referred to the committee on railways.

NEWBURGH, N. Y.—The Common Council has granted a franchise to the Newburgh Electric Street Railway Company. Joseph H. Dickey is president and H. C. Norton is manager.

COLLEGE POINT, L. I., N. Y.—The application of the White-stone and College Point Electric Railroad Company for right to lay tracks and operate a street railway will be given a public hearing on April 19.

BROOKLYN, N. Y.—The State Board of Railroad Commissioners has approved the application of the Brooklyn, Queens County and Suburban Railroad Company for leave to use the trolley system.

LAWRENCE, MASS.—The Lowell and Lawrence South Side Street Railway Company has been granted the right of way through Tewksbury, and will now proceed for extension into the city and Lowell.

ELMIRA, N. Y.—On April 9 will be heard the petition of the West Side Railway Company for permission to build and operate a line on Miller street and other streets. Thomas Spencer is city clerk of Elmira.

CHESTER, PA.—Eugene Harvey, Charles F. Wagner, Jr., John G. Dyer and William Wilson have applied for a charter for the Chester Traction Company, and they will be heard April 29. W. R. Broomall is solicitor.

GERMANTOWN, PA.—A permit has been granted to Contractor McCaul to erect a \$17,000 car shed for the Germantown branch of the Philadelphia Traction Company, on Germantown road, above Church street.

Personal Notes.

GENERAL EDWIN SENECA GREELEY, the head of one of the oldest electrical supply houses in the United States, was born at Nashua, N. H., on May 29, 1822, and from that date to this his career has been one of universal success. His ancestors were of the North of Ireland stock, that settled in and around Londonderry, N. H. When about 12 years old his family met with reverses, and he found himself forced to earn his own living. For the greater part of three years he worked in a cotton factory. He had already developed an inclination for mechanical pursuits, being especially interested in locomotives. He therefore chose the trade of machinist, securing a position in Manchester. He became dissatisfied with that, and started for Schenectady, N. Y., where new locomotive shops had been built.



He obtained a position there, but later was employed in the Rogers Locomotive Works, at Paterson, N. J. In 1854 he visited New Haven, and was so well pleased with that place that he determined to make it his home, and shortly after he entered the employ of the New York and New Haven Railroad Company, where he remained until the outbreak of the Civil War. He was appointed First Lieutenant of a company in the Tenth Connecticut Volunteers, and immediately proceeded to the front. He remained in service throughout the war, repeatedly winning honors and being rapidly promoted, until in the early part of 1865 he was brevetted Brigadier General. Returning in September of that year he soon formed a partnership with Mr. L. G. Tillotson, of New York, a practical telegrapher, who had recently retired from the railway and telegraph supply trade, but who wished to re-enter business in connection with some one who could furnish a personal knowledge of railway materials. The house of L. G. Tillotson & Co. became one of the oldest and most successful manufacturers and importers of railway and telegraph supplies. In January, 1885, Mr. Tillotson died, and his interest was acquired by General Greeley, who conducted the business under the name of E. S. Greeley & Co. until 1888, when it was reorganized as a joint stock corporation, and is known as "The E. S. Greeley & Company." At the beginning the capital was small and their facilities limited, but to-day their trade extends all over the civilized world. General Greeley has taken an active interest in electric lighting, and assisted in organizing the New Haven Electric Light Company and also the New Haven Car Trimming Company, of which he has been twice president. He is a director in various other manufacturing companies, and in the Yale National Bank. He is an active member of the G. A. R. and of the military order of the Royal Legion. Political honors he has steadfastly avoided.

MR. T. J. SMITH, the head of the electrical department of the

E. S. Greeley & Co., is, through the course of training his career has given him, one of the most practical and successful handlers of electrical materials that the supply business has produced. Born in 1853, and consequently 41 years of age, he entered the electrical field before he entered his teens, in connection with the Commercial News Department, familiarly known in telegraph and commercial circles as C. N. D., several years before that department fell to the possession of the Western Union Telegraph Company. He was a telegrapher at 15, the manager of the Hoboken, N. J., office of the Western Union Telegraph Company at 16, and in his 21st year was in charge of the Panama Railroad telegraph office, the cable company's office at Panama, and held office under the Panama Gov-



ernment as instructor in telegraphy to the youth of the National College for the Deaf. In 1876 he was a builder of telegraph and telephone lines in Spanish America, through which countries he publicly exhibited the phonograph, under commission from Thomas A. Edison, and introduced electrical apparatus of all description, from the electric light to the lightning rod, acquiring a knowledge of the people, their language and customs that has been of no small service to him in his subsequent work. He entered the employ of the E. S. Greeley & Co. just ten years ago in the capacity of city salesman, and there won such a position for

himself that upon the death of Mr. W. M. Goodyear, in 1889, he succeeded to the management of the electrical department. Mr. Smith is also a stockholder of some consideration in the E. S. Greeley & Co., and enjoys the distinction of being the youngest member on the board of directors.

Miscellaneous Notes.

A NEW STREET RAILWAY ASSOCIATION.—Representatives of the various street railways of Connecticut met at New Haven on April 3 and formed an association, which is to be incorporated as the Connecticut Street Railway Association. These officers were elected: President, H. Holden Wood, Derby; vice president, Henry S. Parmelee, New Haven; treasurer, E. S. Goodrich, Hartford; secretary, R. A. Fosdick, Stamford; executive committee, A. M. Young, Waterbury; G. A. W. Dodge, New Haven; Israel Kelsey, New Haven.

A COURAGEOUS LADY.—Last week while Mrs. Washington Roebling, of Trenton, was giving an entertainment in her house, she learned that workmen of a trolley road were erecting a pole in front of her grounds. Throwing a cloak over her shoulders she at once proceeded to the scene of action, where she arrived as a pole was about being erected. Upon the refusal of the foreman in charge to desist, Mrs. Roebling took her stand on the pole so that it could not be raised, and directed her servants to fill up the hole. The workmen then proceeded to dig another hole, whereupon Mrs. Roebling seated herself on a lawn settee placed over it, while her butler stood guard in the other hole. As the workmen commenced to dig a third hole a new plan of campaign was adopted, and presently a stream of water from a hose in the grounds temporarily dispersed the workmen, who, however, finally succeeded in erecting a pole about 4 o'clock in the morning, just before friends of Mrs. Roebling had succeeded in procuring an injunction.

Trade and Industrial Notes

THE MERIAM & MORGAN PARAFFINE COMPANY, Cleveland, Ohio, has issued a pretty miniature pamphlet containing a few weighty words, calling attention to its "Paragon" pitch, dynamo oils, and paraffine wax for insulating purposes.

THE BREESE & MANSFIELD COMPANY, electric railway engineers, Betz Building, Philadelphia, represents the Walker Manufacturing Company, of Cleveland, for the sale of electric street railway equipments.

THE GARTON-DANIELS ELECTRIC COMPANY, Keokuk, Iowa, has issued a 20-page catalogue, describing and illustrating the various forms of the Garton lightning arrester, and containing a number of exceedingly favorable testimonials as to its efficiency.

THE ST. LOUIS IRON AND MACHINE WORKS has issued a handsome 36-page catalogue, illustrating and describing the St. Louis Corliss engine. Owing to the clearness of the engravings and the detail in which they are given, the pamphlet will be a useful one to add to the collection of the engineer.

THE MICA INSULATOR COMPANY, 218 Water street, New York, has put in a telephone, No. 968 Cortlandt. Their numerous customers can now be in constant communication with them, and should they be in need of micanite, by simply ringing them up, they can have the material delivered promptly.

THE LODGE & SHIPLEY MACHINE TOOL COMPANY

sends us a 44-page pamphlet containing illustrations, accompanied by concise descriptions, of machine tools for the rapid production of lathe work. Among the machines are a number of turret lathes, pulley lathes, boring, drilling, tapping and facing machines. A number of testimonials from prominent firms are also printed.

THE CARD DYNAMO AND MOTOR COMPANY, Cincinnati, Ohio, which has recently taken up the manufacture of street railway apparatus, has secured a very large order from the Consolidated Street Railway, of Cincinnati, and large orders from other roads, so that it has on hand at present orders for more than 100 street railway motors with the necessary apparatus to accompany them.

I. H. MOSES, 36 South Water street, Cleveland, Ohio, has issued a manual of telegraphy, which also contains a price list and catalogue of telegraph instruments and supplies. Among other useful information is a section containing answers to questions frequently asked by those intending to enter telegraphy or put up short lines, and prices and practical directions in regard to the latter are given.

THE BUCKEYE ENGINE COMPANY, Salem, Ohio, has recently sold engines to the following electrical plants: Ellsworth (Me.) Electric Illuminating Company, 180 h. p., high speed; Dayton (Ohio), Street Railway Company, three 500-h. p. tandem compounds, arranged for direct connection to Siemens & Halske generators; the McKeesport and Wilmerding Street Railway Company, McKeesport, Pa., 80 h. p., medium speed; Richmond (Ind.), Light, Heat and Power Company, two 300-h. p. medium speed tandem compounds.

WARREN WEBSTER & CO., of Camden, N. J., manufacturers of vacuum feed water heaters and purifiers, and oil and steam separators, report that the number of orders they received for the above named specialties during the month of March was very satisfactory, and showed a marked improvement over the few former months. They say that the reason their specialties sell during these times is on account of their goods being fuel-saving devices. Rapid progress is being made upon the new extension of their wrought iron department, connected with the new works, which they built last year.

THE BROWN ELECTRIC COMPANY, of Boston, Mass., one of the most enterprising supply houses in the country, announces a full-size complete telephone, with compound magnet, at a phenomenally low price that will undoubtedly attract quick sales, as it affords an opportunity of enjoying this modern necessity at a small cost. The Brown company announces also, that until it can catch up with orders, occasioned by the exceedingly large demand for these receivers, it will be obliged to fill all orders in rotation. Every instrument is guaranteed to be as perfect as any on the market, and the Brown company always stands behind anything it sells, and customers may depend upon receiving goods from it just as represented.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon Porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient and at prices lower than ever. **THE HAYDEN-BOOKER MFG. CO.**, 2140 DeKalb St., St. Louis, Mo.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED MARCH 27, 1893.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

Reissue. 11,408. **ELECTRIC ELEVATOR**; F. E. Herdman, Winnetka, Ill. Application filed Nov. 27, 1893. The combination of a switch, a second switch, a translating device, and circuit connections whereby upon closing by the first switch a circuit independent of the translating device, the second switch will automatically be operated to close the circuit of the translating device.

Reissue. 11,409. **ELECTRICALLY OPERATED ELEVATOR**; F. E. Herdman, Winnetka, Ill. Application filed Jan. 23, 1894. The combination of a worm shaft, a lever, one end connected to the shaft so as to move therewith, a tension device connected to the lever, and intermediate connection between the lever and the source of power, whereby when the movement of the shaft exceeds the tension device the lever moves over and shuts off the power.

517,017. **INCANDESCENT ELECTRIC LAMP**; R. P. Ashwell and G. W. Tuttle, Newark, N. J. Application filed Aug. 11,

1893. This comprises films reduced from a solution of paste of platinum chloride applied on the adjacent surfaces of the bulb and stopper, and solder of similar material uniting the films.

517,018. **SECONDARY BATTERY**; G. L. Ballard, Toronto, Can. Application filed April 27, 1893. This comprises a bridge or stand, a notch therein, and a plate provided with a foot adapted to enter the notch.

517,028. **ELECTRIC RAILWAY TROLLEY**; F. S. Church, Detroit, Mich. Application filed April 17, 1893. A trolley formed of two wheels, having complementary grooved beveled faces.

517,042. **ELECTRODE FOR ARC LAMPS**; S. Heimann, New York, N. Y. Application filed Sept. 15, 1893. An electrode composed of a mixture of powdered ashes, carbon and a binding surface.

517,069. **ELECTRIC LAMP**; F. C. Rockwell, Hartford, Conn. Application filed Nov. 6, 1893. An electric lamp receiver consisting of a transparent globe, and a base molded to fit the open mouth of the globe to which it is sealed, the base being grooved so as to render it elastic.

517,100. **ELECTRIC SWITCH**; J. S. Gibbs, Hartford, Conn. Application filed Oct. 4, 1903. This comprises a base with stationary contacts and a rotary handle spindle carrying a threaded nut, a block with conducting poles loosely connected with the nut, a lock on the base, and a spring for rotating the block when the nut is released from the lock.

517,105. **ELECTRIC MOTOR OR DYNAMO ELECTRIC MACHINE**; J. W. Henderson, Philadelphia, Pa. Application filed Nov. 1, 1899. The method of regulating an electric motor consisting of maintaining a constant field and varying the length of the wire on the armature inversely with the variations in the speed of the armature.

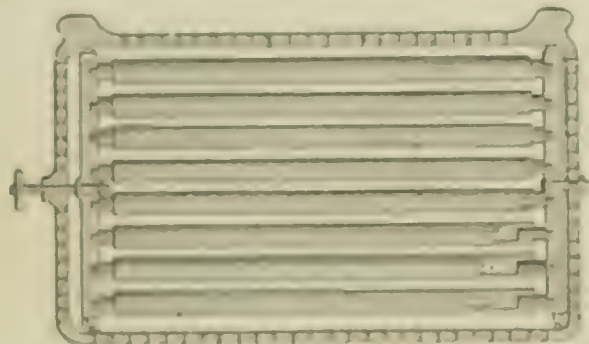
517,120. **SAFETY CUT-OUT FOR ELECTRICAL APPARATUS**; H. Lemp and M. J. Wightman, Hartford, Conn. Application filed July 31, 1905. This comprises the two poles of a circuit, an interposed mass of material which is normally an insulator, but which, when a current is passed over it, is heated and reduced to a conducting state, and forms a permanent bridge between the poles.

517,134. **APPARATUS FOR SUPPLYING OR REMOVING STORAGE BATTERIES**; W. E. Worthen, New York, N. Y. Application filed Aug. 5, 1893. The combination in a railway car having floor trucks, of a removable battery truck provided with wheels and carrying a storage battery and motor.

517,162. **ELECTRICAL MEASURING INSTRUMENT**; R. M. Hunter, Philadelphia, Pa. Application filed March 24, 1893. This comprises a stationary frame, a pivoted structure carried thereby, an expandible body connected at one end to the pivoted frame and at the other to the stationary frame, and over which an electric current to be measured is passed, a movable pointer connected with the pivoted frame, and a compensating body connected to the pointer and to the movable frame.

517,163. **ELECTRICAL INDICATOR**; A. E. Kennelly, Orange, N. J. Application filed Oct. 26, 1892. This comprises a magnet, disc armature situated flatwise between the poles of the magnet, and having a winding adapted to carry the current to be measured, and an indicating device moved by the disc armature.

517,166. **TROLLEY CATCHER**; L. G. Mowry, Buffalo, N. Y. Application filed Dec. 11, 1893. The combination with a pivoted depressor rod and its locking and releasing devices, of a trip cord connected with the trolley and an adjustable attachment connecting the trip cord with the depressor rod.



NO. 517,170.—ELECTRIC HEATER

517,169. **ELECTRIC APPLIANCE FOR DUMB WAITERS**; J. H. Roberts, Brooklyn, N. Y. Application filed Sept. 11, 1903. This comprises electric switches in the path of the waiter combined with a reversible rheostat, a switch-board adjacent thereto, switch arms thereon operable from the rheostat, and conductors from the switch-board to the rheostat and the switches.

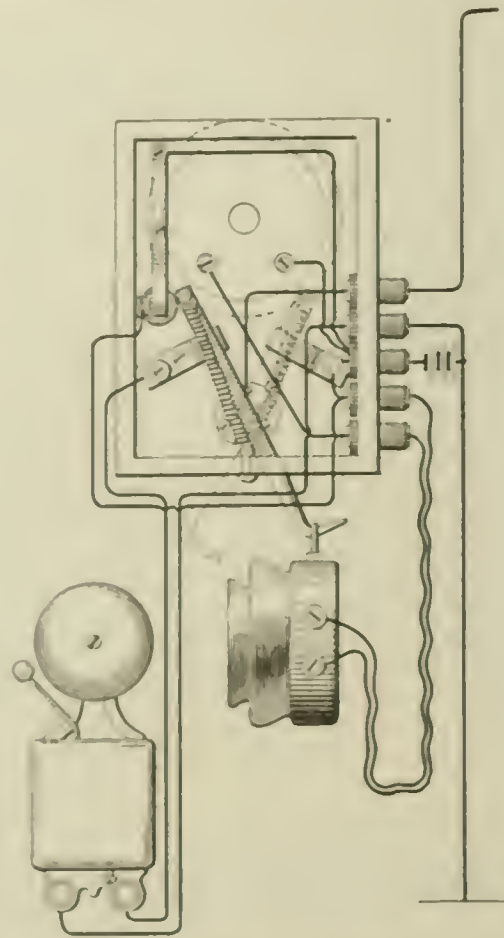
517,170. **ELECTRIC HEATER**; L. H. Rowley, Ashland, Wis. Application filed Jan. 20, 1902. This comprises a plurality of tubes of non-conducting material, electrical resistances therein, plugs closing the ends of the tubes and in contact with the resistances, and two metallic plates, one located at each end of the tube and in contact with all the plugs, one of the plates being mounted upon rollers and provided with means whereby it may be moved for the purpose of varying the resistance of the material within the tube. (See illustration.)

517,190. **VALVE**; J. E. Steward, Springfield, Mass. Application filed July 24, 1905. The combination with a casing having a main passage and lateral extensions, of a valve and valve piston reciprocating in the extensions, the valve comprising a slotted hollow cylinder having a central internal extension.

517,243. **SINGLE LINE TELEPHONE SYSTEM**; J. I. Sabin and W. H. Hampton, San Francisco, Cal. Application filed March 13, 1893. This comprises a line, an operator's telephone normally in connection therewith, and means at the subscriber's station whereby he may include his telephone set in circulation with the operator's telephone.

517,253. **GALVANOMETER**; E. G. Williams, Philadelphia, Pa. Application filed June 25, 1899. This comprises a controlling magnet, and two adjustable tubular parts combined with a core upon which are fitted the tubular parts and in which the tubular parts are adapted to be simultaneously moved upon or off the core part to vary the magnetic flux of force, and in which the movable tubular parts are relatively magnetic to the core, or vice versa.

517,525. **ELECTRICAL RAILWAY**; B. Bidwell, Philadelphia, Pa. Application filed Jan. 8, 1895. This comprises a line of conductors, a loop in the generator circuit having telephonic instruments and resistance coils, in combination with a car having a traveling circuit connector, a motor circuit and a loop from the motor circuit, and including a telephonic instrument and resistance coils.

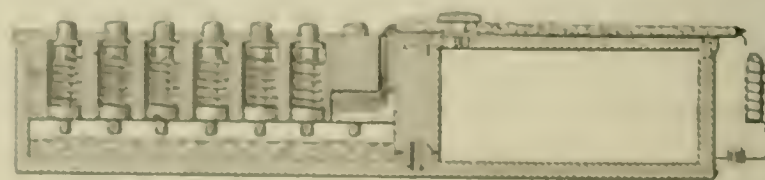


NO. 570,263.—TELEPHONE SWITCH.

517,263. **TELEPHONE SWITCH**; F. R. Colvin, New York, N. Y. Application filed Dec. 6, 1893. A switch provided with a tilting hook for the telephone, the free end of the hook normally pointing upward, the angle of tilt to shift the switch being sufficient to cause the hook to point downward to shed the telephone. (See illustration.)

517,276. **METAL COVERED ELBOW**; E. T. Greenfield, New York, N. Y. Application filed July 14, 1891. An elbow made of insulating material and a close fitting surrounding metallic jacket or sleeve.

517,299. **ELECTRIC CALLING APPARATUS**; D. H. Rice, Brookline, Mass. Application filed Feb. 11, 1892. This comprises a converter having an annular core with a segment cut out of it and a metal block fitted thereto, and arranged to complete the core, an armature connected with the block, and a magnet in the secondary circuit of the converter, arranged to lift the armature and withdraw the block, when the electric current generated by the converter exceeds a predetermined strength.



NO. 517,402.—ELECTRICAL KEYBOARD.

517,402. **ELECTRICAL KEYBOARD**; C. E. Allen, Salem, Mass. Application filed Dec. 29, 1893. A key support for electric key boards consisting of a non-conducting plate provided with parallel rows of chambers and grooves or channels in the plate between the rows of the chambers. (See illustration.)

517,404. **CIRCUIT CLOSER**; C. E. Allen, Salem, Mass. Application filed Dec. 29, 1893. This comprises a key or push button and a mercury contact therefor, whereby a continuous metallic circuit can be obtained.

517,419. **ELECTRICAL APPARATUS FOR CONTROLLING SIGNALS**; M. B. Leonard, Richmond, Va. Application filed June 17, 1891. This comprises a visual signal at each station and means for locking the same in normal position, unlocking magnets, a normally grounded wire extending between the stations and including the magnets, a local battery at each station, and means for transferring the ground connection to either of the local batteries so as to include the distant unlocking magnet and release the distant signal, and an electric motor adapted to automatically shift the signals when released.

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1883 " 63 " " "	1890 " 289 " " "
1884 " 82 " " "	1891 " 325 " " "
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THE BERLINER SUIT.

The taking of testimony in the suit of the United States Government to annul the Berliner telephone patent was ended last week, and the record closed, and we have been informed by one of the Government counsel that the case will soon come before the United States Circuit Court at Boston for trial. The suit, besides the interest which its great importance attaches to it, will also probably develop technical features of interest, one of which will doubtless be the question whether a transmitter made under the specific claims of the Berliner patent will really transmit speech.

THE NEW POSTAL TELEGRAPH BUILDING.

The very full description we give elsewhere in this issue of the electrical features of the new Postal Telegraph office building, in which The Electrical World has taken up its abode, will be found interesting as showing among other things what a large part electricity plays in a modern building of this description. The electrical machinery for supplying the current for the electric elevators, for lighting and for telegraphic purposes, though the latter is but a very small fraction of the whole, aggregates no less than 625 h. p., or sufficient to run an express train continuously at a high rate of speed. As a comparison between dynamos for generating electricity for telegraphic purposes and primary batteries, it may be stated that the motor-dynamos that will supply the Postal Telegraph lines with current could be placed in the space occupied by a few hundred gravity cells, and yet they furnish at an insignificant expense and with no regular attendance the current that would otherwise require thousands of cells, occupying an enormous space and at a great cost for chemicals, zincs and care. In addition to the other applications of electricity, there will be electric ventilating fans for summer use, and the desks in different departments of some of the larger offices will be connected by a local telephone circuit, thus obviating the necessity of passing from one room to another when desiring to consult on the numerous questions that arise in the conduct of a large business. With the most extensive and costly offices of any purely technical periodical in the world, located in perhaps the most modern office building in existence, The Electrical World makes a fitting entry upon its twenty-first year, and with its facilities thus extended, ought to still further increase the lead which it has so long maintained in the field of electrical journalism.

RAPID TRANSIT IN BOSTON.

The subject of rapid transit is rapidly coming forward in our larger cities, and of these Boston, after New York, is the one most eagerly seeking a solution to the problem. Three plans have been urged—elevated railways, tunnels, and a subway under one of the most congested streets in connection with elevated roads at the termini. The sacred Commons has interfered with some of the plans that proposed to appropriate a right of way through it, and elevated railways seem to have been discussed largely without reference to the atrocious manner in which they disfigure a city, or the retrograde step in civilization that the toleration of their accompanying din implies. If Boston accepts the elevated railway, then the paragraphs in regard to the worship of John L. Sullivan by its citizens, which were formerly current, can be accepted seriously and as an indication of the changed character of the inhabitants of the Hub. What seems to be by far the best plan offered is one similar to that proposed by the Chamber of Commerce for New York, and, like the sub-

way scheme, involves the use of electricity for motive power. The plan embraces six double tunnels radiating from a central point—equivalent to three separate lines—and extending to a depth below the surface sufficiently far not to affect the foundations of buildings. The stations would be about as far below the surface as the New York elevated stations are above, the down and up grades at each station serving the useful purpose of assisting in gaining momentum when leaving, and losing momentum when arriving at a station. It is estimated that the lines can be built for \$1,500,000 per mile, or all for less than one of the single alley elevated lines proposed. There can be no doubt but that the underground plan, with electricity for motive power, is the only one that offers a permanent solution to the rapid transit question in any city. If the New York Chamber of Commerce rapid transit bill, as modified last week, is passed, as now seems probable, an impetus will be given to the underground system, through furnishing a model for other cities, that will have a far-reaching effect, and also definitely fix the status of electricity as a motive power for rapid transit purposes.

GALVANOMETER SHUNTS.

We print elsewhere in full the paper on "A Universal Shunt Box For Galvanometers," recently read by Prof. Ayrton before the English Institute of Electrical Engineers, with corrections and additions by the authors. The advantage of the form of shunt box described over the usual forms is very apparent, as it not only obviates the accurate division of a shunt resistance in terms of the resistance of the galvanometer, but also reduces errors due to change in temperature. Other advantages are that the same shunt box may be used with different galvanometers, changes in the shunt introduce smaller changes in the resistance of the circuit, and ballistic currents are measured by its means with much greater accuracy than with the old form, though no proof of this is given. To apply the shunt to any galvanometer it would seem from the description that it is only necessary to determine once for all the ratio of the current passing through the galvanometer with any one of the plugs in, and the quantity expressing this ratio may then be combined with the galvanometer constant. This ratio could be determined either by means of another galvanometer, in which case the value of the resistance of neither the galvanometer nor of the shunt box need be known, or by calculation, both these quantities being then known. It is needless to say that this invention marks a real advance in laboratory apparatus, and it seems singular that such a simple and obvious device has not been thought of before.

THE PRACTICAL MAGNETIC UNITS.

One of our contemporaries devotes considerable space to a discussion of the provisional names recently adopted by the American Institute of Electrical Engineers for the C. G. S. magnetic units, and while bestowing approval in some respects, indulges in some rather remarkable criticism in others. The desirability of concrete names for the units is agreed to, the argument for Greek names is disapproved, and it is acknowledged that so far as the names adopted are simpler than the terms before in use, they are an improvement—which concedes all that is practically at issue. It is argued, however, that instead of following the system adopted in naming the electromagnetic units, and consequently bestowing proper names on the magnetic units, the names of the former with prefixes or affixes—preferably affixes—would have been more appropriate, as "indicating their connection and relation with the former"—that is, with the volt, ampere and ohm. It is left to the ingenuity of the reader, however, to invent the proper affixes, and to determine whether a field of force, for instance, is to be expressed in the terms of the ampere, volt or ohm. The writer dwells upon the necessity of a

nomenclature that shall "clearly indicate the inter-relation between the electrical, magnetic and mechanical units, and that inter-relation should be expressible by 10 or powers of 10," and at the same time desires the magnetic units to be directly derived from the electromagnetic ones—as they now are. He might as well ask that π should be given the value of unity with respect to a circle without any change in the funda-

mental linear unit. π in measurements of the circle and $\frac{1}{4\pi}$ in magnetic measurements are constants of nature, and cannot be thus summarily disposed of. If, for example, our present system of linear measurements were based on π instead of on 10, then, while the ratio of the circumference to the diameter of a circle would become unity, the diameter would have to be expressed in terms of π ; similarly, if the practical unit of magnetomotive force, or gilbert, were made equal to an ampere-turn, or unity, as proposed instead of .7958, as objected to, then the reluctivity of air, for example, instead of being unity, would be expressed by $\frac{1}{.7958}$ or 1.2566. While

thus practical difficulties would be encountered, the plea of the writer that the magnetic units should be directly derived from the electromagnetic units and their direct inter-relation maintained would also be fruitless, for the constant objected to is, in fact, that which binds the two systems together. Should magnetomotive force be made expressible in ampere-turns, either directly or in powers of 10, then the direct connection of the two systems would be severed, or, if maintained, the constant gotten rid of in the magnetomotive force would have to appear in current, electromotive force or resistance. This follows from the centimetre, gramme and second being equally the basis of both the electromagnetic and magnetic units. If we make a change in the value of the unit of magnetomotive force derived from these, that implies a change in one of these fundamental units; if the unit of magnetomotive force is to be expressed by unity, it will be seen, bearing in mind the B. A. definition of current,

that the dyne must be reduced from unity to $\frac{1}{4\pi}$, and,

therefore, either the centimetre or gramme would be changed in the same ratio if the units in the two systems are to remain directly related, and consequently the present values of the unit of electromotive force, current or resistance would also be changed. Were these difficulties not present, any change in the magnitude of units, it may be here remarked, would not have been within the province of the Institute. The action of that body was not, as seems to be supposed by some, the adoption of a new system of units, but merely consisted in giving names to the present C. G. S. magnetic units. As these same units were already in universal use as practical units, for we need not count the absurd "Kapp lines," no change was made beyond giving them concrete names. The ampere-turn is not displaced nor affected in any way, for the gilbert, though then nameless, was used in all previous operations involving magnetizing force—that is, ampere turns.

Patent Litigation.

Judge Cox, of the United States Circuit Court, on Monday, April 6, heard the arguments of the General Electric Company for a preliminary injunction against the F. P. Little Electrical Company, of Buffalo, N. Y., and the E. G. Bernard Company, of Troy, N. Y., for alleged infringement of various patents, as follows:

Patents on compound winding, the three-wire system, coupling dynamos (two), lamp sockets, multiple arc system, double-pole safety catch, and safety catches with special ends and porcelain bases. The above eight patents were in both

bills, and in addition a patent on the use on the same circuit of incandescent lamps of different candle power in that of the E. G. Bernard Company, and one on coupling compound dynamos in parallel in that of the F. P. Little company. Counsel for the General Electric Company asked permission, which was granted, to withdraw the patents on the three-wire and multiple arc systems, double-pole safety catch, coupling compound dynamos in parallel, and the one relating to incandescent lamp sockets, which is the same that was recently declared void by Judge Coxé, in the suit of the Syracuse Electrical Engineering and Supply Company.

The court sustained the demurrer of the counsel of the E. G. Bernard Company on the ground of multifariousness of the bill of complaint, and dismissed the motion for a preliminary injunction with leave to use the papers heretofore served, when amended, in any new motion for an injunction, if one is made.

In the case of the F. P. Little company, the court refused to consider the motion for a preliminary injunction on the ground that it involved the consideration of questions of fact, which should not be determined on affidavits but postponed for proper consideration on final hearing. The defendant filed a bond of \$5,000 and the case was put over for final hearing.

Unipolar Induction and Current without Difference of Potential.—II.

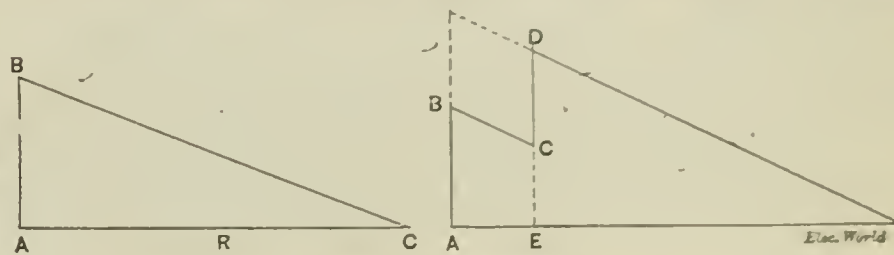
BY A. G. WEBSTER.

CURRENT WITHOUT DIFFERENCE OF POTENTIAL.

This is another frequent stumbling block. In the issue of Feb. 17 Mr. Philip K. Stern falls foul of the typical example given by Prof. Anthony, propounds a theory involving strains in the luminiferous ether, and winds up with the request to be kindly informed if a current flows in a ring without difference of potential, which way it may be expected to flow. This depends on which pole of the magnet is thrust into the ring. Prof. Anthony might retort by asking, if there is a difference of potential, at which point of the ring it may be expected to be the highest. I suppose there is no question that a current would flow in the ring. The trouble in the matter generally proceeds from a misapprehension of what potential and electromotive force really are. Difference of potential implies a disturbance of the distribution of charge from the state of equilibrium, requiring work to produce it, but not to maintain it. In order to maintain it a counterbalancing electromotive force is necessary; otherwise the charges will flow back, causing a current. Now an electromotive force may act continuously with or without a difference of potential. Ohm's law tells us that the current in a conductor between two points is proportional to the electromotive force in the conductor between them plus the difference of potential, or "drop," between them. If the electromotive force is equal and opposite to the drop, there will be no current. If, on the other hand, there is an equal electromotive force generated in every unit of length all around the circuit, there will be no difference of potential. The case of the ring mentioned is an example. A symmetrical solenoid closed on itself with a magnet thrust into it, or with another solenoid forming a transformer, is another.

Perhaps the subject is made simpler where the electromotive force is not due to induction, and is not continuous in the conductor. Consider a single cell of a battery. If we represent the potential of different points in the circuit as ordinates to abscissas representing resistances measured from a fixed point of the circuit, we get a straight line whose slope represents the strength of the current. At some point in the cell the potential rises abruptly by the amount $A B$ Fig. 9. Consider now two cells, each of half the former electromotive force, the whole resistance of the circuit being

the same as before. The current is the same as before, but the greatest difference of potential between any two points is now represented by $E D$, Fig. 10, and is less than before. Consider now any number of cells, say six, each of one-sixth the original electromotive force, connected in a ring,



FIGS. 9 AND 10.

without external resistance, the total resistance being still the same. The current is the same as before, but the maximum difference of potential between two points is only $A B$ Fig. 11, one-sixth as much as at first. Consider now a great many cells so connected, the total electromotive force and resistance being the same, hence the current also, while the difference of potential between any two points is extremely small, and in the limit zero. Thus we see how, when the



FIG. 11.

electromotive force is continuously distributed, we may have a current as large as we please, without difference of potential. In all the figures the oblique lines are intended to have the same slope.

In the issue of Feb. 24 Mr. Oliver B. Finn describes a pretty experiment with an oil can and an electrical belt (not of Harness'), and he also propounds a theory, involving ether vortices this time. I am beginning to regret that Prof. Lodge ever wrote that book. If Mr. Finn will take the trouble to calculate the magnetic effect of a moving charge, bearing in mind the size of the ratio between the electrostatic and electromagnetic units, he will get some idea of the inadequacy of his explanation. The same remark applies to Prof. Elihu Thomson's recent theory of terrestrial magnetism. For although the effect of a charge in motion is the same as that of a current, and although, as Hertz has shown, moving magnetism or varying electromagnets produce electrostatic effects, the magnitude of such effects is so small that they have never been observed except by Rowland, in his classical experiment, and in a similar one by Röntgen. The exact symmetry, by the way, between the electromagnetic and magneto-electric equations, as brought out by Hertz, and unfortunately a good deal disguised in Maxwell, is a good reason for preferring Hertz's equations to Maxwell's.

The writer, like many others, has difficulty in remembering the relative directions of magnetic force, current and motion. He finds the following rule convenient. It is only necessary to remember the direction of linking of current and line of force. The positive directions in the two links are taken as the directions of rotation of the hands of a watch standing before you and lying on its back, respectively. Either link represents the current and the other the line of force produced by it. Unlinking induces a positive current. This gives us the following two rules for motor and dynamo. The right hand gives us the directions for motor, the left for dynamo. Forefinger gives magnetic Force, Middle finger direction of Motion, thumb current in motor, or electromotive force in dynamo.

(In replying to the first part of Mr. Webster's article, I regret that I cannot agree with him that he has "effectually disposed of the question whether the field of a symmetrical magnet rotates with it or not." The question whether the

lines or tubes of force rotate with the generating coil or with the iron core (which, I suppose, is what he meant in the above quotation) still remains unanswered. All that he has shown is that theoretically it appears to make no difference what the answer to this question is, a point which I, for my part, never disputed. Practically, however, that is, in the actual construction of a machine, it may make a very great difference. As the principal obstacle in the construction of a unipolar machine lies in a practical difficulty, namely, in

Analogies and Differences Between Magnetic and Electric Quantities.

BY CARL HERING.

Students and beginners may find some assistance in the following tabulated summary. Although the analogies are not perfect, yet they are at least sufficiently so to assist one in obtaining a good general idea of most of the magnetic quantities:

ANALOGIES.

MAGNETIC				ELECTRIC			
Quantity.	Sym- bol.	Practical and C. G. S. unit.	Formula.	Quantity.	Sym- bol.	Practical unit.	Formula.
Magnetomotive force	$\mathfrak{A}$	gilbert †	$\mathfrak{A} = \frac{4\pi}{10} A t$	Electromotive force	E, e	volt	$E = \frac{\phi}{10^9 T}$
Magnetizing force	$\mathfrak{H}$	gauss‡	$\mathfrak{H} = \frac{4\pi A t}{10 L}$	(No analogy)	.....	.....	.....
Reluctance	$\mathfrak{R}$	oersted	$\mathfrak{R} = \frac{L}{S} r$	Resistance	R, r	ohms	$R = \frac{L}{S} \rho$
Flux	ϕ	weber	$\phi = \frac{\mathfrak{A}}{\mathfrak{R}} = \mathfrak{H} S$	Current	C, c	ampere	$C = \frac{E}{R}$
(No analogy)	.....	.....	.....	Quantity	Q, q	coulomb (ampere hour)	$Q = C T$
Reluctivity or specific re- luctance (air = unity)	r$	.....	r = \frac{1}{\mu}$	Resistivity or specific re- sistance	ρ$	.....	\rho = \frac{R S}{L} = \frac{1}{\gamma}$
(Not used)	.....	.....	.....	Conductance (popularly called conductivity)	G, g	mho	$G = \frac{S}{L} \gamma = \frac{1}{R}$
Permeability (air = unity)	μ$	.....	\mu = \frac{1}{r} = \frac{\mathfrak{B}}{\mathfrak{H}}$	Conductivity or specific conductance (popularly called specific conduc- tivity)	γ$	.....	\gamma = \frac{1}{\rho}$
Field intensity and Magnetic induction.	$\mathfrak{H}$ $\mathfrak{B}$	gauss gauss	$\mathfrak{H} = \frac{\phi}{S}$ $\mathfrak{B} = \mu \mathfrak{H}$	Current density	.....	amperes per unit of cross sec- tion	$C = \frac{E}{R}$
Magnetic law	.....	.....	$\phi = \frac{\mathfrak{A}}{\mathfrak{R}}$	Ohm's law	.....	.....	$C = \frac{E}{R}$

the necessity of having a large number of sliding contacts, this question might be of considerable importance in the actual construction of a machine, even though theoretically it might not affect the results.

I must differ with him very decidedly in his rather brusque statement that this question is "devoid of sense," for, aside from the reasons given above, I cannot agree with him that it is ever "devoid of sense" to try to understand a phenomenon or experiment thoroughly in all its details. In this very subject of unipolar machines it has generally been a want of a thorough understanding that has led many to construct inoperative machines.

The question at issue, if it is of interest to any one, could be decided very easily by constructing a crude unipolar machine of a disc in front of an electromagnet by revolving the disc, first, with the whole magnet at rest; second, with the core revolving with the disc, the coil remaining at rest, and, third, with the coil revolving with the disc and the core remaining at rest. If the E. M. F. between the centre and the circumference of the disc be measured in each case, it seems to me the question could be settled. (Carl Hering.)

British Association.

At the coming meeting of the British Association, at Oxford, Prof. A. W. Rucker will preside in section A (Mathematics and Physics), and Prof. Kennedy in section G (Mechanical Science). Sir Douglas Galton will be proposed as president for the meeting in 1895, which will be held at Ipswich.

$A t$ = number of ampere turns in a coil, S = surface or cross section in square centimetres, L = length in centimetres, T = time in seconds. With the exception of C for current, all the symbols used are those recommended by the recent International Congress (see THE ELECTRICAL WORLD, Sept. 23, 1893), in which I and i are used in place of C and c for current. The practical magnetic units are the same as the C. G. S. units.

† These two formulas form the connecting links between the two systems.

‡ Ampere turns are used more frequently as the practical unit, but an ampere turn is not numerically equal to the C. G. S. unit of gilbert: 1 ampere turn = 1.25664 gilbert or C. G. S. unit; 1 gilbert or C. G. S. unit = 0.795775 ampere turns.

§ Magnetizing force is more frequently measured in ampere turns per centimetre of length.

DIFFERENCES.

The two important differences between the two systems are:

(1) That the specific electric resistance of the usual materials is very nearly constant (varying only slightly with the temperature), while the specific magnetic reluctance varies very greatly with the flux density.

(2) That, as a magnetic circuit cannot be "insulated" magnetically, it is similar to an electric circuit which "leaks" very much; that is, to an electric circuit placed, say, in a poorly conducting liquid whose specific resistance is from several hundred to several thousand times as great as that of the magnetic circuit.

A Good Advertisement for Lightning Rods.

Abraham Lincoln, in a political speech, is reported to have said that a certain political opponent had felt obliged to erect a lightning rod over his house to protect a guilty conscience against an offended God. Soon after this the lightning rod business boomed all over the country.

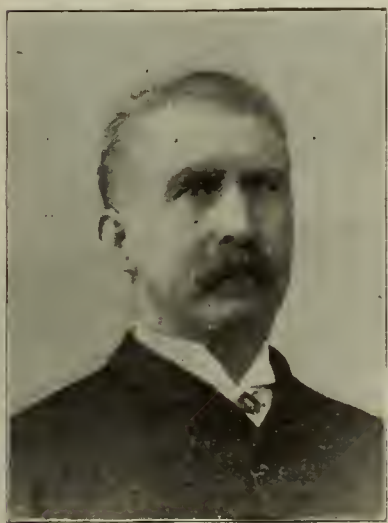
THE POSTAL TELEGRAPH CABLE COMPANY'S NEW BUILDING

ELEC. WORLD. N. Y.

The most striking feature of lower New York to-day is the tendency towards magnificent office buildings, as evidenced by the lofty structures which are now springing up on every side. There seems to be a common desire for more ambitious quarters, and the modest buildings which a few years ago were thought to be quite sufficient for the needs of New York business firms are rapidly being replaced by structures of a radically different type. The tendency is decidedly in the direction of high buildings, the natural result of the appreciation of real estate in this section of the city. This tendency heavenward, if it may so be called, while certainly commendable, is capable of abuse, and in some buildings has resulted in the sacrifice of all the finer qualities of architecture in the gratification of this ambition.

Of the more recent additions to the long list of new buildings, the home of the Postal Telegraph-Cable Company, on the corner of Broadway and Murray street, is one of the most

While familiarly spoken of as the Postal Telegraph Building, it is really the property of the California millionaire, Mr. J. W. Mackay, president of the Commercial Cable Company, and chief stockholder in the Postal company, the two companies being lessees of the property. The father of the enterprise may justly be said to be Mr. A. B. Chandler, president of the Postal company, whose conception it was and through whose untiring efforts it has finally been carried out. Too much praise cannot be accorded the building committee, consist-



John J. Conwell

Principal Stockholder.



A. B. Chandler

President.

attractive and pleasing. Although an immense structure, covering a large area and reaching up fourteen stories in height, the architects, Messrs. George Edward Harding and Gooch, have avoided any appearance of unnatural height and have happily blended grace of design with a sense of solidity. While the architectural details are beyond the scope of this article, we cannot fail to note the admirable manner in which the plans of the architects provided for the installation of the electrical circuits by means of accessible runways in the masonry and partitions. Notwithstanding the great part which electricity now plays in modern buildings, it is too often the case that no rational provision is made for this purpose, and it is therefore with pleasure that we call attention in this respect to the work of the architects of the Postal Building, the senior member of which is a brother of H. McL. Harding, so well known in the electrical field as Eastern representative of the Walker Mfg. Co., and who, by the way, has taken an office in the building.



VIEW OF THE BUILDING FROM CITY HALL PARK.

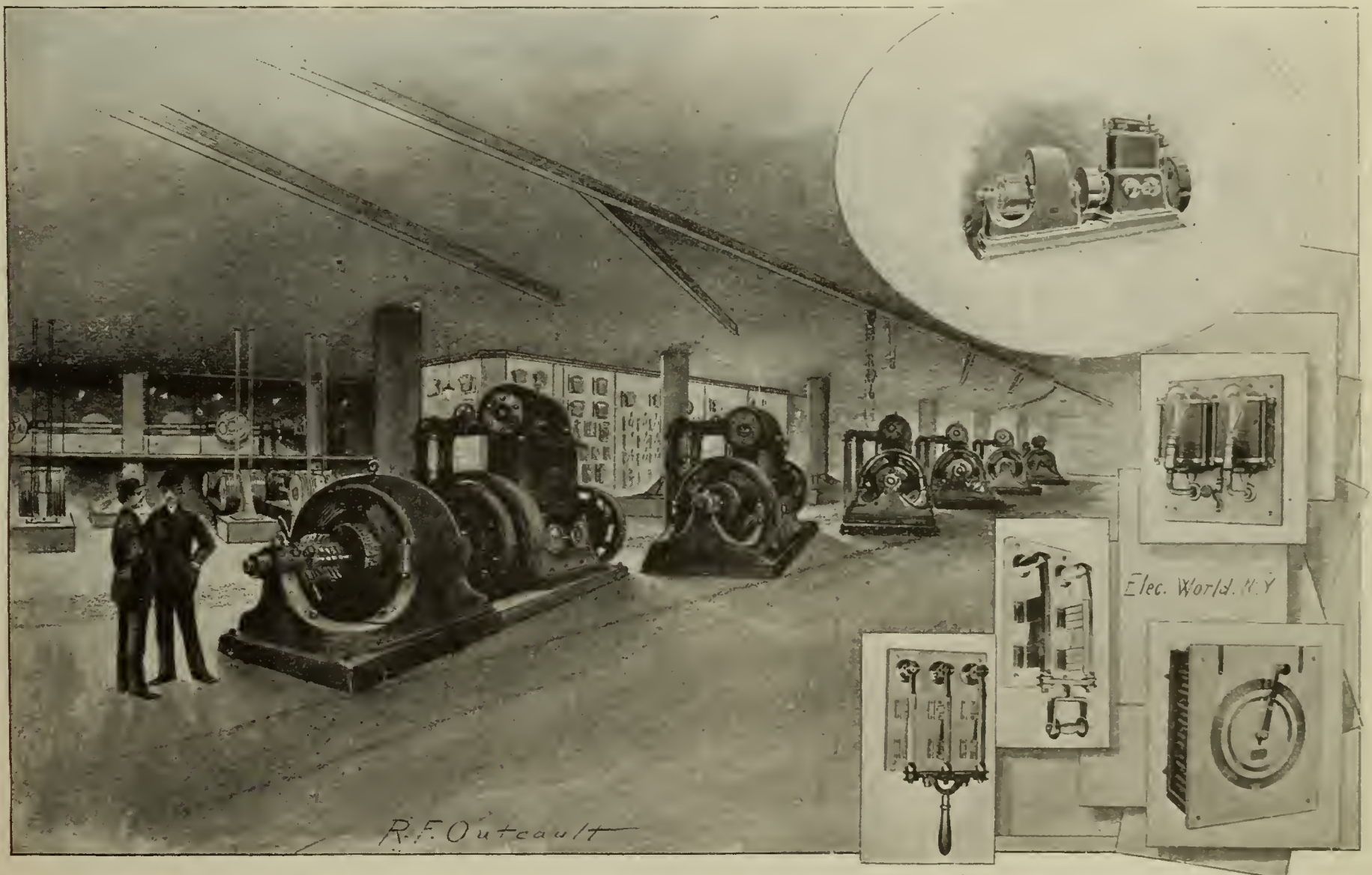
ing of Mr. W. H. Baker, vice-president, and Mr. E. C. Platt, treasurer of the Postal company, and Mr. Geo. G. Ward, vice-president and general manager of the Commercial Cable Company, who are responsible in a large measure for the suc-

with excellent results, keeping the pressure constant within a variation of one pound. Many of the steam accessories were installed by John Acton, including a 14-inch back pressure valve, which operates, it is claimed, perfectly noiselessly; a 6-inch reducing valve on the heating main, where the pressure is only 2 pounds, and an exceedingly sensitive valve is required, and a 1 1-2-inch high pressure valve. The steam piping is carried from the boiler beneath the floor, adding much to the appearance of the boiler and engine room. A pressure of 110 pounds will be used.

The pumping room equipment consists of one 7 1-2 X 4 1-2 X 10 Worthington duplex boiler feed pump, two 6 X 4 X 6 Worthington duplex sanitary and house service pumps, and one 6 X 4 X 6 Worthington automatic feed pump and receiver. The arrangement of the house and sanitary supply is on the pressure system; that is, an enclosed cylindrical tank of 2,350 gallons capacity, supplied by two 6 X 4 X 6 pumps, having three separate and independent suctions, one from Warren street, one from

Adams & Cartwright Elevator Company. One of these is a worm-gear and screw-steam elevator, located in the light shaft and running to the roof, a distance of 200 feet. This machine lifts a live load of 2,000 pounds at a speed of 200 feet per minute. The other two machines are steam sidewalk elevators, travelling from the sub-basement to the sidewalk, with a capacity of 3,000 pounds each.

From the accompanying illustration, a general idea of the arrangement of the dynamos and engines, as well as of the type of machines used, can be obtained. There are at present five units, but provision has been made for a sixth, as shown, when it may be needed. The engines are of the Westinghouse vertical compound type, the two in the foreground of the illustration being of 160 h. p. and running at 240 revolutions, while the others are of 100 h. p. and run at 50 revolutions per minute faster. The foundation is of solid concrete, 8 feet deep by 20 feet wide, and running the entire length of the room and entirely isolated from the floor, so that it is thought that the vibration of the ma-



THE GENERATING PLANT.

Broadway, and an auxiliary suction tank of 2,000 gallons beneath the floor. Water is pumped direct into the tank, which is supplied with air through the suction of the pump and maintained on the quarter line of the tank—a pressure of 120 pounds being constantly maintained and regulated automatically. An enclosed cylindrical tank for hot water of 420 gallons capacity takes its supply through a direct connection with the cold water tank, with a check valve to prevent back pressure. The temperature is controlled by a thermostat valve, which operates at 150 degrees, and the water is heated by a steam coil in the tank. All the returns from the steam heating drips, etc., gravitate to the Worthington automatic feed pump and receiver, and are automatically returned to the boiler, the pump being of ample size when running light to feed 720-h. p. boilers. All connections are made in duplicate, so that in case of fracture shutting down of the water supply is obviated.

Three steam elevators have been installed by the Mc-

achinery will not be perceptible in any part of the building. It will be noticed that the machines are set diagonally, this being found necessary in order to give them an isolated foundation and get them into the required space, and the plant is consequently very compact.

The generators are of the Westinghouse 4-pole railway type and are direct connected. Four springs connect the two sides of the coupling, permitting, it is claimed, a maximum extension of 9 inches, thus making provision for the greatest possible variation in load without injury to either machine. The couplings are well insulated with fibre. The two generators connected to the larger engines are of 120-kw. capacity, and furnish current at a pressure of 240 volts to supply the elevators. One is sufficient for this purpose, and they will probably run alternately, with one as a reserve.

The other generators are of 75-kw. capacity, and constitute the lighting plant, one of them also being used to feed the motor-dynamo of the Postal plant. A terminal board

on one side of the field yoke contains the connections for the field winding and main leads, and on the other side is a cut-out switch. Eight 6000 stranded lead-covered cables run through iron ducts beneath the floor, giving practically no drop between the machine and the switchboard. At the rear of the machines is a trench for the equalizing mains, and the terminals are run to separate bus bars on the rear wall. There are two equalizing boards, one for the power and one for the lighting machines.

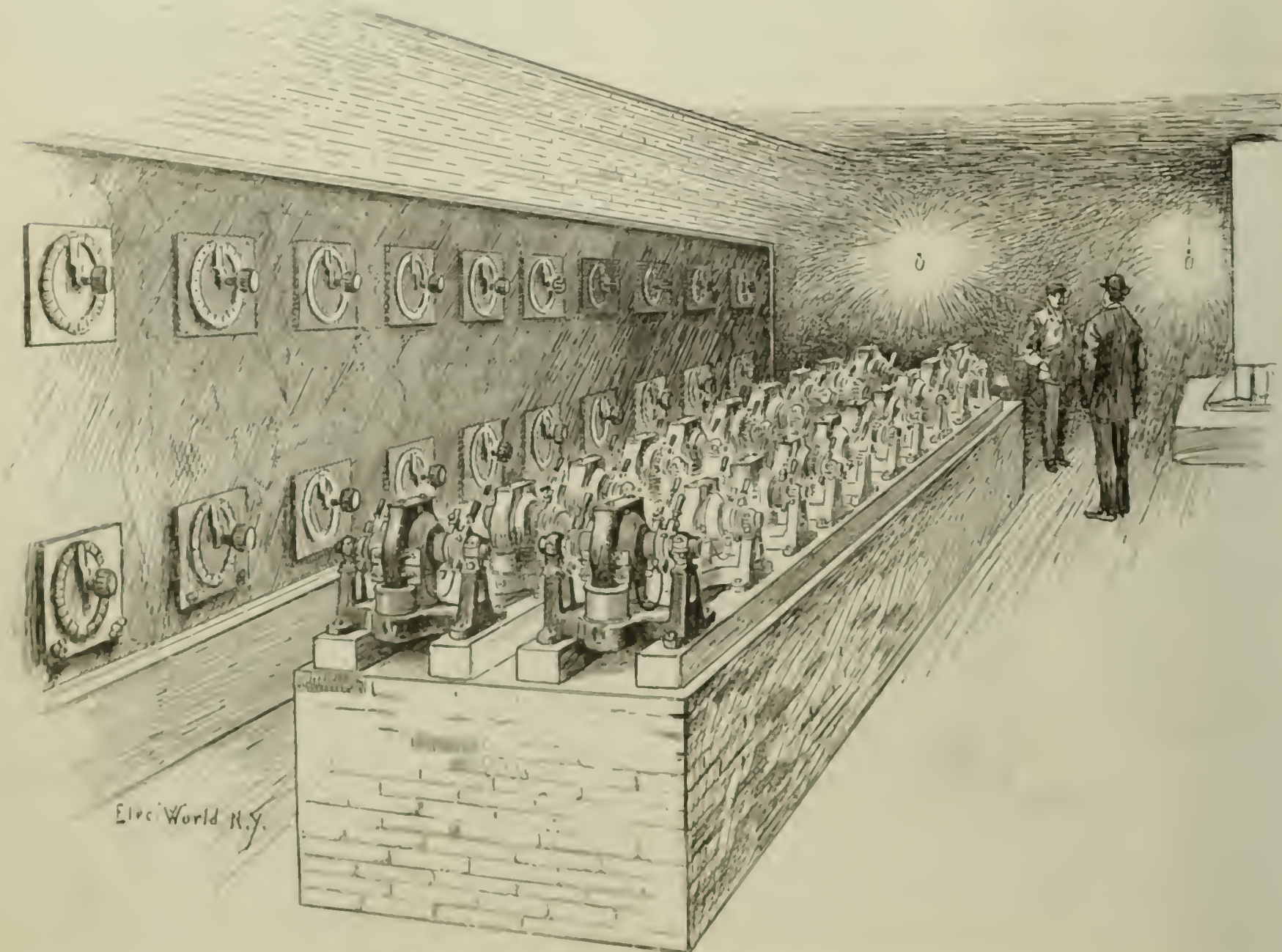
Much credit is due to the Westinghouse Electric and Manufacturing Company for the excellent plant which it has installed, and to Mr. Edward W. Seymour, who has so ably superintended its design and erection.

The dynamos and engines occupy the whole south side of the room, which is approximately 100 feet square. In the

a fraction of the space required by the batteries, performing the work more satisfactorily and requiring much less attention.

In the opposite corner, on the north side of the dynamo-room, is located what may perhaps be regarded the most interesting feature of the electrical equipment of the building, on account of its novelty—the Sprague-Pratt electric elevator plant. The introduction of electric elevators in a plant of this magnitude was an important step and its career will be watched with great interest on account of the effect it will have on the elevator industry in the future.

The elevators are divided into three groups, or pairs, two sets being "way" elevators, stopping at all floors, excepting the twelfth and thirteenth, and arranged with one general frontage, a gangway in the middle and the main stairs winding around one set. The remaining set constitutes the "ex-



THE POSTAL TELEGRAPH MOTOR-TRANSFORMERS.

northeast corner is a most interesting plant of the Postal company, shown below. It consists of 20 Crocker-Wheeler motor-dynamos, or continuous current transformers, arranged as shown, and of varying sizes and voltages. The potential of the different machines varies, the lowest being 40 volts, the highest 350, with 85, 130 and 200 as intermediate voltages. There are two machines for each potential, one positive and one negative, and each machine is entirely independent of the other. They are driven as motors from the lighting circuit and individually controlled from a panel of the main switchboard. On the wall at the rear are rheostats for each machine. A special switchboard, not shown in the illustration, but situated just to the left of the plant, controls the dynamo circuits of these machines. The advantages of such a plant are very marked, and its introduction is one of the most important advances made in telegraph work in recent years. These machines replace an almost countless number of cells, occupying only

press" elevators, and stops only at and above the eleventh floor, being practically private elevators for the Postal Telegraph and Commercial Cable offices, operating room and restaurant. This set is placed in the rear of one pair of way elevators and separated from them by the main stairs. All cars have independent platforms fitted with centrifugal governors set to be operated at 600 feet car speed by standing ropes. The car finishes are of ornamental bronze of the usual type. The "way" cars are a fifth larger than the express and have four hoisting and two counter-weight ropes, while the latter have two less hoisting ropes. The required loads are directly and the speeds inversely proportional to the floor areas, those for the "way" cars being 2,400 pounds live load at 325 feet, and for the express cars, 2,000 pounds at about 400 feet. The speeds running light are about 10 per cent. higher. These are the present normal speeds, but the motors have been found to be of so abundant capacity that the speeds can be increased to 450 feet for the "way" and

from 575 to 600 feet for the "express" without difficulty or straining.

The shaft and overhead work is identically the same as in first-class hydraulic plants and variable chain counter-weights are used to make the pull equal at all points of the hoistway for any given carload. The lower landing is at the street level, with pit extending into the basement. The hoisting



Francis Sprague



Char R. Pratt

Inventors of the Sprague-Pratt Elevator.

ropes lead directly to the outboard sheaves of the hoisting machines in the sub-basement and dividing on either side of the crosshead, pass around the sheaves, 10 geared for the "way" and 12 geared for the express, and are anchored to the heads of the machines.

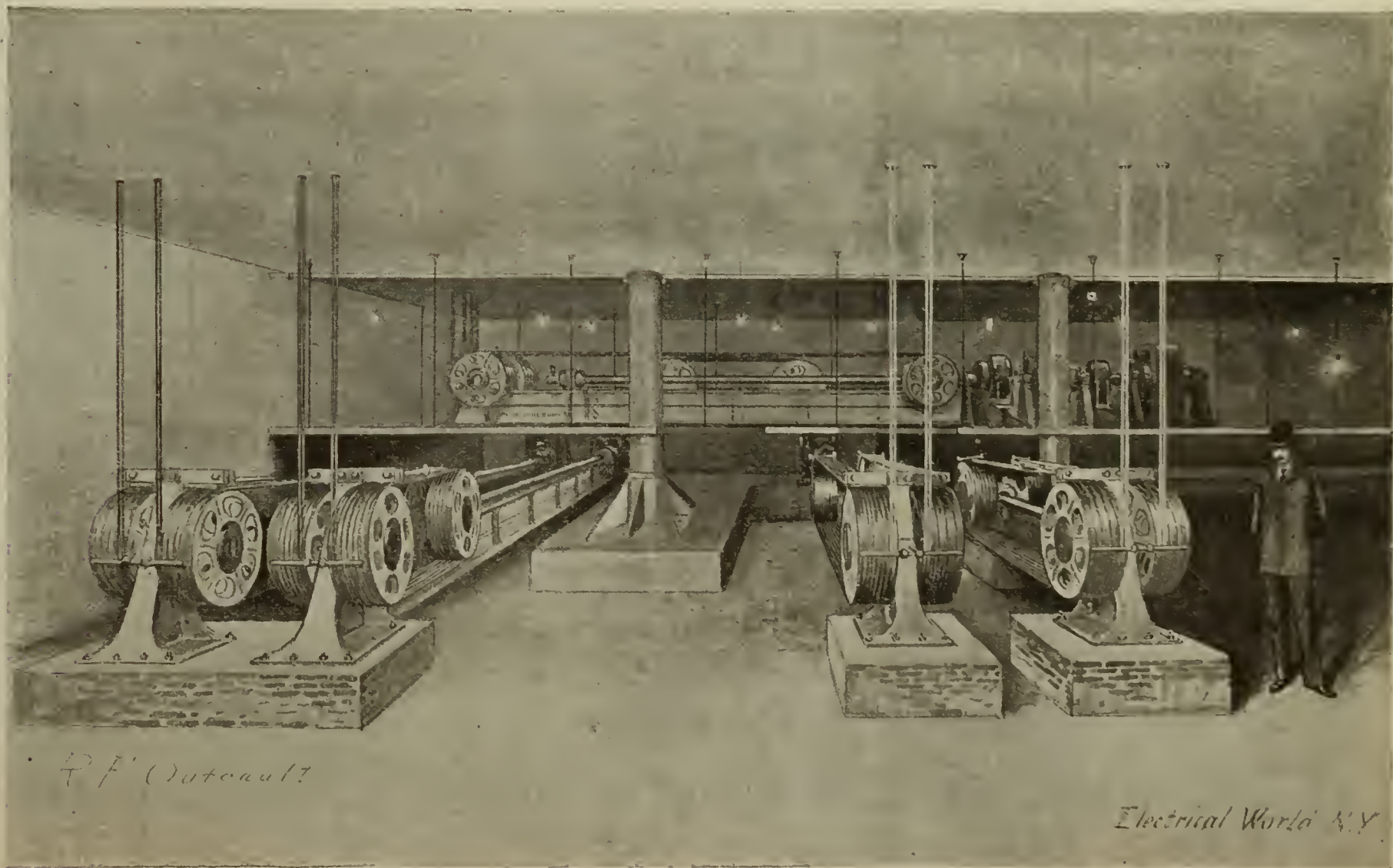
So far, with the exception of the control, the practice is that of the horizontal hydraulic elevator.

the cars the position of the foundations and the party wall, six machines, two at right angles and above the other two, are placed in a space about 30 feet square, with ample room for at least eight more machines, all self-contained, each perfectly independent, and with every facility of access.

Briefly described, the machine is of the horizontal multiple sheave type with a travelling crosshead and frictionless ball nut driven by a screw revolved by a motor directly connected and governed by a pilot motor and rheostat.

The elevation on the next page will show the general mechanical construction. This consists of a heavy main beam carrying the travelling crosshead and lower screw bearing, with special castings bolted at each end, one carrying the fixed set of sheaves and the other the thrust bearing, brake and motor. The regulating apparatus is independent and self-contained, and is placed on the wall. From the car to the system of multiplying sheaves this machine and the horizontal hydraulic elevator are practically the same. The crosshead, however, marks the point of departure in the two types, and this is the one at which the troubles of the hydraulic elevator begin, and from which the Sprague-Pratt electric elevator marks its evolution in elevator practice.

In the hydraulic machine this crosshead is rigidly attached to the end of a rod terminating in a piston moving in a cylinder having an inside length equal to the lineal movement of the crosshead. This cylinder in the vertical type of hydraulics varies from 30 to 45 feet in length, with from two to eight sheave multiplications, and in the horizontal types the multiplication runs as high as 12 with corresponding diminution of length of cylinder and increase in cross section. Whatever the gearing, however, the length of cylinder is a function of the car travel. In this electric elevator, the crosshead being moved along a screw stationary so far as lineal movement is concerned, there is, with any given number of



GENERAL VIEW OF THE ELECTRIC ELEVATOR PLANT.

Coming now to the machines in the basement, the distinguishing features of the electric plant become pronounced, and first, and by no means the least important, is the space occupied, for here, on account of the peculiar disposition of

sheaves, only one variable, the length of screw, and for all heights above about 90 feet, the electric machine has an advantage in matter of length which with increased rises becomes of great importance.

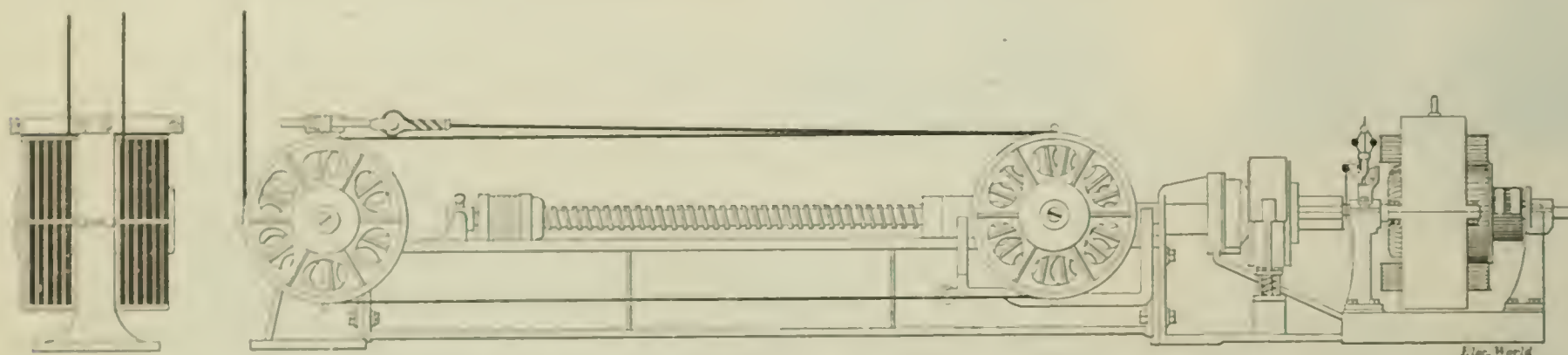
Turning now to the operation of this machine, there are four features claiming special attention. These are the nut, screw and bearing, the brake, the motor and the regulating apparatus.

The hoisting nut being the first step in order, its connection with the travelling sheaves is the first thing to consider. It will be seen that it joins the crosshead of the travelling sheaves by a conical seat. There is no fastening between the nut and the crosshead, the continual weight of the car always keeping them in contact, and the friction at this point being greater than between the nut and the screw enables the latter to transmit a straight line movement to the crosshead when the screw is revolved by the motor, and also to revolve the screw and drive the motor as a dynamo when the mechanical brake releases the screw to allow the car to descend.

To continue the line of transmission of power, it will be

with a peculiarly shaped thread. It passes through the clearance hole in the steel trunnion crosshead which carries the travelling sheaves, then through the nut system, and is carried at the outer end by a pivoted bearing. At the other end it terminates in the thrust bearing, where the pressure is taken by about 220 steel balls carried in a bronze guide plate and bearing on specially hardened steel discs. The thrust of the screw being thus taken up on the inboard end, the strain on the screw is invariably between that end and the travelling crosshead, never beyond this; hence, it is always under extension strain, never under compression. Beyond the thrust plates is keyed a radially lagged iron and wooden pulley connected by a flexible coupling with the motor shaft.

The function of the brake is that of locking the screw when at rest, and is not a means of varying the speed. In case of accident it has the additional function of helping to stop the screw. It may be described as a compound electro-



ELEVATION OF ELECTRIC ELEVATOR.

seen by the cut that the only points of contact between the nut and screw are by a chain of balls which occupy twelve threads, and are shown entering and leaving the ends of the nut through a tube, which takes the balls as they leave one end and returns them to the other end at a tangent to the line of travel between the threads of nut and screw. This is one of the most vital points of the elevator apparatus, and herein lies one of the most potent reasons of its success—the reduction of friction by rolling instead of sliding surfaces on almost all parts under pressure—for not only is the nut so constituted, being, in fact, a developed spiral thrust bearing, but the thrust bearing at the motor end of the screw is taken on balls and the sheaves are carried on ball or roller bearings.

So free is this machine from static friction that it is pos-



SECTIONAL VIEW OF BALL NUT

sible to start the car with a slight increase of current over the normal hoisting current, provided time be taken so that the work done in acceleration is small compared to the work of lifting.

A test was recently made on a Fairbanks testing machine in New York to determine the liability of balls crushing under normal or extra working strain. Ten balls of two different makes were put under crushing strains, and required from 20,000 to 40,000 pounds to break each of them. The working pressure varies from 50 to 125 pounds per ball.

The nut system is a compound one, for besides the working ball nut there is another, called the safety nut, keyed to it, and between the two is a powerful spring under compression.

The screw is a specially forged bar of high carbon steel

mechanical brake. The brake band, of steel and leather lined, is anchored at one end, the hoisting side, on the motor bed frame, and the other end is continually pulled down by a powerful spring under compression. The mechanical movement in opposition is through the medium of a lever fulcrumed on a peculiar magnet casting and having at its short arm end a universal socket connection to the divided core of a closed circuit steel magnet. This core has a movement of one-eighth of an inch, and with the expenditure of a quarter of a horse power of electric energy has a pull of nearly three-quarters of a ton. It is operated by a dual circuit, one in hoisting, another in lowering, each possessing peculiarities in its action. In the event of failure of current for any reason or too high a speed on the down run this magnet releases the brake, in the latter case by a snap switch operated by a Pickering centrifugal governor driven by the main screw, and the brake band promptly grips the brake wheel softly, yet powerfully.

The motor is of the 4-pole type, two poles being consequent, and the winding is strongly compounded. The field magnets are of a special grade of steel. The direction of current in the field coils and armature is never reversed, and the machine is never demagnetized, because in hoisting the line E. M. F. predominates, while in lowering the reversed E. M. F. of the motor is the only active one in the armature circuit. It should be remembered that this type of elevators is differentiated from all other electrics in that, like the hydraulic, it always works against gravity; the motor takes current from the line in hoisting, but in lowering it is cut off from the line and is operated as a driven dynamo by the falling weight of the car.

The armature is ironclad, is of the two-path special slotted drum construction, has one turn of wire to each coil, and each turn is securely imbedded in an independent insulating tube rigidly held. The carbon brushes are double, have independent movement, and ample capacity to carry the full current without flashing. The neutral point is fixed. The machine is self-oiling and the bearings are independent of the field castings.

The last individual feature of the machine is the regulator

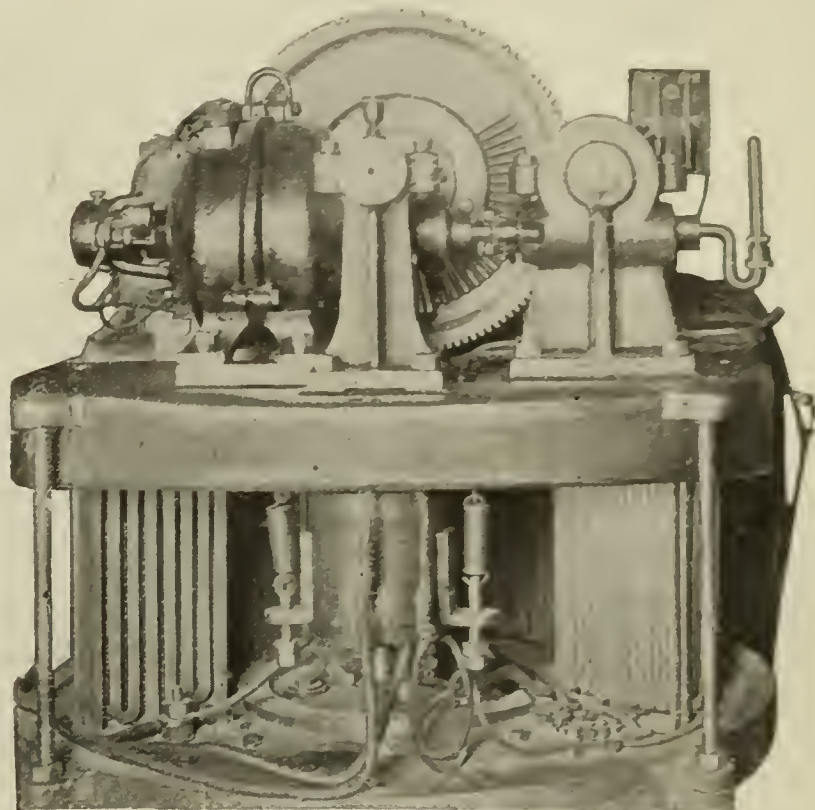
and the method of operating it. This is shown below, but since this photograph was taken the apparatus has been simplified and the cables and devices shown in the interior removed. This apparatus is an independent one and connected to the hoisting machine only by the wires necessary for the circuits. It is, in brief, an open cast iron frame carrying inside a slate disc having on the lower side a row of bronze contact clips, and on the other, attached to these clips and to each other by tap screws, a series of grids arranged in a circle. These grids are about 9 inches long, 4 inches wide and 3-8ths of an inch thick, and are cast in a form somewhat resembling a ribbon folded on itself. They are freely flexible when taken separately, although iron is one of the principal ingredients. The resistance averages about fifty times that of copper. The grids can stand a very high current and the temperature coefficient, while not constant, is sufficiently small not to be objectionable.

On top of the frame is carried a 1-4-h. p. motor connected to the car switch through a pilot board by a cable of four insulated wires which operates the rheostat and circuit changers. The motor is coupled to a worm gear which carries a small pinion meshing into a spur gear on the circuit changer and controlling cylinder. This cylinder has a bevel gear driving a pinion on top of a vertical shaft at the lower end of which is the rheostat brush arm. This brush arm carries carbon brushes which bear on the bronze clips. There are 120 of these, and the difference of potential between them is too small to allow any sparking. A quick acting circuit breaker prevents arcing at the first clip. The operator in the car is at liberty to put the brush at any point of its travel and leave it there as long as necessary. The same rheostat is used in hoisting and lowering, and the arm travels over the whole range of clips in either movement. This operation is controlled electrically either from the car or from the pilot controlling the switchboard in the engine room.

In hoisting, as seen from the car, the operator moves a

regulate his speed from slow to full speed, which last may be as high as 600 feet per minute. A small rheostat in the field of the hoisting motor gives a fixed adjustment of about 10 per cent. variation in the maximum speed of the car.

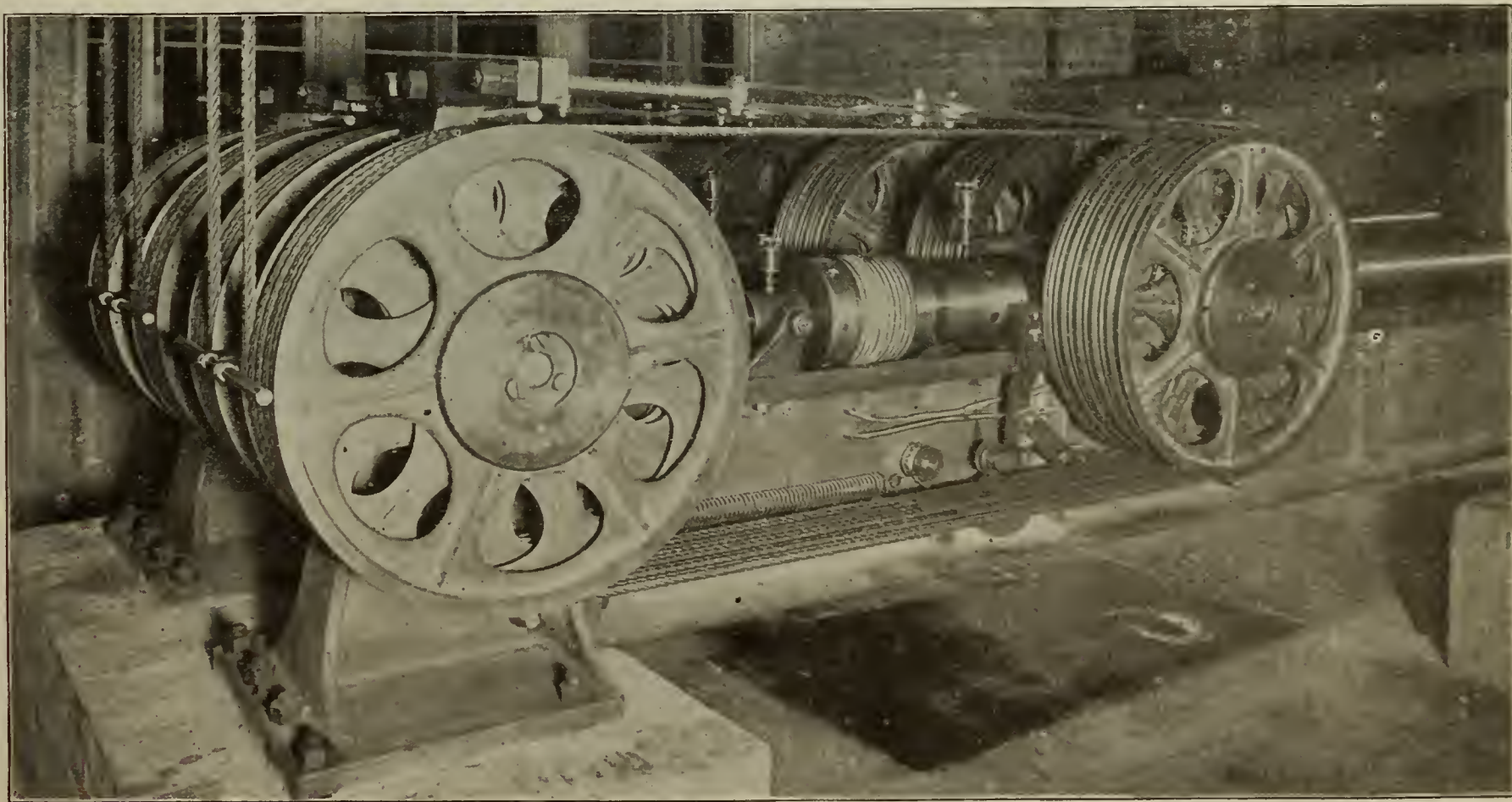
If the operator forgets or is unable to operate his switch



ELEVATOR REGULATOR.

to stop the car, there are two automatic stops which will only allow it to go a few feet above the top floor.

The moving of the switch to "up" puts current through the up coil of the pilot motor, which, moving the regulator, connects the main motor to line, sends current through the armature and a progressively reduced resistance, the current re-



HOISTING NUT AND SHEAVES OF ELECTRIC ELEVATOR.

small lever and the car starts with a perfectly accelerating speed, no jerks or pulsations being felt. Ordinarily he puts the car to full speed and makes his stop exactly at the landing with one motion of the switch. If, however, he stops a short distance below the landing floor he can raise the car that distance as in a hydraulic elevator. The operator can

leasing the brake and increasing the torque until the armature begins to turn without shock or jar, and thus accelerates the car in a perfectly timed progression. A return of the switch to "steady" instantly arrests the movement of the rheostat arm, checks the pilot motor by an automatic brake and stops the acceleration of car speed. A return to "stop" cuts

off the current, gradually but more promptly than the reverse movement is made.

In lowering, the rheostat brush closes circuit on the zero resistance clip, and at the same time closes a circuit through a shunt coil on the brake magnet, releasing the brake. The motor now becomes a separately excited compound dynamo with the weight of the car to drive it.

There is no effort of the motor exerted to aid the car in lowering. The friction for the weight of the car to overcome in order to start this dynamo load consists of that of the car guides, overhead sheaves, multiplying sheaves, the cross-head guide, the ball-bearing nut, the thrust bearing of the screw, and all the screw and armature bearings. The fact that 500 pounds on the hoisting ropes will overcome this and start the motor instantly is due to the use of rolling friction on all sheaves, the nut, and the screw thrust bearing.

It is impossible to attain a rapid acceleration of speed on the start down, for at the first position of the rheostat brush the torsional resistance of the armature will not allow the full carload to drive it above 5 per cent. of its normal speed, and from there to the highest resistance there are 120 variations of speed up to the maximum. Aside from this, the mechanical conditions of starting a screw to revolve by pressure on the nut from a limited force when the pitch is slight and the inertia of the armature is considerable render a sudden start impossible and insure an even acceleration of speed independent of the dynamo action.

When the car is within about six feet of the lower landing a roll on the travelling sheaves engages a lever that reduces the resistance in a by-path in the armature circuit and brings the car to an easy stop at the landing independent of the operator.

Besides the control from the car there is provided in the basement a general controlling switchboard by means of which the control can be taken from the switch in any car and transferred to the switch in this board. In this way general inspection, cleaning, testing, or, if needed, replacement of any part of the regulator or machine, whether in the ordinary course of affairs or in case of accident, and the hoisting of safes, all can be carried on from below without an operator in the car; in fact, even while in motion the control can be instantly taken from the operator and the car run from the pilot board.

The care and attention required by an elevator of this type as compared with the hydraulic plant are in its favor, for, aside from the ball-bearing nut, there are no more parts to attend to and renew than there are in an ordinary electric elevator. The thread of the nut is hardened by a special process that renders it for a depth of one-fourth of an inch as hard as steel can possibly be made. The thread is afterwards ground true and smooth. Tubes are then inserted to circulate the balls from one end to the other. The balls are one-half inch in diameter and of standard make.

One of these nuts has run for 24 hours a day for 16 months, and was only removed twice in that time for inspection. The operating nuts of the Postal Telegraph plant, although at times under vicious duty, show no wear of the working thread. As illustrating the facility of access, a car can be slung by its ropes from below, the end screw bearing, the buffer nut, and the working nut all removed, the balls taken out and inspected, the nut cleaned, and the whole restored and the car put into operation again within thirty minutes. The balls in the nut can be inspected while the machine is in operation.

The multiplying sheaves run on bearings which show no wear at all and do not require oiling or cleaning more than once a year. Not a drop of oil runs out of them. There are four nests of sheaves on this elevator and any nest can be exchanged for a spare nest within five minutes after the

ropes are slacked. A machine can be absolutely dismantled and practically every working part laid on the floor in an hour and a half.

As to the question of safeties, the following elements may be considered: First, the screw; this is a bar of special forged steel under tension and torsion strains, and capable of sustaining twenty times the heaviest load applied to it. Second, the hoisting nut; this is of special steel hardened and finished by a special process. In addition to this is a safety nut. This nut is normally out of contact with the screw's thread; it is secured to the hoisting nut, and should any accident happen to the latter which would break its hold on the screw's thread, this safety nut, the thread of which interlocks with the screw's thread to a greater depth than the thread of the hoisting nut, would then take the place of the hoisting nut and form an anchorage to hold the travelling sheaves with a grip exceeding the strength of the screw. This would put the elevator out of operation, as the friction between this nut and the screw is greater than the friction caused by the pressure of the travelling sheave crosshead against it: this nut would then act simply as a collar on the screw, and revolving the screw would transmit no motion to the car.

There is another safety in the nut system, however. As before stated, the hoisting nut is only held from revolving by its friction against the crosshead; when the nut gets to the upper limit of its travel the safety nut meets a solid collar on the screw, which stops its travel and causes it and the ball-bearing nut to revolve with the screw, thus stopping the travel of the nut absolutely without stopping the motor, and allowing the travelling sheaves to be stopped simply by the weight of the car. This stop has been made at full speed without any injury whatever.

Another important function performed by the hoisting nut in a very simple and direct way is its action as a slack cable device. The car descending at high speed and driving the nut along the screw, revolving the screw and armature thereby, meets an obstruction, the pressure against the nut is reduced to only that given by the weight and sag of the ropes and the working nut recedes slightly, which allows the spiral spring between the safety and ball bearing nuts to extend and force the safety nut against the back of the screw's thread. The friction then between the nuts and the screw is greater than between the safety nut and the crosshead, therefore the hoisting nut at once revolves with the screw, its travel along the screw ceases, and it checks the travel of the travelling sheaves before the cables are really slack.

It is moreover evident that if the screw should become free to revolve unchecked by motor or brake, the weight of the car would not cause the screw to revolve at a speed at all comparable to a free fall. In any event, there remains the rubber buffer at the lower end of the screw to cushion the end of such a run. The use of the buffer, as well as the frictionless character of the nut, have been most effectively illustrated by actual drops from heights up to the twelfth story. This buffer nut can stop a car going at a speed of 800 feet per minute in 24 inches without starting a bolt or fastening.

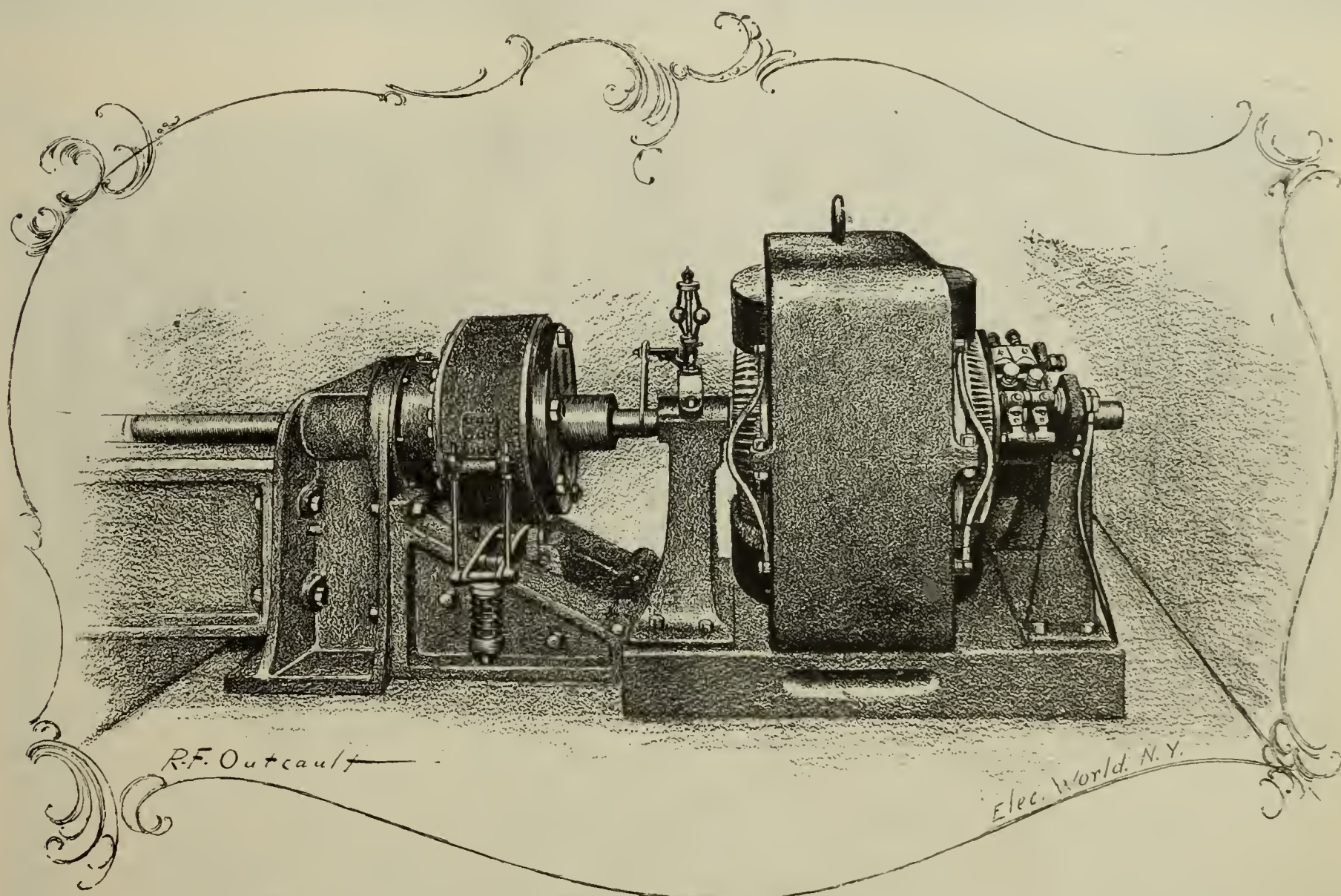
The rope fastener used on this elevator consists of a solid body of metal, which has a double spiral groove; the ropes enter this groove by being passed through a loop in one end, wound twice in one groove, passed through a loop in the other end, returned in the other groove in spiral convolutions between the first winding and out through the loop in the first end. This engages about 3 feet of the rope, instead of about 3 inches, which other rope fasteners hold. There is but one way that a rope can be put in this fastening, and it will hold almost any size rope equally well. Tested in Fairbanks' testing scales it took 10,500 pounds to break a 2-8-inch iron wire rope, which gives this rope a higher rating than quoted by the makers in their catalogues.

Besides the lower limit switch already described there is an upper limit switch for cutting off the current. This is a double-operating and self-cleaning lock snap switch, moved by a roll on the crosshead, and cuts off the current in hoisting at the upper limit, allowing the brake to come on and stop the car. On the reverse movement the circuit is closed for hoisting.

The centrifugal on the machine for operating the brake when running down too fast has already been mentioned. This is set to operate at a small excess above the allowed speed. It does not interfere with the operation of the car centrifugals, but simply puts the brake on the machine in case of limited excess of speed, and is ready for use again as soon as slowed down instead of being tied up, as is the case when a car safety works.

In regard to the question of economy, the Sprague-Pratt company make the following claims: While buying current from the street system at the rate of 5 cents per horse power hour, reckoned on an 850-watt rate, pending the operation of the local plant, the cars have been operated at a cost not exceeding 3-5ths of a cent per round trip of 26 floors, which is not over 40 per cent. of the cost of operating a like hydraulic system, even with an independent plant. The standard hydraulic elevator, as now operated, is supplied at a

of friction, the total average load is about a third of the maximum. For an example, take a car of 30 feet floor space. This can be loaded up to about 100 pounds per square foot, or 3,000 pounds live load, while the average live load will not be over 600 pounds. In a hydraulic elevator it would take about 900 pounds excess of weight in car over the counterbalance to insure proper running. This means a load of 3,900 pounds on the ropes, but this is not all. Since the speed of the car with any given opening of the valve is a function of the difference in pressure in the supply and the cylinder, and since there must be an excess of pressure on the supply side in order to have the car move at all, then to move this total load of 3,900 pounds at even a low speed, there must be a capacity to actually lift about 500 pounds more than this, or 4,400 pounds; yet the average load on the ropes is only 1,500 pounds. In a Sprague-Pratt electric elevator such a car can be operated with 600 pounds excess of weight, making an average load on the hoisting ropes of 1,200 pounds, and since this elevator uses power very nearly in proportion to the load over friction, we would have, as between the two classes of elevators, a constant equivalent duty on the hydraulic of 4,400 pounds and on the electric of 1,200. Here, then, is a difference of nearly four to one in favor of the electric, consider-



VIEW OF ELEVATOR MOTOR AND BRAKE.

practically constant pressure by a compression tank automatically regulated in the basement, or a roof tank, which may also be a compression tank. Whatever the load identically the same amount of water at the same pressure is used for every foot of travel, and consequently no matter how light the car may be running, it always uses the maximum power. Statistics taken time and again prove that the average live load on a passenger car is not over one-fifth the maximum which it can carry. Including the counterweight, which in a high-speed hydraulic elevator is, fully four hundred pounds lighter than in an electric elevator of equal capacity on account of the difference

ing solely the question of work actually done in the cylinder and on the screw. Roughly speaking, the friction of the electric machine is quite as low, if not lower, than that of the hydraulic, because one is on ball bearings and the other has a tightly packed gland and piston. Going back now to the generation of power, the best pumps in common use require 70 to 85 pounds of water per horse power delivered to the water column, whereas electric power can be delivered to the mains of the motor for an expenditure of about 35 pounds of water.

The switchboard of the plant is located in the centre of the dynamo room, and is one of the most interesting features of

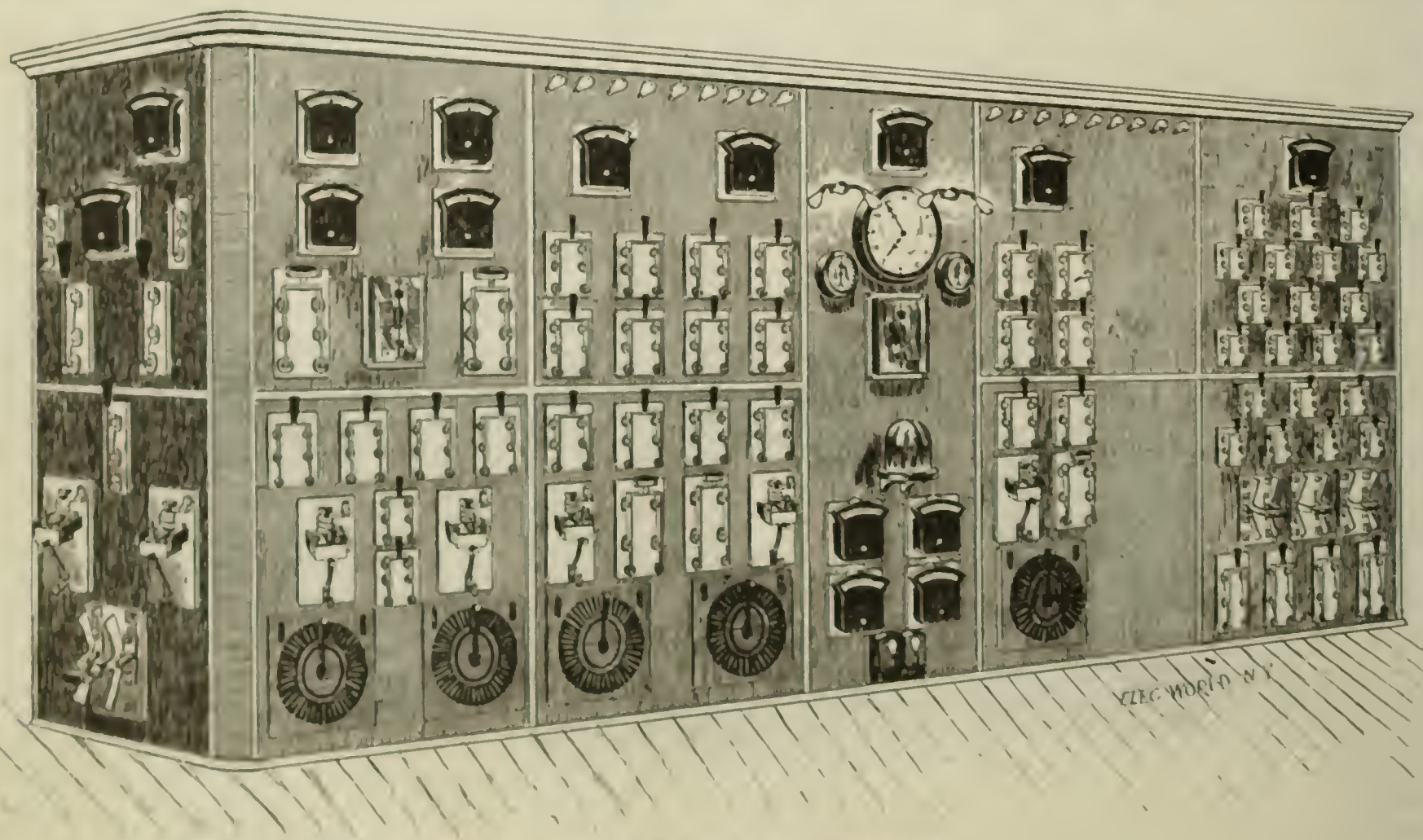
the installation. It is the design of Mr. Paul Lemaire, the electrical contractor of the building, who has been ably assisted in the work by his superintendent of construction, Mr. E. Neilsen. The board is enclosed in the rear by a solid brick wall, access to the interior being had through a door at the right end. There is abundant space inside for inspection and repairs. The front of the board is of marbled slate. Where bolts pass through the holes have been reamed out and fitted with a bushing of plaster and then covered with asbestos paint, thus insuring very high insulation.

The accompanying illustration gives a view of the board. The front face consists of five separate panels, each devoted to a special portion of the plant. The panel to the right contains the switches which control the Postal dynamotor plant, each machine having its own switch. The four lower switches on this panel are double pole and so connected to four of the machines used for a reserve that in case of need they can be thrown in either as positive or negative. The next panel is devoted to one of the lighting machines, one-half of it being left vacant for the additional machines which will be installed later. It contains an ammeter, rheostat, magnetic circuit-breaker and main and circuit switches. The centre panel contains the main indicating instruments, a standard clock for supplying the time for the building, steam and vacuum gauges and an Edison recording press-

and indicate whether the circuit is closed and also give a comparison of the candle power of the lamps on each circuit, with those connected to the bus bars. In order to provide for the Edison service three bus bars are used, two being ordinarily connected to form one side of the circuit. A separate bus bar is provided for the main indicating instruments. For public lighting two separate circuits, called the east and west circuits, are run from one switch at the distributing board on each floor to either end of the building.

Provision has been made for running the elevators from the lighting circuit, at half speed, if so desired at night when but few lights are needed and but a single elevator running. As the potential of the elevator circuits is 240, and of the lighting 125, care must be taken to avoid connecting the two. The power bus bars are connected to the lighting circuit by special switches, and a pilot lamp indicates whether the switch should be thrown or not. Additional safety is secured by a mechanical device, between the high and low tension switches, so that if one is closed with the other in circuit, the latter is automatically opened.

The wires, both for the lighting and telegraph plants, is of the Safety Insulated Wire Company's make. Over 100 miles of safety cable is used in which are from four to fifty wires. For the circuits 150,000 feet of Nos. 12 and 14 was required: 150,000 feet of the New York Insulated Wire



GENERAL VIEW OF THE SWITCHBOARD.

ure gauge. The next panel contains the controlling devices for the remaining two lighting generators, and the last to the front left controls the two power generators.

The left end of the board makes an angle of about 120 degrees with the face, and constitutes an auxiliary board for the Edison service. The plant has been running for some time on the street service. The board is thus arranged so that any of the panels can be switched on to the Edison service in case of an accident to the boilers. The electrical instruments on the board are all of Westinghouse manufacture except the voltmeters and ammeters, which are of the Weston type.

The building is lighted on the two wire system, two sets of separate mains running from the bus bars to the distributing centres on each floor. A row of pilot lamps at the top of the board are connected to each centre of distribution

Company's Vulca ducts, and 7,000 feet of Interior Conduit and Insulation Company's brass covered tubing. The fixtures and electroliers are from the Central Gas and Electric Fixture Company. Edison lamps will be used throughout, except where arc lamps are employed.

In the basement, over the sub-basement, is located the distributing board of the Postal company's plant, providing connections between the subway cables and the wires to the switchboard in the operating room. This board is made of non and slate and is entirely fireproof. Six cables come in from the subways, three carry 78, two 63, and one 104 conductors.

The entire eleventh floor has been given up to the operating room of the Postal company, and no expense has been spared to make this the most complete installation of its kind in the world. It is equipped with the most modern

apparatus and embodies a number of new ideas, which will facilitate the handling of the company's large and constantly increasing business. The illustrations hardly give a fair

in the general view. The switchboard, a view of which is shown, is situated in that portion of the room. Another illustration presents a view of the main switchboard, while



CITY SWITCHBOARD IN OPERATING ROOM.



VIEW IN THE OPERATING ROOM.

idea of the size of the room, which extends the entire length of the building and across each end. Windows on three sides furnish an abundance of light and air. One of the

another gives a view of the manager's desk, taken from the same point, but looking in the opposite direction—to the south.



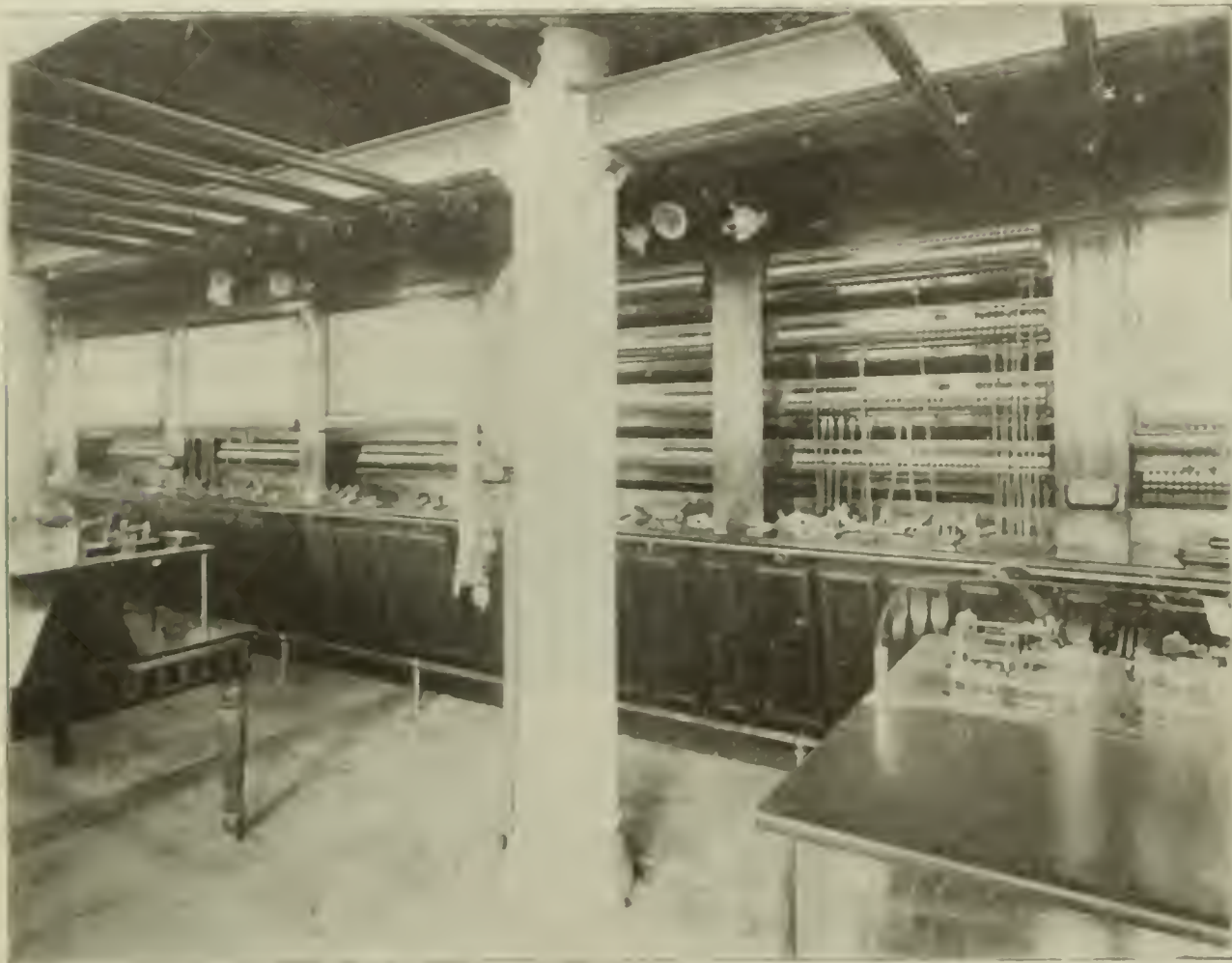
GENERAL VIEW OF THE OPERATING ROOM.

accompanying illustrations gives a general view of the operating room from the southeast corner, while another shows from the gallery the northeast corner, which is hidden

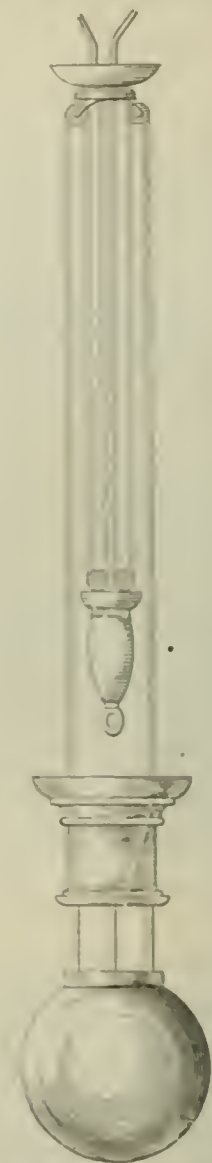
There are 308 sittings for operators in the room. It will be noticed that each table is arranged for four operators, two tables with accommodations for eight being placed end to

end. The tables and desks are of highly finished cherry. At variance with the common custom, the tables are not divided by glass partitions, this not being considered necessary with the use of "sounders." These sounders consist merely of a revolvable box, mounted on a standard, shaped like the quarter of a cylinder, with one of the plane sides left

for a typewriter, a section being cut out for this purpose. This saves the space occupied by the ordinary typewriter table. Each table is provided with an electric light



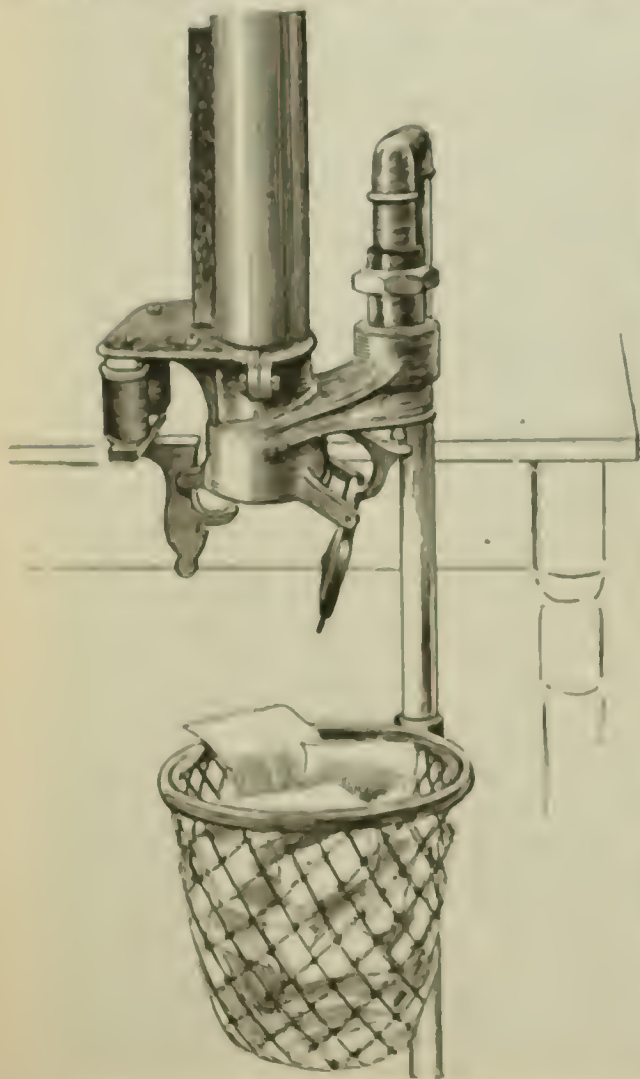
MAIN SWITCHBOARD IN OPERATING ROOM.



ARC LAMP IN OPERATING ROOM.

open. The sounder is placed in this and the operator turns the box until the sound waves are thrown directly in his ear.

standard with porcelain shade, upon which are hung wire baskets for the reception of messages and cards showing the line connected to the instruments on the desk. Each desk is also provided with a Hayes fireproof fuse box.



DETAIL OF PNEUMATIC TUBE.



EAST END OF OPERATING ROOM FROM GALLERY.

A brass rack on one end of the sounder is provided for the messages.

Another excellent idea is the provision made in each table

The main switchboard is a magnificent specimen of work. It was made by the Western Electric Company. The board is fireproof in construction, being made of

marbleized slate and the wires insulated with fireproof material, so that danger of damage by fire is practically ob-

double-decked tables for the repeaters, as shown, are placed in front of the board. The distributing gallery is



WHAT ATTRACTS THE ATTENTION OF ELECTRICIANS ON BROADWAY.

viated. The board contains eight sections, with space for two more, giving a present capacity of 400 wires. The loop

above the switchboard. All messages are sent here to be assorted for distribution. A pneumatic tube system has



THE ELECTRICAL WORLD OFFICES—RECEPTION ROOM.

switch, which, though a part of the system, is independent of the main wire switches, has a capacity of 372 legs. The

been installed to replace messengers in collecting and distributing messages to different parts of the room. Thir-

teen tubes diverge from the gallery and are so distributed as to divide the floor area into equal parts. There are also four tubes running to the city department on the first floor. An electrical device, the invention of the company's elec-

The telegraph instruments were furnished by the Western Electric Company and J. H. Bunnell & Co., and are of the most improved type.

The operating room is lighted by 16 Lemaire arc lamps, burning on the low tension incandescent lighting circuit. They are placed two in series, and require only 5 amperes at 50 volts each. The accompanying cut, page 536, shows the style of lamp and the simple sliding device employed to vary the height of the lamp. Eighteen of these lamps will also be used on the first, or ground, floor of the building.

It is thus evident that the Postal Telegraph-Cable Company and the Commercial Cable Company have found a home suited in every way to their needs, with facilities for handling the continually increasing volume of their business. The provisions made for the comfort of the other tenants are equally complete.

THE ELECTRICAL WORLD OFFICES.

Adjoining the magnificent edifice in which this journal has just taken up its abode is the building known as No. 9 Murray street, one of the few old and modest structures now remaining in the vicinity. At No. 9 Murray street was located the first office of The Electrical World—in a small room near the roof. Modest as were these quarters, their rental marked a step in advance, as previously the sole address of the young journal had been P. O. Box. 3,332, and a

gratuitously furnished desk at the printer's answered both for a business office and an editorial sanctum. As years passed by more rooms and nearer the ground were taken, until finally growing business required larger facilities, which



THE ELECTRICAL WORLD OFFICES—ENTRANCE TO THE BUSINESS DEPARTMENT.

trician, Mr. F. W. Jones, has been attached to the system, which renders it practicable for this service. It is shown in detail above, and can be readily understood from the drawing. As the carrier emerges from the tube and drops



THE ELECTRICAL WORLD OFFICES—THE PUBLISHER'S PRIVATE OFFICE.

into the basket, it makes a contact, closing a circuit which energizes the electromagnet attached to the tube at the starting point. The armature of this magnet releases the lid, which drops and closes the valve in the air supply pipe.

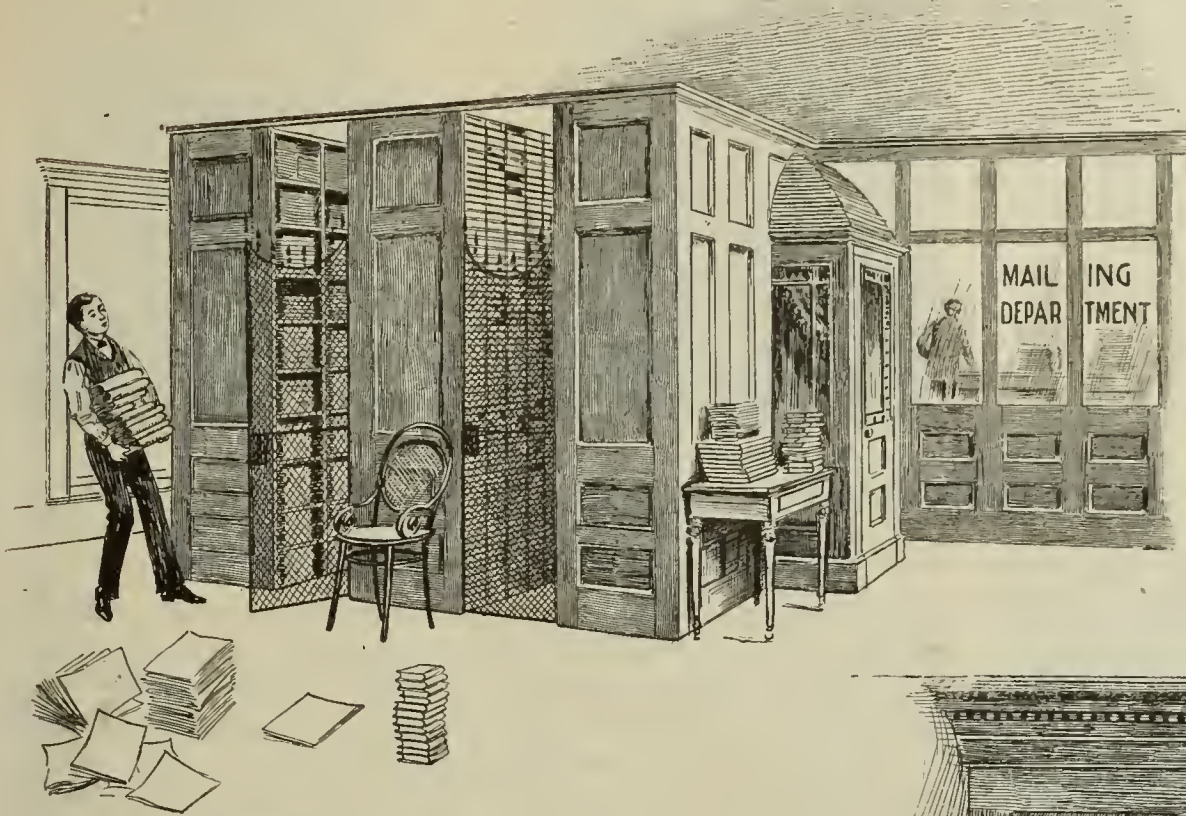
were found in the Potter Building, though at a rental thrice that paid in Murray street. The next move was to still more commodious quarters in the "Times" Building, in which The Electrical World was the first tenant to take

rooms, as it has been one of the first to move into the Postal Telegraph Building.

It is a little remarkable that notwithstanding the rapid development of the paper, it should have changed its address only twice in two decades—for this is its third re-

ments, while adjoining the reception room is the private office of the publisher. The Broadway side of this room is formed by three of the seven windows of the great hemistyle which furnishes such a noble setting for the main entrance to the building. From this office—as well as from the business office on the right and the editorial rooms on the left—a fine view of Broadway is obtained, extending across the City Hall Park and taking in the great newspaper buildings on the other side, including the two former abiding places of The Electrical World.

To the right of the reception room is the main business office, a room 24 by 40 feet, in which is employed the force necessary to attend to the vast and growing details of The Electrical World, its publishing and bookselling departments and the correction and preparation of that now almost absolutely necessary annual, "Johnston's Electrical and Street Railway Directory." To the left of the reception room is a space of the same dimensions as the business office,



A CORNER IN THE SHIPPING DEPARTMENT.

moval—and that the different buildings it has occupied are all in sight and within gunshot of each other. Its old postoffice box, 3,332, it continued to occupy until the postoffice at the beginning of this year abolished all boxes bearing a number over 3,000, and it was assigned a new one, 769. The paper used by The Electrical World, moreover, has been supplied by the same mill for almost the entire twenty years, and much of the work on it not done in its own office has been in charge of those who have attended to it about the same length of time.

The location chosen by The Electrical World in the new building at 253 Broadway comprises the entire front of the third floor and extending 40 feet on Murray street. Whether one walks up the two easy flights or ascends by one of the Sprague-Pratt elevators, on reaching the third floor and turning to his left he will find the offices of The Electrical World directly in front of him.

From the hall one immediately enters the reception room, where everything will be found arranged for the convenience of the visitor. An attendant will take his card, or announce his name, if he desires to see any one connected with the business or the editorial department, or place at his disposal files of the various electrical papers, or permit him to examine electrical books from the cases containing a copy of every electrical book in print. On either side of the reception room arches open, on the right to the main business office and on the left to the editorial and other depart-



IN THE EDITORIAL ROOMS.

but divided into editorial rooms, a mailing room, a circular room, and extensive alcoves for books, papers, cuts, circulars, etc.

The main editorial office faces on Broadway, and is a secluded nook, very advantageously situated and well supplied with the necessary equipment, including a reference

library and a file of every electrical periodical in the world—always at the disposal of those making special researches. Near by is the office of the proofreader and advertising editor, also fronting on Broadway and taking in the two northern windows of the hemistyle, the corresponding windows on the southern side opening into the business office.

In the mailing room are the letter files, in which are kept, so arranged as to be easy of access when wanted, the extensive correspondence of The Electrical World and its different departments. Outside of this is a large room where several employees are constantly engaged in addressing circulars regarding The Electrical World or inquiries for data for use in the directory. Adjoining are alcoves containing, among other things, thousands of cuts, circulars, etc., and a large stock of electrical books, probably the largest carried on this continent.

BIRTH AND GROWTH OF THE POSTAL COMPANY.

The history of the Postal Telegraph-Cable Company, from its birth in 1881, has been somewhat varied, but with re-

vantage over all rivals, a company was incorporated on June 21, 1881, under the laws of the State of New York. It was called the Postal Telegraph Company, and the capital stock



J. H. Emery

T. D. Parker

General Superintendents Eastern and Western Divisions.

was \$21,000,000. The system adopted was based on the Leggo automatic and the Gray harmonic telegraph. The conductor was made upon plans devised chiefly by Chester Snow, at Ansonia, Conn., and consisted of a steel wire heavily coated with a deposit of pure copper, giving great strength and conductivity. A two-wire line was very thoroughly constructed between New York and Chicago and thence to St. Louis, extending also to Washington and several other important centres. With a capitalization entirely out of proportion to the cost of construction, which had amounted to about \$3,000,000, the company could hardly anticipate immediate success, and for some years struggled in an effort for existence.

Meanwhile the Commercial Cable Company had been organized. It was thought that another Atlantic cable might



J. G. Ward

General Manager Commercial Cable Co.

E. C. Bradley

Assistant General Manager Postal Telegraph-Cable Co.

markable singleness of purpose the leading spirits of the organization have pursued a far-sighted, conservative, business-like policy which has finally resulted in the substantial success which the company now enjoys. Only those who have actively participated in the organization and development of a telegraph company can appreciate the difficulty of the task, and only those thoroughly familiar with the history of the electric transmission of intelligence, realize the number of disasters that have overtaken such attempts.

In the belief that the use of a compound wire and a mul-



J. C. Barker

Scott H. Baker

Superintendent and Assistant Superintendent of New York District.

be made a profitable investment, and Mr. J. W. Mackay, Mr. John W. Garrett and Mr. James Gordon Bennett proposed to assume equal interests in the new enterprise. A cable was constructed, and on Dec. 24, 1884, was placed in operation. Mr. Garrett, however, withdrew before the completion of the cables, his interest being acquired by Mr. Mackay, and Mr. Bennett also relinquished the major portion of his share, which passed into Mr. Mackay's hands. A uniform rate of forty cents was established at the start, the rate of the rival companies being fifty cents. The result was one of the most bitter wars in the history of telegraphy which lasted for a period of two years and two months, at a loss, it has been estimated, of over \$5,000,000. The competitive companies reduced their rates to twelve cents per word, in an effort to force the Commercial company out of the field. The



A. C. Davis

Electrician

M. M. Davis

Assistant Electrician

tiplex system of telegraphy would render it possible to transmit a large amount of business at much lower rates than those in vogue at the time, and thus confer material ad-

Commercial lowered its rate to twenty-five cents but would go no lower. Its patrons, realizing that if the new company was driven out, the old rates, at least, and probably still higher ones, would be established, continued their support, with the result that the rival companies eventually raised their rate to twenty-five cents, which has been the uniform rate since that time.

In 1883, Mr. Mackay, in undertaking to financially assist a friend, became largely interested in the Postal Telegraph Company. In order to place the property upon a better basis a new company was subsequently organized with an authorized capital of \$10,500,000 in stock and \$10,000,000 in bonds, called the Postal Telegraph-Cable Company. The company, however, continued on a non-paying basis, and in the summer of 1884, the Baltimore and Ohio Telegraph Company and the Bankers and Merchants' Telegraph Company determined to join interests with the Postal company. Almost immediately after, however, the Bankers and Merchants' company went to pieces and the Baltimore and Ohio company soon withdrew. The Postal company then sought the advice of Mr. A. B. Chandler, who had a wide experience in the telegraph field. Mr. Chandler recommended a reorganization of the company upon a new and diminished capitalization, and the extinction of the mortgage bonds. His plan was accepted and he consented to act as receiver of the company. The work of reorganization continued as rapidly as possible, but occupied a full year, at the end of which the presidency of the new company was offered to Mr. Chandler and accepted. During the past nine years the interests of the company have been zealously guarded by Mr. Chandler, and his honorable and conservative administration of its affairs, together with the sound views, right purposes and ample resources of Mr. Mackay, and the aid of the very efficient officers who were brought into the service, has finally brought the organization to its present prosperous condition. Unlike its predecessors the company has not sought to engage in a bitter warfare with its great rival, the Western Union Telegraph Company. On the contrary, the relations of the two companies have been friendly and the only rivalry has been that of a fair, although sharp and very active, business competition. The results of these methods have been crowned with success and the magnificent home which the Postal Telegraph Company has just found is a sure indication of its prosperity.

A Universal Shunt Box for Galvanometers.*

BY W. E. AYRTON AND T. MATHER.

Several years ago Mr. Latimer Clark drew attention to the fact that when shunts were used with a ballistic galvanometer in the comparison of the capacities of condensers, the results were inaccurate if the multiplying powers of the shunts were assumed to be the same as those employed with steady currents; shortly afterward the matter was investigated mathematically by the late Mr. Hockin, and he showed that the inaccuracy was caused by the change which the application of the shunt produced in the damping of the swing of the ballistic galvanometer. Hence the instantaneous deflection of a galvanometer when shunted showed an extra diminution, as if its resistance had been increased by an amount which depended on the details of the construction of the particular galvanometer, and on the adjustment of the controlling magnet.

In 1892, when giving a preliminary account of our "workshop ballistic galvanometers" at the Physical Society, we incidentally mentioned a method that we had devised of constructing shunts which entirely overcame this difficulty. At that time we had only perceived that our method of constructing constant damping shunts was of value in connection with ballistic galvanometers; but subsequently it occurred to us, when specifying the resistance of such con-

stant damping shunts, that this method of construction not only removed the difficulty which had been pointed out by Mr. Latimer Clark in connection with ballistic galvanometers, but it enabled the same shunt box to be used with any number of different galvanometers of any resistance and of any type, and with an accuracy in the measurement far greater than could be obtained with the ordinary form of shunt box which had been specially constructed for the particular galvanometer.

As this method of making shunt boxes has not yet been published, and as it possesses important advantages of which we were not aware when we alluded to it at the Physical Society, we have thought that a short description of the method may interest the members of the Institution of Electrical Engineers.

To appreciate its advantages let us first consider the common, well-known method of constructing shunts, and the defects it possesses.

1. The resistances of the 1-10th, 1-100th, and 1-1,000th shunt must have exactly 1-9th, 1-99th, and 1-999th of the resistance of the galvanometer; therefore, if the resistance of the galvanometer be 1,000 ohms, for example, the shunts must have 111.1, 11.11, and 1.111 ohms resistance; hence we must construct the 1-1,000th shunt accurately to the one-thousandth of an ohm if we wish it to be correct to even 1-10th per cent.

2. But the galvanometer is wound with copper wire; we are therefore at once met with the difficulty as to what wire we ought to employ in winding the shunts. If we use German silver, platinoid, manganin, or any substance of low temperature coefficient for the wires of the shunt coils, their resistances may be quite constant, but a rise of 10 degrees C. in the temperature of both the shunts and of the galvanometer will make an error of 4 per cent. in the resistance of the former relatively to that of the latter.

If, on the other hand, we wind the shunts with copper wire, then since the shunts are not inside the galvanometer case, it is very difficult to ensure, from the readings of thermometers, that there is not a difference of some two or three degrees between the mean temperatures of the shunt box and of the galvanometer, so that the resistances of the shunts may easily be 1 per cent. wrong relatively to that of the galvanometer.

In fact, except in the rare case when the galvanometer, as well as the shunts, are wound with German silver, manganin, or other wire of low temperature coefficient, it is useless spending time making accurate adjustments of the resistances of the shunt coils as ordinarily constructed.

3. Even if the resistances of the shunts be exactly 1-9th, 1-99th, and 1-999th of the galvanometer, they act as if they did not allow 1-10th, 1-100th, and 1-1,000th, respectively, of the charge in a condenser to pass through the galvanometer when used ballistically.

4. Lastly, for each galvanometer there is needed a separate set of shunts.

All these defects arise from the fact that the method hitherto adopted of varying the current through a galvanometer while the current in the main circuit remained the same, has consisted in varying the resistance of the shunt to the galvanometer. If, however, we leave the shunt to the galvanometer untouched, and, instead, vary the current through the galvanometer by varying the point of attachment of the main leads, we remove all these difficulties at once.

A shunt box constructed in this latter way is seen in Fig 1. The terminals *A* and *B* of the shunt box are permanently connected respectively with the terminals of the galvanometer *G*, while the terminals *B* and *C* of the box are connected with the two main wires which lead the current up to, and away from, the galvanometer and shunt. The ends of a coil of *any* resistance *n* ohms are permanently connected as shown, and at points in this coil corresponding

*Paper read before the English Institution of Electrical Engineers.

with $\frac{r}{10}$, $\frac{r}{100}$, $\frac{r}{1,000}$ ohms permanent connections are made with the various blocks of the shunt box as illustrated.

Then, whatever be the resistance of this coil, r , compared with the resistance of the galvanometer g (either or

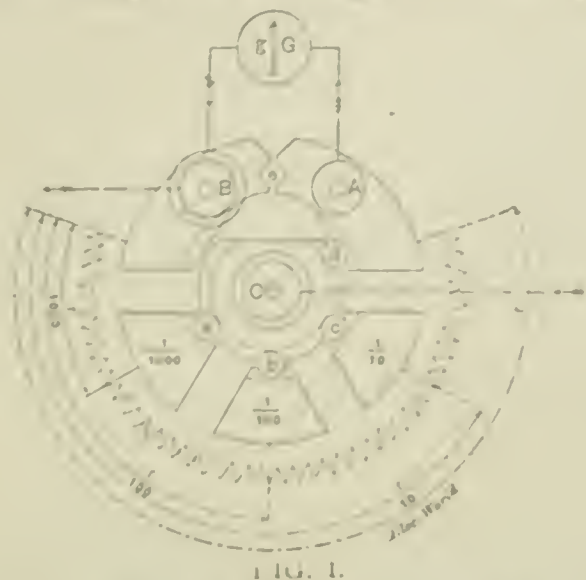


FIG. 1.

both of which may therefore be unknown), it is easy to show that if G amperes be the current flowing round the galvanometer when a plug is placed in the hole marked d , it will be $\frac{G}{10}$, $\frac{G}{100}$ and $\frac{G}{1,000}$ amperes respectively when the plug is put instead into the holes marked c , b and a respectively, provided that the current in the main circuit remains constant—the condition which is, of course, assumed to be true in the ordinary use of shunts. Or, if a definite quantity of electricity flow into or out of a condenser in the main circuit, and Q coulombs be the quantity of electricity that flows round the galvanometer when the plug is in the hole marked d , $\frac{Q}{10}$, $\frac{Q}{100}$ and $\frac{Q}{1,000}$ coulombs will be quantities that flow round the galvanometer when the plug is put into the holes c , b and a respectively, and the deflections will correspond with these quantities.

For let the constant current in the main circuit be called A : then, when plug is in hole d , the galvanometer current equals

$$\frac{r}{r+g} A, \text{ say } G$$

when plug is in hole c , the galvanometer current equals

$$\frac{\frac{r}{10}}{\frac{r}{10} + \left(\frac{9}{10}r + g\right)} A, \text{ or } \frac{G}{10}$$

when plug is in hole b , the galvanometer current equals

$$\frac{\frac{r}{100}}{\frac{r}{100} + \left(\frac{99}{100}r + g\right)} A, \text{ or } \frac{G}{100}$$

when plug is in hole a , the galvanometer current equals

$$\frac{\frac{r}{1,000}}{\frac{r}{1,000} + \left(\frac{999}{1,000}r + g\right)} A, \text{ or } \frac{G}{1,000}$$

Similarly, if K be the number of coulombs flowing into, or out of a condenser in the main circuit, and pK , or Q , be the number of coulombs that flow round the galvanometer when the plug is put into the hole marked d , it may be proved that, since the resistance of the galvanometer plus that of the shunt is constant, and therefore the damping is constant, the quantities of electricity that will flow round the galvanometer when the plug is put instead into the holes marked c , b , a , respectively, are $\frac{Q}{10}$, $\frac{Q}{100}$,

$$\frac{Q}{1,000} \text{ coulombs.}$$

Hence the galvanometer may be wound with copper or with any other wire; a single set of shunts may be made of manganin wire, and be accurately subdivided into *exact* numbers of ohms, *fractions of an ohm being unnecessary with our system*; the galvanometer may have any resistance and be at any temperature, provided it is constant while a set of tests is being made, then the subdivision of a steady current or the subdivision of an instantaneous rush of electricity into parts having the ratios of 1 , $\frac{1}{10}$, $\frac{1}{100}$,

$\frac{1}{1,000}$, is effected with *great accuracy*.

The arrangement of shunt box illustrated in Fig. 1 may be regarded as possessing one defect—viz., that the whole current flowing in the mains cannot be sent round the galvanometer without disconnecting the main wire from the terminal C and connecting it instead with the terminal A . To save the trouble of having to do this, and to enable every combination to be made by simply shifting the plugs, we sometimes construct the blocks of the shunt box as seen

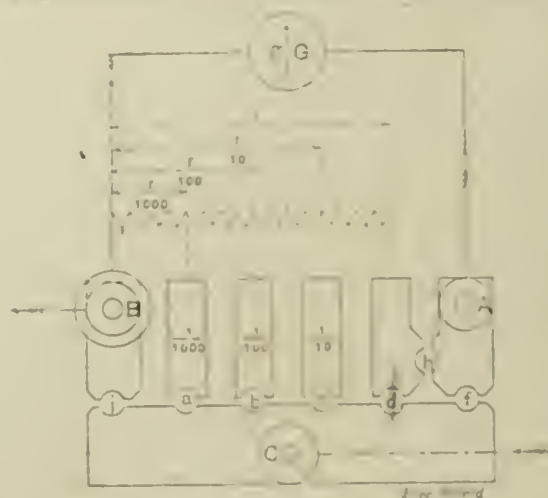


FIG. 2.

in Fig. 2. When one plug is placed and left in the hole marked d , and a second plug is placed in one or other of the holes marked c , b or a , we obtain exactly the results already described in connection with the box seen in Fig. 1. Placing, however, one plug only in the hole marked d , the entire current flowing in the mains circulates round the galvanometer. If a plug be placed in the hole d , and another in the hole c , the galvanometer is short circuited—a result obtained by placing the two plugs in the holes marked d and e in Fig. 1. The arrangement shown in Fig. 2 has the further advantage that it is possible, by putting a single plug into the hole marked d , to disconnect one terminal of the galvanometer from the circuit without breaking the circuit. This method of connecting is convenient to employ when taking the zero with a very sensitive galvanometer, for in that case it may happen that, although the galvanometer is apparently short circuited, through a very low resistance, enough of the main current, although but an extremely small fraction, passes round the galvanometer to produce a small deflection.

When, however, r is more than about ten times as great as g , the simpler form of shunt box illustrated in Fig. 1 is sufficient for ordinary purposes: for, although by merely shifting the plug with this type of box, it is impossible to send a greater current round the galvanometer than $\frac{r}{r+g} A$ amperes, where A is the current in the mains, this value of G , being more than $\frac{10}{11} A$, is sufficiently near A for ordinary purposes.

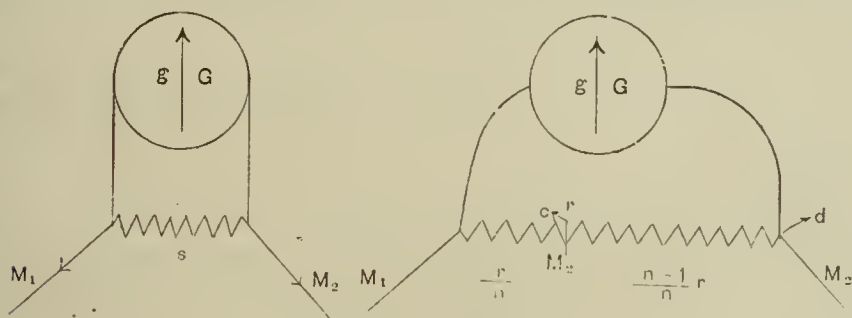
Of course, whatever be the value of r , whether large or small compared with that of g , the current that flows round the galvanometer when the plug is put into the poles marked c , b and a , respectively, is exactly 1-10th, 1-100th and 1-1000th of its value when put into the hole marked d . The only advantage that is gained by making r large compared with g is that $\frac{r}{r+g} A$, or G , the unit current, becomes then practically equal to A .

The method of using shunts above described has, then, the advantage that it enables the same shunt box to be used with any galvanometer of any resistance, whether ballistic or not; but it does more than that, for a consideration of our method of varying the point of attachment of one of the mains, instead of varying the resistance of the shunt itself, shows that any ordinary resistance box can be employed as a shunt with any galvanometer, and the fractions of the current that pass round the galvanometer and through the shunt respectively can be read off at once, without any calculation and without a knowledge of the resistance of the galvanometer, to a far higher degree of accuracy than is possible with a set of shunts specially constructed for the particular galvanometer in the ordinary way.

By employing this device we also find that great simplification and cheapening of cost are effected in the employment of a d'Arsonval galvanometer with shunts of platinoid or manganin sheet for the measurement of electric currents over a wide range.

It is well known that with the ordinary method of constructing shunts the resistance of the circuit is altered when the shunt is varied. An interesting question therefore arises whether this change in the resistance of the circuit is greater with the method that we have proposed of constructing a shunt or with the ordinary method.

With the ordinary method of keeping the main leads, M_1 , M_2 (Fig. 3), permanently connected with the galvanometer G and of varying the current through the galvanometer by



FIGS. 3 AND 4.

altering the resistance s of the shunt, the change that is produced in the resistance of the circuit on applying this shunt is, as is well known, from g to $\frac{sg}{s+g}$; that is, the resistance is diminished by $\frac{g^2}{s+g}$. If then the shunt be such as to allow $\frac{1}{n}$ th of the current to pass through the galvanometer, s equals g , and the resistance in circuit is diminished by $\frac{n-1}{n} \times g$ when this shunt is applied. For example, if n be 10, the resistance of the circuit will be diminished by $\frac{9}{10}$ of g .

With our proposed method of keeping a fixed resistance r attached to the galvanometer G (Fig. 4), and of varying the current through the galvanometer by varying the connection of one of the main wires, for example, by moving the main wire M_2 from the point d to the point c the resistance of the circuit is altered from $\frac{rg}{r+g}$ to $\frac{r(\frac{n-1}{n}r+g)}{r+g}$;

that is, the resistance in the circuit is diminished by

$$\frac{1}{r+g} \left\{ \frac{n-1}{n} rg - \frac{n-1}{n^2} r^2 \right\}. \quad (1)$$

Now this expression depends not merely on the values of n and g , but also on the value of r . If r is selected so as to be less than ng , the expression (1) is positive; that is, the resistance of the circuit is lessened by shifting the main M_2 from the point d to the point c ; whereas if r is selected so as to be greater than ng the expression (1) is negative, which means that shifting the main M_2 increases the resistance of the circuit. Lastly, if r be chosen so as to be exactly equal to ng , shifting the main produces no change

whatever in the resistance of the circuit, so that the current now passing through the galvanometer after shifting M_2 is exactly $\frac{1}{n}$ th of the current that previously passed through the galvanometer, for the current in the main circuit undergoes no change whether the resistance of the circuit be large or small.

By selecting r then so that it is roughly equal to ng , our proposed arrangement gives the following result on shifting the main M_2 from d to c :

(a) If the resistance of the rest of the circuit be large compared with that of the galvanometer, the current that now passes through the galvanometer is exactly $\frac{1}{n}$ th of that which previously passed, whatever be the temperature.

(b) If the resistance of the rest of the circuit be even small compared with that of the galvanometer, the current that now passes through the galvanometer is very nearly $\frac{1}{n}$ th of that which previously passed, whatever be the temperature.

Contrasted with this we have, with the ordinary method of applying a shunt, the result:

(a) Even if the resistance of the rest of the circuit be large compared with that of the galvanometer, it is only when the temperature has one definite value that the current that now passes through the galvanometer is exactly $\frac{1}{n}$ th of the current that previously passes.

(b) If the resistance of the rest of the circuit be small compared with that of the galvanometer, the current that now passes through the galvanometer is far greater than $\frac{1}{n}$ th of the current that previously passed.

Lastly, whatever be the values of g , r and n , our method of altering the current through the galvanometer produces less change in the resistance of the circuit than the ordinary method. For, as already seen, with the ordinary method of applying a shunt, the resistance of the circuit is diminished by $\frac{n-1}{n}g$, while on moving the main M_2 from d to c with our method, the resistance of the circuit is diminished by

$$\frac{1}{r+g} \left(\frac{n-1}{n} rg - \frac{n-1}{n^2} r^2 \right);$$

therefore, the ordinary diminution of resistance minus the diminution of resistance in our case equals the difference between these expressions, which is

$$\frac{(n-1)}{n^2} \frac{(ng^2 + r^2)}{(r+g)} \quad (2)$$

Now, this expression (2) is always positive, when n is greater than unity, therefore our method of shunting produces the less change in the resistance of the circuit in all cases.

Annual Meeting of the General Electric Company.

The annual meeting of the General Electric Company was held at its offices in Schenectady on April 10. Proxies on a very large block of the stock were voted by Oliver Ames, second, of Boston, and the old board of directors of last year were re-elected. The date of the stockholders' annual election was changed from the second Tuesday in April to the second Tuesday in May. The fiscal year ends Dec. 31. The number of directors was changed from eleven to thirteen. No election of officers took place.

Competition for Self-Propelled Vehicles.

An enterprising daily paper of Paris has offered a series of prizes ranging from \$1,000 down to \$100 for self-moving vehicles, a test of which is to take place in Paris on June 1 of this year.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

COMPILED FROM
PRINCIPAL FOREIGN
ELECTRICAL JOURNALS
BY CARL HEDING

(Note.—Owing to a delay in the foreign mails, some of the journals of March 15 to 31 have not yet been received.)

ELECTRO-PHYSICS.

Sound Produced by Light.—According to "Cosmos," March 17, Mr. Semmola found that by focusing intermittently the rays from the sun by means of a lens on to the diaphragm of a Hunning transmitter a sound will be produced in a telephone connected with it, the pitch of which will depend on the rate of intermittence; it is due to heat radiations, being increased if the diaphragm is blackened and disappears completely if the rays are passed through a heat absorbing substance; the bright spot should be sufficiently hot to carbonize paper; the diaphragm was 0.2 millimetres thick; the heat causes dilations and contractions, which produce the variations.

Cathode Rays.—Mr. Lenard's article, mentioned in the Digest last week, is continued in the Lond. "Elec.," March 30.

MAGNETISM.

Magnetic Field Inside of a Circle.—The Lond. "Elec. Rev.," March 30, contains a mathematical article by Mr. Rimington, in which he shows a method of approximately determining the magnetic field at any point inside of a circle carrying a current; it can be applied to any point not too near the edges; the width and depth of the coil are assumed to be negligible; the final approximate formula is

$$F = \frac{2 \pi c}{r} \left\{ 1 + \frac{3}{4} \left(\frac{a}{r} \right)^2 \right\}$$

in which F is the strength of the field (presumably in gaussses or absolute units), c is the current (presumably in absolute units of 10 amperes), r is the radius and a the distance from the point to the centre of the circle (both presumably in centimetres); this is for one turn, if there are n turns the value of F must be multiplied by n ; for applying this to the correction in a tangent galvanometer for small deflections, a is, of course, the half length of the needle.

Non-Magnetic Watches.—According to the Lond. "Elec. Eng.," March 30, the difficulty in the way of using palladium for non-magnetic watches seems now to have been overcome by using an alloy of that metal; it is stated that watches in which this alloy is used are now so well made that excellent Kew certificates can be obtained for them.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Universal Shunt-Box for Galvanometers.—The paper of Prof. Ayrton and Mr. Ma'her, read before the Institute of Electrical Engineers, is reprinted in full in another column.

Ruhmkorff Coils.—In an article by Mr. Armagnat in "L'Ind. Elec.," March 25, he gives a simple mathematical discussion of the various quantities and factors involved, including simple formulas for calculating the various quantities. The induced E. M. F. at closing is so small that even

with the largest coils a spark of only a fraction of a millimetre can be produced; there is a great difference between using direct and alternating currents in the primary, the output of the apparatus being much greater by using the latter, the efficiency being also much greater, but the frequency required to produce the equivalent of a direct current is far greater than those usually used in practice, and it is therefore necessary to increase the current; he shows that the condenser ought to be as small as possible, and discusses its effect and the calculation of it, concluding that the best way to adjust it is by experiment; the true action of the condenser is not to counterbalance completely the self-induction of the bobbin, as is sometimes stated; theory and experiments accord in the case of small coils, but not in the case of large ones.

Measuring the Difference of Phase.—In a paper by Mr. Hess, reprinted in "L'Ind. Elec.," March 25, he describes a method in which each of the two currents is made to create a turning magnetic field; if the currents have the same amplitude and the fields turn in opposite directions, there will be a resultant if both act on the same point, from the inclination of which the difference in phase can be determined; the resultant is indicated by means of a small needle of soft iron.

Rapid Verification of Meters.—The article by Mr. Picou, abstracted in the Digest April 7, is reprinted in abstract in the Lond. "Elec. Rev.," March 30.

ELECTRIC RAILWAYS.

Heilmann Locomotive.—The article by Mr. Haubtmann is concluded in "L'Elec.," March 24. The two causes for the inferiority of this locomotive are the small power furnished by the steam engine and the enormous weight of the whole locomotive; it was found that the steam engine was much too small in proportion to the boiler, a defect which was discovered too late to be remedied, but even if it had been equal to that of the boiler, there would have been only 750 to 800 h. p. at the wheels, corresponding to a velocity of about 42 miles per hour, which is accomplished daily by ordinary locomotives with a train of double the weight; but even if the steam engine was equal to that of the boiler the whole locomotive would do but 50 per cent. of the work of the Bousquet locomotive; it is therefore quite inferior to present locomotives; it would be difficult to construct such a locomotive at 198 to 220 pounds of dead weight per horse power; certain locomotives at present in use give 1,100 h. p. with a weight of 80 tons, or about 151 pounds per horse power, which it would be almost impossible to arrive at with an electric locomotive of this kind; for the same useful work the power of the electric locomotive would have to be increased 25 per cent. above that of steam locomotives. Tables are quoted from the recent paper of Mr. Bousquet, giving the calculated weight and horse power for a series of speeds for locomotives of different weights per horse power for draw-

ing a train of 100 tons up a 5-per cent. grade, showing that the weight and horse power become infinitely great at speeds of 84 to 120 miles per hour, the latter being for a weight of 77 pounds per horse power (it seems doubtful whether these figures are perfectly reliable, in view of the high speeds which have been arrived at in this country with steam locomotives).

Mr. Lea, in the Lond. "Elec. Rev.," March 30, in reply to the recent editorial in that journal, thinks that due justice was not done to the capacity of the motors for operating in series when starting and in parallel when the normal speed is attained; he also calls attention to the fact that a high speed service is essentially one of few stops, implying that the starting is not such an important factor.

Budapest Conduit Road.—The conduit road in the city of Budapest is said to be one of the most flourishing in Europe, and its rapid development shows that such systems can, under certain conditions, give very economical results; in 1893 12.5 million passengers were carried, the receipts being \$500,000, enabling a dividend of 8 per cent. on a capital of \$2,000,000 to be paid; the number of cars has now been increased to over 100.

High Speed Railroading.—Mr. Behr, in the Lond. "Elec. Rev.," March 30, states that his company is preparing for the construction of a full sized lightning express trial line for carrying out experiments.

Railway in London.—According to the English journals it is proposed to construct an underground electric railway from near the centre of London to Hampstead, a distance of about five miles; a two and a half minute service is proposed, seating 200 passengers per train.

Early Invention of the Overhead Method.—"L'Ind. Elec.," March 25, reprints a French patent recently found by Mr. Tanner, to a Mr. Boue, dated Sept. 17, 1878, No. 126,446, in which he describes a system of electric railways in which the current is received by means of a trolley traveling on an overhead line, returning by means of the rails; the illustrations are reproduced; the grooved trolley wheel is shown carried by guides in the form of rollers traveling on overhead guide rails; in addition to the trolley there are metallic brushes; to the combination he gives the name of sliding wheels.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Parallel Working of Long Lines.—The discussion of Mr. Mordey's paper is continued in the Lond. "Elec. Eng.," March 30; Major General Webber cited a curious instance in one of the London stations in which a Mordey 100-kw. machine driven at 167 revolutions was coupled with a Thomson-Houston 130-kw. alternator driven at 170 revolutions, the two machines being in different stations 7,500 feet distant from each other; they had been worked in parallel more than a year very successfully. Prof. Ayrton claimed that the usual methods employed for synchronizing alternators were cumbersome and useless; he showed how easy it is to gauge the exact moment of synchronism by putting the test appliance on the high pressure side, and advocated the use of an ordinary electroscope like the common gold-leaf type; this is connected to the two machines, the foils being connected to one and the container to the other, a very fine conducting wire being also used to join the two machines direct; the period of divergence becomes slower and slower, until at synchronism it is zero. Mr. Mordey, in replying, stated that he agreed with Mr. Kapp as to the margin of power (see Digest last week), but did not think it ought to be obtained by the use of devices which prevented machines from doing work.

Balancing a Three-Wire System with Only One Machine.—The discussion in the Lond. "Elec. Rev." is continued by Mr. Seaman in the issue of March 30, in which he says that the principal drawback to the Edgumbe arrangement is the

difficulty which would be experienced if there was a wide difference of charge between the two halves of the battery; it could be regulated to prevent one-half from being discharged, but only by the expense of a waste in the other half; he has used a balancing machine without any battery at all; in case of further adjustment of potential than that given by the machine, he suggests an arrangement shown in a diagram, in which the battery can be either charged or discharged.

Crane.—According to the Lond. "Elec. Eng." March 30, calculations based on a series of tests, with a weight somewhat less than a ton, show that the efficiency of the electric jib crane used in Pimlico on the Thames is 78 per cent.; the maximum lifting power is three tons; its capacity is 200 tons of coal per day (but the weight is not given).

Gas Engines and Accumulators.—A translation of the article mentioned in the Digest Oct. 7, together with some illustrations, is given in abstract in the Lond. "Elec. Eng.," March 30.

Key.—In the Lond. "Elec. Rev.," March 30 Sir David Salomon suggests placing a small piston and spring in the hole of keys used for turning on street lights, in order to prevent the key from being left in the switch.

Brussels.—The English journals of March 30, give illustrated descriptions of this station, in which the three-wire low pressure system is used in conjunction with accumulators.

Morton's Steam Turbine.—The Lond. "Elec. Rev.," March 30, gives an illustrated description; the steam passes through the circumference of successive rings placed one inside of the other; several good illustrations are given.

Refuse Destructor.—"Ind. and Iron," March 30, contains an illustrated article, with tables and data, of the Livet destroyer.

Testing of Engines and Boilers.—The Lond. "Elec.," March 30, reprints at some length a lecture by Prof. Kennedy on boiler testing.

WIRES, WIRING AND CONDUITS.

Rules for Ship Lighting.—In the concluding section of Mr. Kennedy's serial in the Lond. "Elec. Rev.," March 30, he gives the modifications and alterations which he suggests to be made in those suggested in Lloyd's Register and reprinted in Jamieson's "Rules and Tables." Regarding dynamos, he suggests that ironclad dynamos and motors may be used closer to the compasses than a limit of 30 feet; the compasses should be adjusted with the dynamos and motors at rest; any defections due to the dynamos should be remedied first, and after that any due to the currents; paragraphs 2 and 3 are to be erased; in paragraph 6, under section IV., he adds that in places exposed to weather, oil, steam, water or heat, as also cargo spaces, coal bunkers or spaces which may at any time be used for cargo or baggage, or which are not at all times accessible, the leads must be thoroughly protected by lead covering, galvanized iron wire, armoring or concentric return metallic covering, no wood casing being allowed; wood casing may be allowed in dry places not included in the above; paragraphs 7 and 8 are to be erased; to paragraph 10 he adds that the back blocks containing the contact terminals must be of iron or other unbreakable material and should screw down perfectly watertight; regarding the joints in branches, he states that for main branches and all branches in damp places as specified above, they must be incased in watertight metallic junction boxes or by plumbers' joints; joints in small leads in dry places may be protected by wood casing only, but the joints must be watertight; joints with the hull are to be allowed with concentric wiring, in which system the outer conductor may be grounded; single wiring without concentric returns shall not be allowed, nor the hull alone be used as a return; in damp places metal case switches and fuses should be used,

and they must be perfectly watertight; in petroleum-carrying vessels lamps should be nited in large groups with the smallest number of switches possible; small fuses from 1 to 5 amperes must be of such a type that a larger fuse cannot be inserted into the cut-out than that for which it is made, and the amperes for which the cut-out and fuse are made should be clearly printed or stamped on both. It is claimed that these rules leave the choice of several good systems, but prohibit jerry wiring; he claims that concentric wiring is not expensive, and watertight junction boxes are just as cheap as others; he prefers the ironclad type of dynamos; he suggests that the alternating system may be the best; for engines he prefers the steam turbine or single acting inverted vertical engine. In an editorial discussion, in which nothing new is given, it is stated that the rules are admirable in most respects, except that they entirely exclude single wiring and that they offer a fairly sound basis on which to form a set of rules.

Explosions in Conduits.—The report of Prof. Kennedy on this subject is reprinted in the Lond. "Elec. Eng.," March 30, and concludes with the following recommendation: the boxes (manholes) should be carefully examined periodically by means of gas detectors; the cover should be completely sealed; if the gas comes through the bottom of the box it should be covered with cement; to ventilate them by connecting them to a chimney and thus reducing the air pressure he thinks is a mistake, as that would draw in the gas; forcing air into them he claims has the drawback that the gases would be sent through the tubes into the houses; he thinks the most practical method of ventilation is to ventilate individual boxes by pipes carried up the sides of adjacent buildings.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Electric Fog Signal.—The Timmis & Abernethy system is described and illustrated in the Lond. "Elec. Eng.," March 30; the position of the signal arm is indicated on the locomotive and in the cabin by electric bells.

ELECTRO-CHEMISTRY.

Purification of Sewage.—"I. Elec.," March 24, publishes an article by Mr. Vitoux, describing the Hermite process somewhat more in detail than in former descriptions, some of the dimensions of the apparatus being given, as also their capacity. The efficiency as a generator of chlorine is said to be high, corresponding to one gram per ampere-hour. For the city of Paris the cost would be 72 cents per inhabitant per year, while the cost in the method used at present is \$1.40; the cost of the installation sufficient for the whole city would be about twelve million dollars. A report of Dr. Piton is quoted from, giving the results of experiments; he gives the number of litres of sea water which can be charged to different degrees with chlorine by the apparatus at the city of Brest (the size or horse power of which, however, is not given); relatively the figures show that more than two and one-half times the quantity can be charged to 0.5 gram per litre than to one gram; he also states as the results of the experiments, that the deodorizing power is perfect, that the liquid has no power to dissolve solid matter, that for sterilizing 150 grams of undiluted sewage 6 litres saturated to one gram per litre are required, 9 of 0.5 gram and 12 to 15 of 0.25 gram; that in equal volumes it takes five minutes to sterilize this at one gram per litre, that it takes five minutes with the same concentration to sterilize an equal volume of a pure culture of the cholera or typhus bacillus, 10 minutes at 0.5 gram for sterilizing an equal volume of a pure culture of the cholera bacillus, 15 minutes at one gram for sterilizing an equal volume of a pure culture of the bacillus subtilis spore, and finally that an intimate contact is indispensable, thus requiring some mixing apparatus before the sewage reaches the sewer; in conclusion, he says that it is an excellent antiseptic, destroying very rapidly the

most resisting micro-organism, but only under the condition that there is intimate contact with the disinfecting liquid. Mr. Hermite has made experiments on fishes, stating that a species of red fish does not seem to be affected in water mixed with a quarter of its volume of the disinfecting liquid.

Electrolytic Sodium Process.—In the Vautin process, described in "Ind. and Iron," March 30, some of the chief difficulties in the electrolysis of the fused salt have been overcome; he employs a cathode of fused lead which has a great affinity for sodium, which is easily deposited into it; the anodes are arranged at the top of the vat, the cathode of melted lead at the bottom; the latter, when sufficiently charged with sodium, is run off; if caustic soda is to be used it is cooled and put into water, where hydrogen and caustic soda will be formed, leaving the lead in the form of powder; the chlorine is led off into lime chambers in the usual way. This lead sodium alloy is applicable to most processes for which sodium is at present employed, a number of cases being mentioned. The process is made continuous by drawing off the charged lead with a pipe into a second chamber; the diffusion of the sodium in the melted lead is said to be astonishingly rapid; the lead in the second vessel is treated with steam, which produces fused caustic. The action of the chlorine on the iron is prevented by using a mixture of chlorides for the electrolyte so as to procure a low melting point; the iron is dipped into the fused common salt, which forms a protective coating, which does not melt at the ordinary temperature of working.

Electricity in Metallurgical Operations.—Mr. Garnier, in an article in "Comptes Rendus," abstracted briefly in the Lond. "Elec.," March 30, suggests a method by which the process in certain metallurgical operations can be followed, especially those in the refining of metals; the apparatus consists of a tube of refractory material, in which some substance like powdered oxide of nickel mixed with charcoal is placed between two soft steel rods, sealing the tube at both ends, the thickness of the material being a few centimetres; when placed horizontally in a furnace the process in the tube is indicated by the electrical resistance offered by this material.

Electrolysis in Chemical Industries.—In a lecture by Mr. Rideal, reprinted in Lond. "Lightning," March 29, he describes electro-chemical processes for manufacturing iodoform, bromoform, chloroform, indigo and a number of metallic colors.

Aluminium and Platinum Alloy Plating.—An alloy of aluminium and platinum forms a yellow metal, which is very durable and suitable for protecting steel knives, besides forming a substitute for gold plating; in the Darling method, described in Lond. "Lightning," March 29, the bath consists of a solution of sodium aluminate, to which is added platinum cyanide dissolved in an excess of a potassium cyanide solution; the anode of the battery consists of a block of carbon or a sheet of platinum; the deposit has a pale yellow color like gold alloyed with 5 per cent. of silver, and contains only a very small per cent. of platinum, for which reason it is not expensive.

Conductivity of Cupric Chloride Solutions.—The Lond. "Elec. Eng.," March 30, quotes from the "Ann. Phys. Chem.," stating that such solutions show a regularly diminishing rate of increase of conductivity with temperature, that it varies with the concentration and that the maximum conductivity is obtained with solutions containing 18 per cent. of the salt; the temperature coefficient varies with the concentration and reaches a maximum at about 40 degrees (C?).

MISCELLANEOUS.

Wormproof Poles.—According to the "Elek. Tech.," Feb. 28, Mr. Mer states that as the worms eat the starch which is contained in the wood, if the wood is free from starch it will be proof against the worms; to free it from

starch, the trees which are to be cut in the fall should have the bark stripped in the spring for the length of one foot around the whole tree; the tree in its growth will then consume the starch to form the leaves, after which it will die, leaving the wood free from starch.

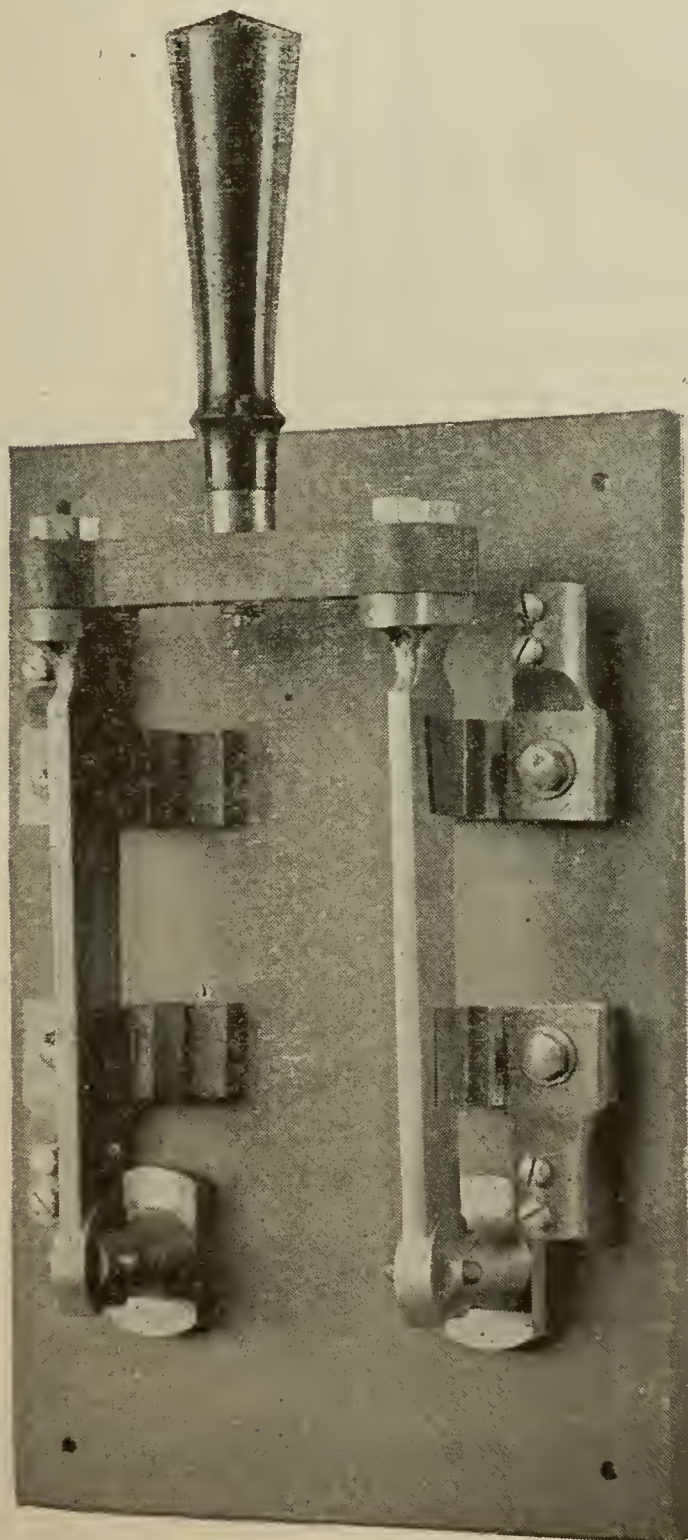
Electrical Treatment of Infantile Paralysis.—The Lond. "Elec. Rev.," March 30, reprints a paper by Dr. Jones on this subject, recently read before the Medical Society of London, in which he describes the successful treatment in a number of cases.

Electric Clock.—"La Nature," March 17, describes and illustrates a simple form of electric clock operated by a battery and an arrangement similar to the Hipp movement.

Commercial Progress of Electricity.—An article on this subject by Major S. Flood Page in the Lond. "Times" is reprinted in the Lond. "Elec. Eng.," March 30.

Double Pole Switch.

The switch illustrated, manufactured by N. S. Large & Son, 321 Chestnut street, Philadelphia, is made in sizes from

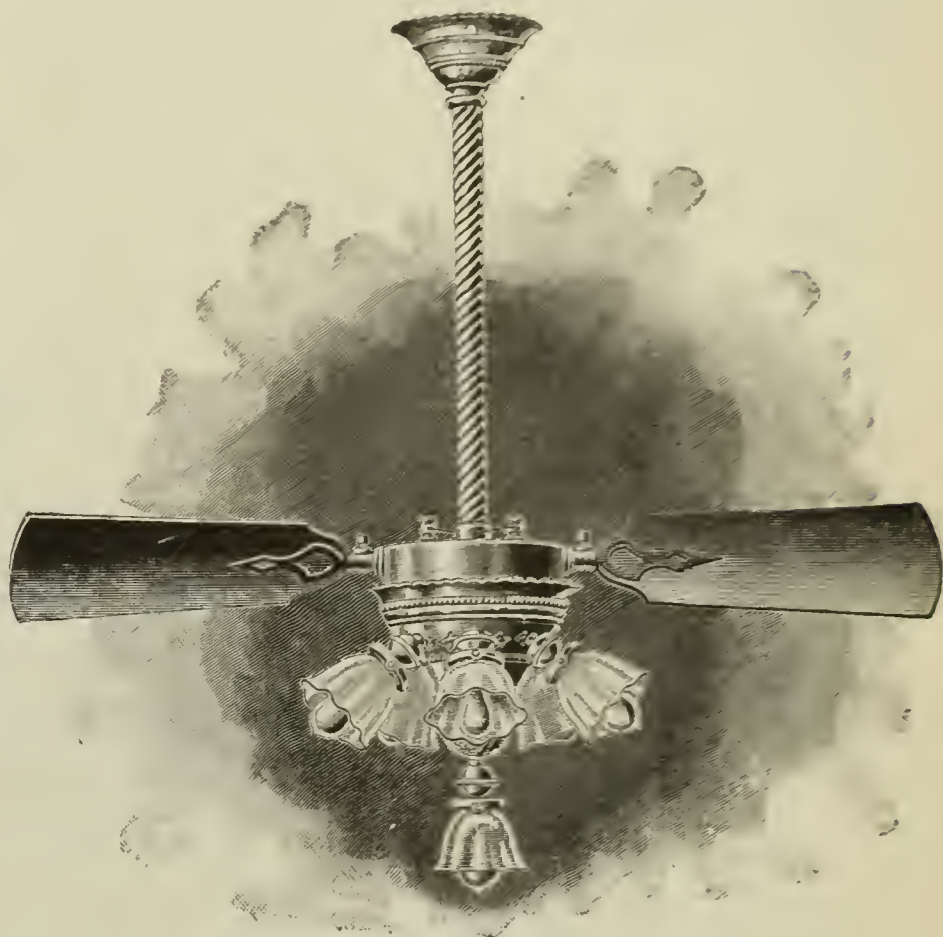


DOUBLE POLE SWITCH.

40 to 600 amperes, both dipped and polished, and with or without fuses. All parts of the switch are well proportioned, the contacts being of large area and taking a firm hold on the blade. The same style is also made in single and triple pole.

Combined Fan and Electrolier.

The combined fan and electrolier illustrated, manufactured by Diehl & Co., Elizabeth, N. J., is a neat combina-



FAN AND ELECTROLIER.

tion that will be appreciated during the summer months. Both lights and fan can be operated together or separately, as desired, and the blades are detachable, so that their presence may be dispensed with during the winter.

The Warren Engine-Dynamo.

We illustrate a combined engine and dynamo now being placed on the market by the C. C. Warren Electric Company, 307 Dearborn street, Chicago, Ill., which possesses a number of points of interest.

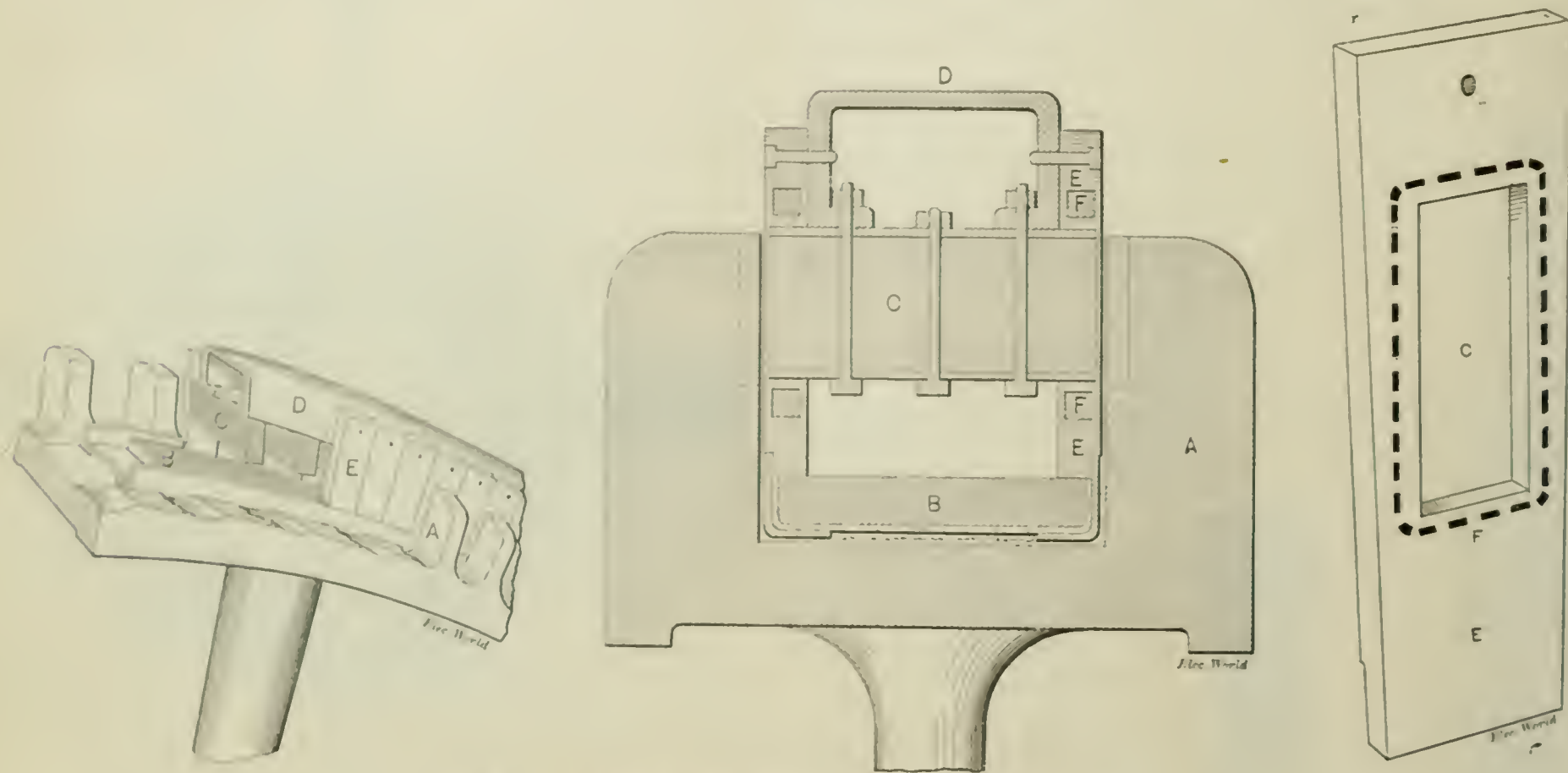
In most engines nearly or quite enough metal is used in the rim of the flywheel to serve for the purposes of the field core or magnetic part of a dynamo whose output in electrical energy is equal to the power developed by the engine. In the dynamo illustrated, the iron of the engine flywheel is utilized for the field and the pole pieces of the dynamo. Nothing revolves but the iron of the flywheel; there are no commutator, collecting rings, brushes, nor any current carrying apparatus whatever that is in motion. It is claimed that with this engine-dynamo not only is a duplication of iron for magnetic use avoided, but the power usually lost in belts, countershafting, etc., is saved, as well as valuable space; and that the cost of labor in the operation of the station, the first cost of the plant, and wear and tear are all reduced.

The illustration shows a tandem compound engine, which runs at a speed of 134 revolutions per minute, and around whose flywheel is built a 200-kw. alternator capable of operating 4,000 50-watt incandescent lamps, exclusive of line and transformer loss. The entire space required for this 4,000-light plant (exclusive of boiler room) is 15 feet by 35 feet, which allows ample space all about it. The alternator illustrated is adapted to any voltage, and may be changed from high to low voltage, or vice versa, by simply changing the stationary armature coil connections, no new part or parts being required in making such changes. It may be used as an alternating current arc lighting machine, or its circuits

may be divided and arc lights operated on one portion and incandescent lamps on the other.

The construction of the rim of the flywheel is shown in Figs. 2 and 3. The polar projections, *A*, are laminated next to the armature coils in order to prevent heating. A sufficient amount of metal is provided in the rim and polar projections to keep the maximum magnetic density within

angle iron rings are secured to the stationary support, *D*, which also carries the armature cores and coils. The magnet wire, *B*, is wound on 1-4-inch fibre board, which rests on these two angle irons. The least and greatest diameter of the completed circular magnet is 15 feet, 1-2 inch and 15 feet, 8 1-2 inches. The weights are: Iron rings, 440 pounds; fibre, 135 pounds; magnet wire, 3,700 pounds.



FIGS. 2, 3 AND 4.—WARREN ENGINE-DYNAMO.

40,000 lines per square inch. A metal satisfying this requirement is obtained from a mixture consisting of one part Lake Superior iron, one part Pittsburgh or Southern iron, and one part Swedish iron, with one pound of aluminium to each ton of the mixture. The following are the dimensions of the flywheel: Diameter, 15 feet; width, 30

The armature cores, *C*, are also shown in Figs. 2 and 3 and are attached, as shown, to the hollow stationary support, *D*, a full view of which is had in Fig. 1. The cores are stamped from No. 28 or 30 rolled plates, and each lamination is insulated with manilla paper and the bolts insulated by means of fibre tubes. The weight of the laminated iron

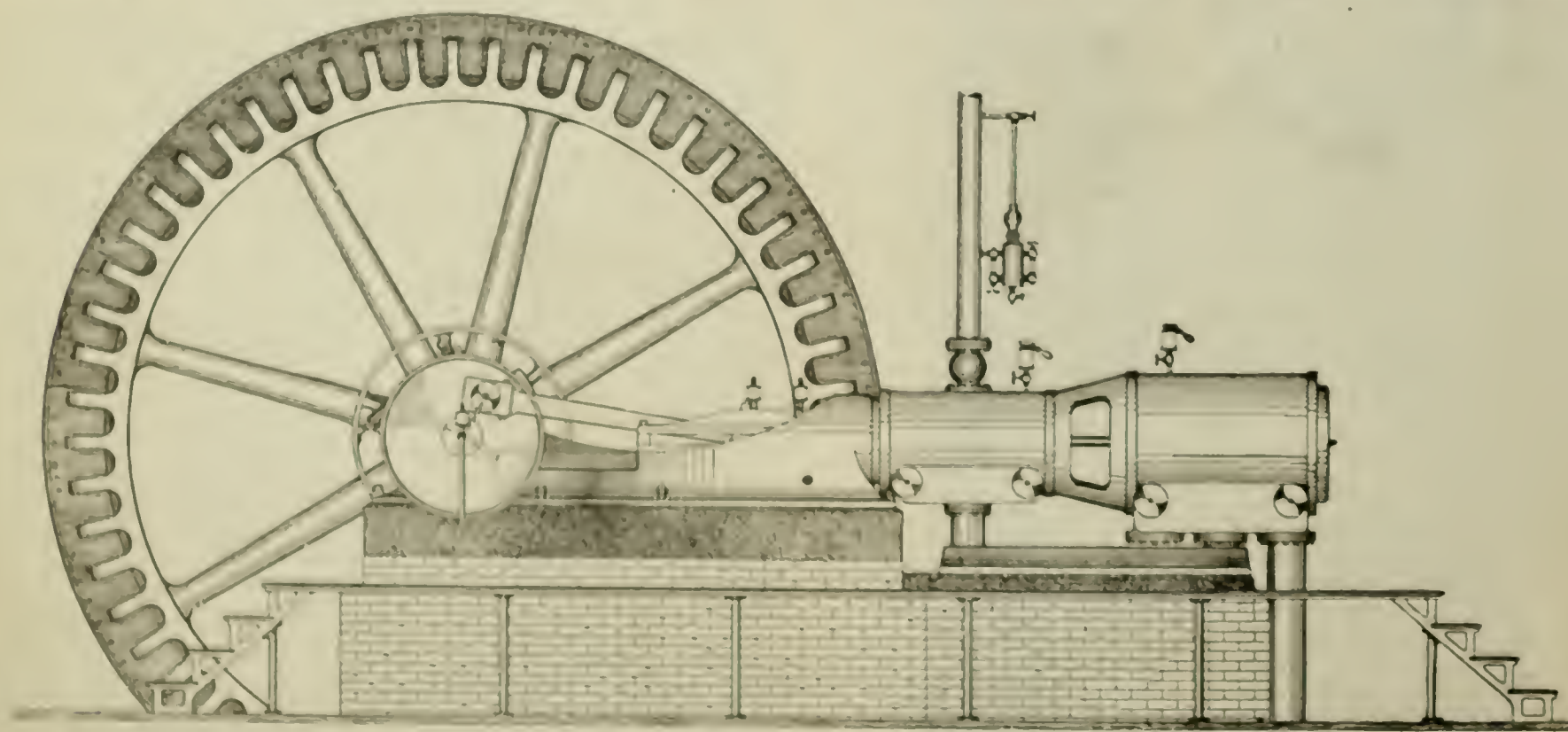


FIG. 1.—WARREN ENGINE-DYNAMO.

inches; thickness, 4 1-4 inches; radial length of polar projection, 11 1-4 inches; sectional dimensions of same, 3 X 7 inches; number of same, 112; weight of rim, 18,500 pounds; weight of polar projections, 80 pounds each; total weight of wheel, 36,360 pounds.

The field magnet, *B*, is shown in Figs. 2 and 3. Two

in the cores is 5,915 pounds, of the paper, 253 pounds, tubing, 22 pounds, the entire weight being 7,460 pounds.

Fig. 4 shows a complete armature coil, the windings being indicated by the dotted line. The magnet wire, *F*, is wound into shape on a form and then bound together with insulating tape to enable the coil to be handled without losing its

shape. The case is made of specially prepared fibre, which is readily moulded to any shape. The case, *E*, is attached to the supporting ring, as shown, and fits on the end of the armature core, *C*, the lower end fitting in the rims of the field coil support. The back portion is recessed to within 1-4 inch of the front surface, in order that a smooth appearance may be given to the machine and also to strengthen the lower part of the case. The weight of 224 fibre cases is 450 pounds, and that of 224 coils is 933 pounds.

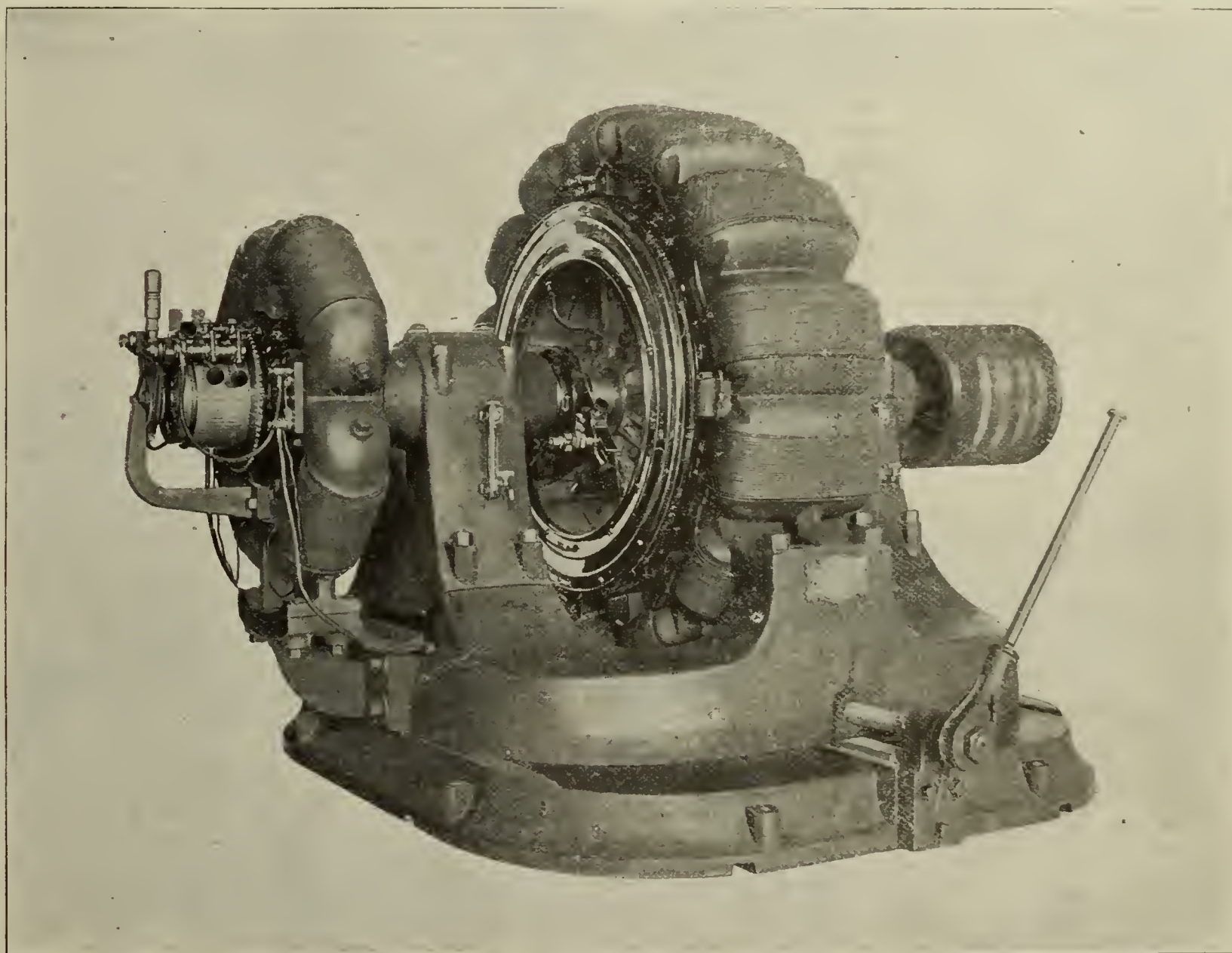
The stationary supporting ring, or frame, to which are attached the armature cores and cases, and field magnet coil, has the two inner flanges surfaced concentric with the wheel, and the outer face cored at various places to reduce the weight. The least diameter of the supporting frame is 17 feet, 4 inches, and the greatest diameter 18 feet, 4 inches, and it weighs completed 3,500 pounds.

The entire weight of the dynamo is 53,035 pounds; deducting from this the weight of the flywheel, there is chargeable to the dynamo proper a weight of 29,035 pounds, which is

for such a long time, and, like its multipolar generators, is a consequent pole machine.

The spherical winding of the fields permits of a free ventilation of the armature and at the same time removes the field windings, it is claimed, from any inductive influence from the armature. Owing to this design, the poles are much shorter, giving a shorter magnetic circuit, and a gross weight in the machine of about two-thirds of other types for the same output.

The armature is of the surface drum wound type, the two halves of the armature being in parallel. The spider construction of the armature is very strong and substantial, and gives a form of ventilation that has long been recognized as desirable. From the illustration it will be noticed that this machine is entirely self-contained, the exciter being part of the generator proper, inasmuch as it is on the same shaft as the armature, the fields being spread around this armature by a brass bracket fastened to the base of the alternator. The exciter is a small multipolar machine with a cross-



NEW STANDARD ALTERNATOR.

made up as follows: Cast iron, 15,860 pounds; wrought iron, 7,405 pounds; copper wire, 4,635 pounds; insulating material, 860 pounds; bolts, nuts, etc., 275 pounds.

The Standard Alternating Current System.

We illustrate herewith the new alternator of the Standard Electric Company, of Chicago, which has just completed its new alternating current system after a year's experiment conducted by their electrician, Mr. C. E. Woods. The generator shown has a capacity of 1,250 lights. It operates at 1,100 volts and 60 amperes, has fourteen poles and revolves 1,070 times per minute with 15,000 alternations. The general lines, or contour, of the machine is the same as that of the series arc lighting dynamo made by the same concern

connected armature, allowing two sets of brushes to be used, which are 90 degrees apart on the upper side of the commutator.

The machine is furnished with self-oiling bearings, using two rings for conveying the oil from the reservoir to the shaft above. A glass oil gauge is attached to each journal protected by a brass shield to protect the glass from breakage. The generator is mounted on an iron sub-base provided with a right and left hand ratchet, which can be attached to either end of the machine as desired.

Mr. Woods has now perfected, in connection with this alternating machine, a new type of transformer, the principal features of which are that it is fireproof inside and weather-proof outside, and also a complete line of measuring instruments, both new and novel in design.

Improved Tandem Compound Engine.

The M. A. Green automatic cut-off engines, manufactured by the Altoona (Pa.) Manufacturing Company, have established a deservedly high reputation, and in this issue we illustrate the tandem compound type, which is particularly interesting.

By an examination of the cut it will be noticed that both pistons can be as easily removed and with as little work as that of a single cylinder engine. All that is required is to remove the low pressure cylinder head and the nuts from the studs which hold the intermediate or packing head in position, they being on the outside between the two cylinders, when both piston rod and intermediate head can easily be drawn through without any disturbance to any part of the valve gear or removal of cylinders; it is not necessary to remove the low pressure piston head from the rod at any time.

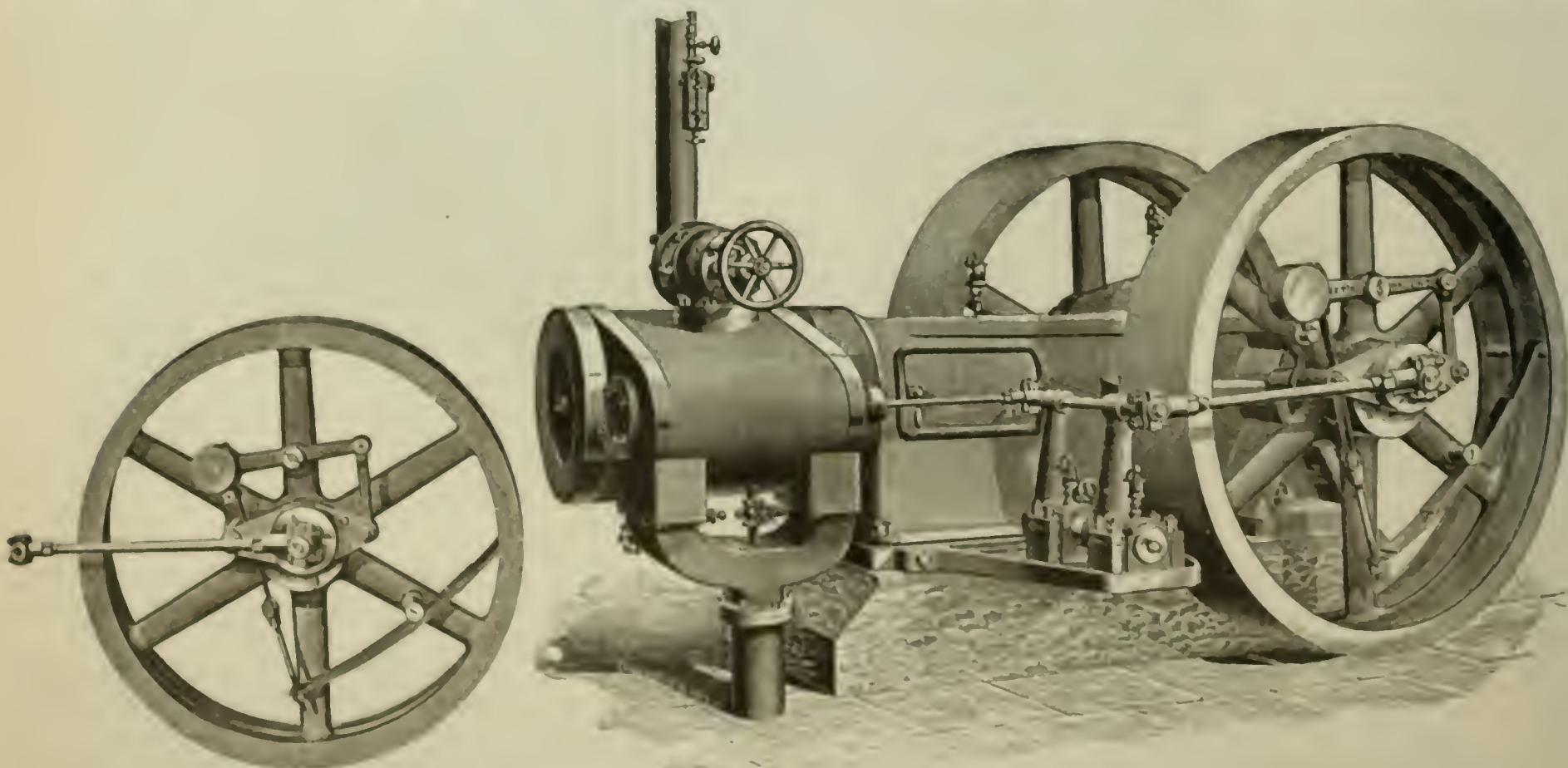
Another valuable feature is that there are no stuffing boxes between the two cylinders. The packing that is in the middle head is a newly designed double metallic packing, which will last from four to five years and require no attention whatever. The stuffing box on the high pressure cylinder is also packed with a new improved metallic packing, which will last about the same length of time. The bearings are bored by a special boring mill, which has two bars, one at a right angle with the other, and whose operation is as follows: The bed is placed upon standard parallel strips, the main bar is brought forward and the frame turned off and bored, and also the guides finished at the same time. The points of the pillow block are spotted with the main bar, thus securing accuracy in regard to the centre alignment; the bar is then run back and the cross bar brought forward, which passes through the main bearings; these bearings are then bored out true and the inner edge of the pillow blocks faced off true in keeping with the spotting that has been done by the centre bar, and the outer edges of the pillow blocks brought to length in keeping with the inner edge. The bed is then placed upon the erecting block. Special babbitt shells are used for the main bearings. The centre core of

and inner diameters, requiring no spotting or fitting. The smooth surface on the babbitt is thus retained as it comes from the moulds, as experiments have shown that the surface or skin produced on the babbitt by casting them in smooth moulds wears much longer and smoother than if that portion of the babbitt were scraped off.

The governor of this engine will, under wide variations of load, regulate within 1 per cent., and much closer if desired. The parts of the governor have anti-friction bearings, which do away with the annoyance of oil. The main bearings also have oil receivers, which return any drippings of oil back into a reservoir in the bed. The discs are completely covered with a hood, so that the engine is absolutely free from the annoyance of throwing oil.

The valve is remarkable for its simplicity and ease of operation, being as perfectly balanced as a piston valve and at the same time is at liberty to leave its seat, even more easily than an ordinary "D" slide valve; for the moment the pressure in either cylinder increases a small percentage over that of the steam pressure, the valve will rise, thus relieving the working order as soon as the pressure has disappeared. It will be noticed that only the high pressure cylinder valve is operated by a governor, while the low pressure cylinder is operated by a governor, while the low pressure cylinder is operated by an adjustable eccentric, which has a constant cut-off of from one-third to three-quarters. Experiments have shown greater economy and smooth running with this arrangement than if the low pressure valve was operated by an automatic governor. Crank shafts are made from a fine quality of forged steel, and the cast iron discs have heavy counterbalances, so as to thoroughly balance the weight of the reciprocating parts, and are bored true and thoroughly fitted to the arms of the crank shafts by an improved method, which produces a practical fit, bolts or babbitt or similar expedients not being used for this purpose. The shaft is extra large in diameter, and has long bearings; the crank pin is the full diameter of the shaft, and all the bearings are ground true.

The connecting rod does away with bolts and keys on the



THE GOVERNOR.

TANDEM COMPOUND ENGINE.

the mould for casting the shells is increased a fraction in diameter over that of the shaft, and the outer shell of the mould is also a fraction larger. By this method allowance is made for the natural shrinkage of the babbitt shells, so that they may absolutely fit the main bearings on the outer

centre crank engine, enabling an incline block to be used to make the adjustment with one screw. This block being the full breadth of the rod, not only forms a firm backing but admits of nice adjustments. Every part of these engines is interchangeable, being built to standard gauges.

The wheels have extra heavy rims with split hubs. This removes all danger of breakage of wheels by unequal shrinkage, and further enables the shaft to be clamped more thoroughly, and the heavy rims insure smooth rotary motion.

New Type of Vertical Compound Engine.

The Corliss engine has been definitely accepted as the type giving the highest economy, and an analysis based upon the principles of steam engineering shows that its economy is chiefly due to two points—correct steam distribution and small clearance space. From the form and position of valves, the clearance is reduced to a minimum, while the wrist-plate motion and the releasing gear admit of an ideal control of the admission and exhaust. Unfortunately, however, the Corliss releasing gear limits the rotative speed to 100 revolutions per minute, or even less, and it was to overcome this limitation that the Ball & Wood Co., of Elizabethport, N. J., designed the engine and valve gear which we illustrate, and in which the automatic cut-off is obtained by independently operated cut-off valves placed inside the steam valves and actuated by a specially designed governor. This arrangement places no restriction on the rotative speed, which is decided by other considerations.

As will be seen from the illustrations, motion is transmitted from the engine shaft to a horizontal shaft by means of bevel gearing. One end of this horizontal shaft actuates a Corliss wrist plate, which gives motion to the exhaust and main steam valves. To the other end of the shaft is secured an

may be here remarked that an independent valve shaft, driven by gearing from the main engine shaft, is used with some of the most successful types of torpedo-boat engines, and that, owing to the slight amount of work required to drive the valve gear, the usual objections against the employment of gears do not apply.

The resultant motion given to the cut-off valves is such that they operate at all points of cut-off relatively to the main valves, just as though the latter were standing still, thus preventing wire drawing of steam at any point of cut-off.

The location of the valves in the cylinder head, giving as it does the shortest possible ports, permits of their being

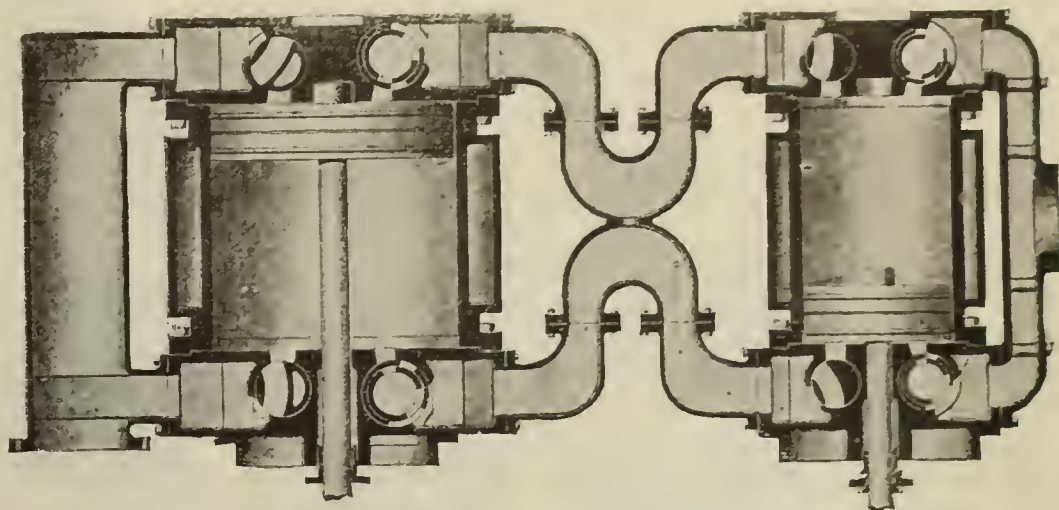


FIG. 3.—SECTION OF CYLINDERS AND VALVES.

of ample capacity without an appreciable increase of clearance. The peculiar motion of the cut-off valve utilizes these wide ports to the fullest possible extent, and the cut-off motion at every point from zero to three-quarter stroke is a rapid one; in fact, as rapid as is obtained from the releasing gear, because of the higher rotative speed of the engine. Another feature of great importance in this gear, particularly with compound engines, or where moments of excessive overload occur, is its ability to cut off at three-quarter stroke, while the Corliss gear is limited to about



FIGS. 1 AND 2.—NEW TYPE OF VERTICAL COMPOUND ENGINE.

ordinary Ball & Wood governing wheel. The cut-off valves, which are placed inside the steam valves, receive a motion which is the resultant of that of the horizontal shaft and the motion of the same shaft, as modified by the governor. It

half stroke. We hope before long to publish a detailed description of the valves and gear, accompanied by indicator cards, and we congratulate Messrs. Ball & Wood on what seems to be a real advance in steam engine design.

General Electric Railway Motor.

We illustrate below the parts of the General Electric G. E. 800 railway motor, whose light weight and simplicity of construction and manipulation have rendered it a general favorite among street railway men. By its use are claimed a decided economy in track expense and diminished maintenance and repair charges. The armature is of the ironclad type, with embedded winding. The bearings are lined with the best quality babbitt, and the brushes are readily accessible. When the motor is mounted on the

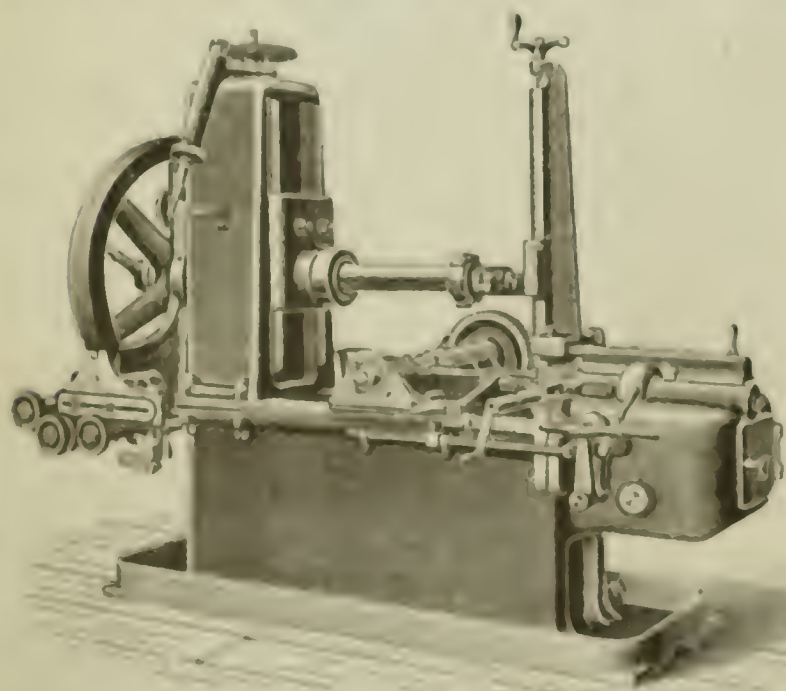


PARTS OF RAILWAY MOTOR

axle and closed it is both water and dust proof, and with the type "K" controller is claimed to form an invincible pair.

Automatic Gear Cutter.

We illustrate below an automatic gear cutter of a new type, manufactured by Gould & Eberhardt, Newark, N. J. The recent development of the electric motor for trolley cars has opened a new field which has made a demand for a machine capable of turning out wheels of about three pitch and with between 60 and 70 teeth and four to five inch face, and to do this work ten hours a day, day in and day out. This



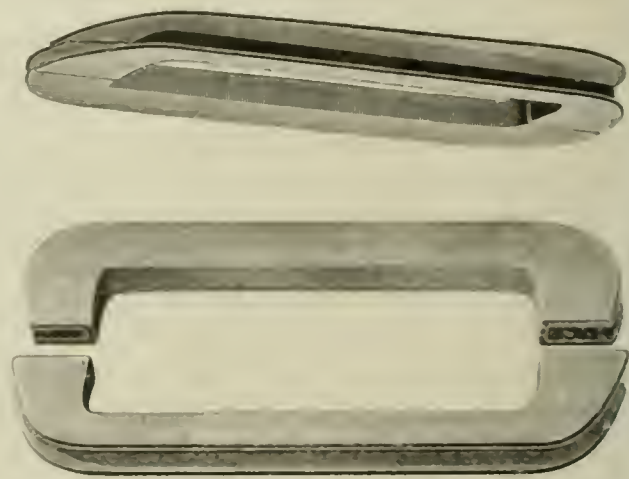
GEAR CUTTER

machine is so constructed that it turns out from two to three times the number of such gears that could be cut by the machines of the old type, and this without strain to the wearing parts of the machine, all of which are so designed as to be of the simplest form, and most handy for manipulation

The cutters are held in the centre of the cutter slide, so that all wear is equally distributed. In this machine, but two belts are used, one from the main shaft to the counter shaft, and one from the counter shaft to the machine. No belt tightener or cone pulleys are required, variations of speed, and feed as well, being obtained by use of change gears.

Armature Spools.

We illustrate a Gramme armature spool recently placed on the market by the Mica Insulator Company, 218 Water



GRAMME ARMATURE SPOOLS.

street, New York. The material of the spool is micanite, which, as is well known, is made of pure India sheet mica, and, it is claimed, is the equal in intrinsic insulating power to India mica used in sheets, while, practically, owing to its superior strength and moulded form, it is much more substantial and less liable to faults. As shown, the two halves fit into each other and allow the coil to fit snugly on the core.

Backus Ceiling Fan.

We illustrate a ceiling fan which the Backus Manufacturing Company, Newark, N. J., has designed for the summer season. The motor is wound for 110, 220 and 500

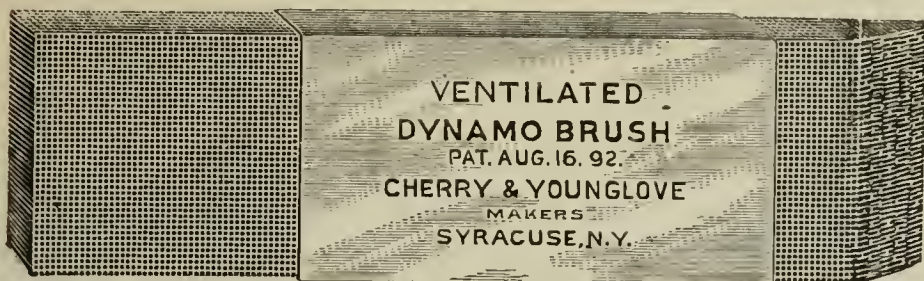


CEILING FAN

volt circuits, but with the first winding the motor can be used on circuits without injury of a voltage up to 140. The brushes are of imported carbon and are held against the commutator by a light spring: it is claimed that they will last two years without attention or adjustment.

Ventilated Dynamo Brush.

The dynamo brush we illustrate, manufactured by Cherry & Younglove, Syracuse, N. Y., will not, it is claimed, spark, heat or cut the commutator, is flexible, thus insuring a steady current, and it is ventilated by the comparatively large openings through it, as indicated in the engraving. The brush is



VENTILATOR DYNAMO BRUSH.

adapted for the ordinary brush holders, and capable of the same adjustment as ordinary dynamo brushes. The ventilating spaces, besides cooling the brush, also, it is claimed, prevent gumming and clogging.

The Wagner Transformers.

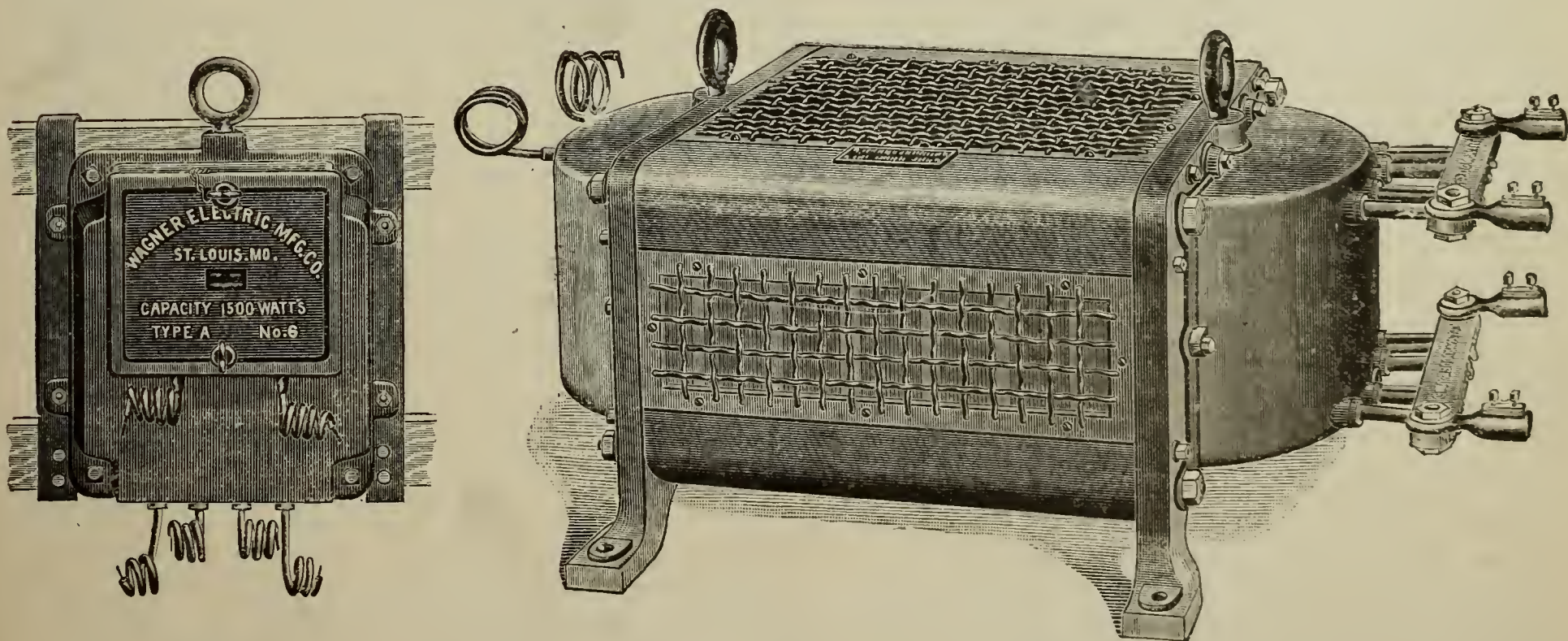
The transformers manufactured by the Wagner Manufacturing Company, of St. Louis, Mo., are the result of actual experience in the use of transformers in one of the largest alternating stations in this country, combined with a very careful study of the theoretical considerations involved. Unusual attention has been given to the question of insulation, it having been thought wiser to insulate transformers so that they will not burn out rather than to make the coils removable, thus introducing two or more breaks in the magnetic circuit, with a consequent loss of efficiency. The degree of perfection to which the insulation has been carried is evident from the fact that all ordinary transformers are tested to 8,000 volts, while with step-up transformers this is carried up to 10,000; as a consequence the manufacturers are enabled to give a guarantee against burning out for a period of two years. The same company will also supply transformers with oil insulation, if desired.

Special attention has also been paid to the question of

the quantity of magnetizing current, upon hysteresis and eddy currents, great care is taken in the selection of the iron to reduce the first and second, and in the construction to reduce the magnetizing resistance and obviate any eddy currents. The iron used in the transformers is made expressly for the purpose, and is the result of a long series of experiments carried out to determine the best formula for its composition. Owing to the careful selection of the iron and to the skill displayed in the design, the manufacturers are enabled to produce transformers differing from one another in efficiency by a very small amount. The company is, therefore, able to guarantee its transformers not to vary appreciably from the efficiency advertised, which is from 95 to 98 per cent., according to size.

The primary fuse box has been one of the weakest and most troublesome parts of transformers, and some manufacturers have consequently been led to abolish the fuse as part of the transformer, and provide separate boxes for them. The fuse box used with the Wagner transformer, while cast in one piece with the transformer box, is really entirely separate from the interior thereof, there being no opening between the two except the two small holes through which the two primary wires pass. The fuses are mounted on two separate porcelain blocks, rendering a short circuit impossible. These blocks are made in two parts, one being permanently attached to the box and carrying the connections, the other carrying the fuse being held in place against the former by means of simple contact springs; these springs are unusually heavy and will carry 25 amperes without heating. The fuse lies in a groove which forms, when the blocks are in place, a closed tube altogether preventing arcing, when the fuse is blown, and there being no screws nor metal parts of any kind on the outside of the fuse blocks, no injury to the hand could result should the fuse blow while being replaced. The connections with the secondary coils may be made for either 50 or 100 volts, and no fuses are used in this circuit at the transformer.

In addition to the usual types of transformers, arc light and step-up transformers are made, as well as special designs for various purposes, such as regulating transformers for feeders, for station switchboards; transformers to convert constant potential into constant current for series arc or in-



30-LIGHT AND 500-LIGHT WAGNER TRANSFORMERS.

regulation and efficiency. Experience having shown that for the best results in central station practice the drop should not exceed $2\frac{1}{2}$ per cent., that has been made the limit for the smallest transformers, while in the larger ones it does not exceed $1\frac{1}{2}$ per cent. As the leakage current depends upon

candescence lighting; transformers for reducing to low potential and large currents for electric welding; reducing and regulating transformers for electro-cautery and surgery, etc. Those illustrated are a 30-light standard transformer for outside use and one of 500 lights for installation inside.

THE PEOTONE ELECTRIC COMPANY, Peotone, Ill., capital stock \$6,000, has been formed to do electric lighting and other electrical business. H. A. Rathje, J. W. Stocker, J. Fedde, E. H. Fedde and M. Collins are the incorporators.

THE HEIMANN CARBON AND INSULATOR COMPANY, Chicago, Ill., capital stock \$500,000, has been incorporated by Solomon Heimann and others to manufacture and deal in long life carbons for arc lamps, insulating compound, insulators, etc.

THE STEVENS INDUSTRIAL STEAM-ELECTRIC COMPANY, Spirit Lake, Iowa, capital stock \$10,000, has been formed to build an electric plant to supply light, power, etc. B. F. Stevens, S. Stevens and E. W. Hawkins, of Spirit Lake, are the organizers.

THE WESTERN ELECTRIC BEER PUMP COMPANY, Chicago, Ill., capital stock \$10,000, has been formed to manufacture and sell beer pumps, freezing machines, etc. R. H. Rudolph, P. Garhart Dahl, Wm. J. Hellwis and L. G. Kunzer are the promoters.

THE ELECTRIC TOY COMPANY, Brooklyn, N. Y., capital stock \$10,000, has been organized to manufacture electrical apparatus, toys, etc. E. S. Boynton, 235 Lexington avenue; R. P. Cole, 582 Warren street, and Thomas Prosser, Jr., 15 Gold street, Brooklyn, N. Y., are interested.

THE LANCASTER AND LITITZ ELECTRIC RAILWAY COMPANY, Lancaster, Pa., capital stock \$100,000, has been formed to construct and operate a railway. The promoters are J. S. Graybill, C. F. Espenshade, H. Yeasley, J. Shaul, H. C. Hopkins and S. H. Reynolds, of Lancaster.

THE THOMAS H. CROSBY COMPANY, New York, capital stock \$5,000, has been formed to manufacture electrotype and stereotype plates. E. A. Tredwell, 521 Nostrand avenue; D. B. Tredwell, 510 Halsey street, Brooklyn, and J. Pendleton, 780 Park avenue, New York, are interested.

THE LANCASTER AND NEW HOLLAND RAILWAY COMPANY, Lancaster, Pa., capital stock \$100,000, has been formed to construct and operate an electric railway in the county of Lancaster. J. S. Graybill, C. F. Espenshade, H. Yeasley, J. Shaul, H. G. Hopkins and S. H. Reynolds, all of Lancaster, Pa., are interested.

THE THIELE CHEMICAL COMPANY, New York, maximum capital stock \$1,000,000, has been incorporated to manufacture and deal in chemicals, electrical articles, etc. F. C. T. Thiele, S. Friedlander and Felix Hamburger, all of New York, are the organizers.

THE H. P. TOOL COMPANY, of Kent, Ohio, capital stock \$10,000, has been incorporated by W. S. Kent and others to manufacture dynamos, motors and electrical goods; also to erect electric light and power plants.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
41 Park Row New York, April 16, 1894.

THE SAFETY INSULATED WIRE COMPANY, 234 West 29th street, New York City, of which Mr. S. L. Requa is manager, will, after May 1, occupy the large six-story building numbered from 225 to 239 West 28th street.

THE UNIVERSAL ELECTRIC PULL SOCKET AND SWITCH COMPANY, 27 Beaver street, New York, is daily appointing agents for the sale of its sockets and switches, the sales of which are far in excess of expectation, times considered.

SEALED PROPOSALS will be received at the fire department of Brooklyn, 367 Jay street, to noon, April 20, for furnishing 100 miles of weather-proof insulated hard-drawn copper wire. F. W. Wurster is commissioner of the fire department.

THOMAS C. PERKINS, vice president of the Mather Electric Company, Manchester, Conn., as in the city recently, and reported business in a flourishing condition, more orders having been taken in the last 30 days than the old company ever secured in the same time in its palmiest days.

A. D. ADAMS, of the Adams Electric Company, Worcester, Mass., was in the city on Saturday. Mr. Adams has designed a new line of dynamos and motors from 3-10 to 20 kw., and for currents of 115, 230 and 500 volts, all of which embody the latest mechanical and electrical improvements.

THE PAGE BELTING COMPANY, 91 Liberty street, New York, announces that notwithstanding the recent loss of its tannery by fire, it has sufficient stock on hand to enable the manufacturing departments to be kept running until the damage is repaired, and that its business will, therefore, not be interrupted.

MR. JAMES L. ROBERTSON, president of the Robertson-Thompson Company, and a member of the Hine & Robertson Company, 57 Cortlandt street, New York, has started on a three months' tour of the country. The straight line indicator, manufactured by this company, is meeting with deserved success among engineers, and, no doubt, Mr. Robertson will return to New York with many orders not only for indicators, but for other specialties manufactured by Mr. Robertson's company.

THE AMERICAN METROLOGICAL SOCIETY.—In accordance with the vote of the council of the American Metrological

Society the annual meeting will be held in Washington, D. C., on Friday, April 20, at 2 P. M. The place of meeting is the Columbian University. Papers of interest are expected. T. C. Mendenhall will report on the International Electrical Congress at Chicago. A. A. Michelson will give an account of his work at the International Bureau (near Paris) in determining the value of the meter in terms of wave lengths of light. The committee on color standards will make an interesting report. Persons interested are welcome at the meetings.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., April 19, 1894.

THE BOSTON ART BRASS COMPANY has been dissolved, and the business is now continued by Robert McGeorge. The offices are in Boston, Mass.

UPTON, MASS.—An electric railroad from Worcester to Boston, via Milford, and passing through this town, is one of the schemes parties are now agitating.

THE BELL TELEPHONE COMPANY has gained its victory with the Massachusetts legislative committee, a majority having reported favorably upon its application to increase its capital to \$50,000,000.

MANCHESTER, N. H.—President Williams, of the street railway, has made a survey of the proposed route of the electric railway from this city to Lake Massabesic. Report says that the line is to be constructed this season.

THE DAY-MOBERG ELECTRIC COMPANY, of Boston, manufacturers of the Jupiter storage battery, has just issued a neat little catalogue and price list, which will undoubtedly meet with appreciation, as it presents in brief form the advantages of the Jupiter battery and the various services to which it is especially adapted.

MR. EVERETT K. DAY, superintendent of the Mousam River Railroad, of Sanford, Me., was a recent visitor in Boston. We met him in the offices of the Brown Electric Company deeply interested in its railway specialties, and it is safe to assume that Messrs. Brown & Reynolds convinced him of their value before his departure.

MR. JOHN P. COGHLIN, of the Columbia Electric Company, Worcester, Mass., was a recent visitor at this office. He reports business as good, and left with us a circular, recently issued by his company, setting forth the merits of the "Columbia" dynamo, as well as the various branches of the electrical business to which his company gives especial attention.

MR. CHARLES E. BIBBER, vice president of the Cutter Electrical and Manufacturing Company, of Philadelphia, whom everybody knows and likes, particularly in Boston, where he resided so long, is at present sojourning in that city for a brief period in the interests of his company, and is receiving a hearty welcome both from a business and social standpoint.

A SPECIAL COMMITTEE of the Boston Board of Aldermen has reported to the main body of aldermen a sweeping order that the West End Street Railway Company shall place all feed and return wires in a certain prescribed district, including most of the business section of the city, underground. The work is to be completed by Nov. 1, according to the order. President Little says that it will be impossible to obey the terms of the order.

ATTLEBORO, MASS.—The Attleboro, North Attleboro and Wrentham Street Railway, which has been tied up by litigation for some months, will be in operation by the middle of May. The power house, which was partly destroyed by fire last winter, will be immediately rebuilt, and there will also be a new car house of brick. A large force of men is at work repairing tracks and motors. The road will start under a new management, and with a stronger financial backing.

THE LAWRENCE (MASS.) ELECTRICAL SUPPLY AND CONSTRUCTION COMPANY is one of the best known establishments of its kind in its section. It does a good and profitable business and represents nothing but the best of electrical specialties. One of the specialties it successfully displays to its customers and friends is a copy of The Electrical World of date March 8, 1884, over ten years ago, and which Mr. Charles I. Alexander, of the company, preserves carefully as a curiosity. Mr. Alexander has continued as a subscriber to The Electrical World ever since the date above mentioned, and so has Mr. John P. McLeod, of the Edison Electric Light Company, of Lawrence. Both of these gentlemen are "old timers" in the electrical business.

MR. F. S. PALMER, of the Electric Heat Alarm Company, of Boston, has just returned from a visit to Bangor, Me., and St. John, N. B. He carried with him a most beautiful exhibit outfit of the system of his company, and, for completeness, we have never seen its superior. It attracted in both cities the closest attention of business men, and particularly the insurance people, from whom Mr. Palmer expects to obtain such an endorsement of his system as will secure a reduction of rates wherever it may be used. This is one of the important advantages claimed by the Electric Heat Alarm Company for its fire alarm system—that it not only protects fully, but also reduces the cost of insurance. The company has also recently designed a new switchboard ap-

paratus for detecting hot journals, which seems to be perfect in every respect. It is doing an excellent business. The Pullman Company has just doubled its order for its thermostats.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD }
736 Monadnock Building, CHICAGO, April 14, 1894. }

THE STROWGER AUTOMATIC TELEPHONE EXCHANGE has given a license for the State of Missouri to a syndicate headed by S. Engel, of 46-48 Van Buren street.

THE SUNBEAM LAMP MANUFACTURING COMPANY, of Chicago, is permanently located in the new Chicago Title and Trust Building, 100 Washington street.

THE CALIFORNIA ENGINEERING COMPANY, Monon Block, Chicago, has changed its name to the New England Engineering Company; same officers and same address.

GEORGE L. THAYER, formerly with the Westinghouse company, and later electrician for the Northwestern Railroad, has opened an office at 1419 Monadnock Block, as consulting electrical engineer. Mr. Thayer is well and favorably known, and his future is full of promise.

THE LOUIS K. COMSTOCK COMPANY is the name under which the business heretofore conducted by Mr. Comstock, one of the best known electrical engineers in the West, will be carried on. Its offices will be in the Monadnock Block, and its corps will embrace several of the ablest engineers and electricians in this section of the country.

JOHN R. MARKLE, one of the pioneers of the electrical business, formerly at Detroit, Mich., is now making his headquarters in Chicago. Mr. Markle has some new and interesting enterprises, which he promises to make known in the near future. For the present his friends can address him care of The Electrical World, 936 Monadnock Block.

THE ELECTRIC STORAGE BATTERY COMPANY, having successfully introduced its batteries into Chicago, through Mr. Charles Blizard, general sales agent, has placed the Western agency with Pierce & Richardson, 527 Manhattan Building. Both these gentlemen are favorably known to the entire electrical fraternity, and their success in handling the electric storage battery does not seem to be questioned.

THE WESTERN ELECTRIC COMPANY reports that it has in progress the wiring of the Astor residences at 65th street and Fifth avenue for 2,100 lights. The wiring is all in brass armored conduit of the Interior Conduit and Insulation Company, after the specification of Architect Hunt. The Scribner Building is going up at a record-breaking pace under the guidance of Architect Flagg and Builder Wills. The wiring contract for 800 lights for this building has been awarded to the Western Electric Company.

SARGENT & LUNDY, Western agents for the Crocker-Wheeler motor, have now on exhibition in their show room, Monadnock Block, samples of all the types of motors manufactured by the Crocker-Wheeler company. These include a new and very ingenious fan motor, known as the 1894 type; a Worthington electric pump for house tank service, and electrically operated machines of different kinds, for which they seem to have a great demand, judging from the number of visitors.

Canadian Notes.

MR. JOHN M. ANDERSON, of North Toronto, who is largely interested in the Metropolitan Railway Company, of that suburb, has issued a writ to restrain the directors from selling the Metropolitan's franchise to the Toronto Railway Company, a deal which has been on the carpet now for some time.

THE QUARTERLY STATEMENT of the Hamilton Street Railway shows the earnings for the three months ending March 24 to be \$23,537.77. The city's share of this sum is \$2,855.47, made up of 6 per cent. of the gross receipts, and \$1,443.20 mileage. This is an increase of \$141 for the corresponding quarter of last year.

APPLICATION FOR INCORPORATION by letters patent has been made by the Packard Electric Company, of Montreal. The headquarters of the company will be in that city, and the capital stock of the company is fixed at \$200,000. Packard Bros., of Warren, Ohio; Howry Bros., of Saginaw, Mich.; A. McKenzie, barrister, of Toronto, are among the proposed incorporators.

THE ELECTRIC INSTALLATION COMPANY, of Chicago, has applied to the finance committee of the London City Council for information respecting the electric railway franchise. A plan of the streets has been prepared and forwarded to the company, and it is expected an offer will shortly be received from them, which, it is thought, will force a fresh one from the London Street Railway Company.

ALDERMAN LAMB has written, instructing the city engineer to report on the cost of a plant necessary to enable the city to do its own electric lighting, and to secure estimates from leading manufacturers in the United States and Canada as to the cost of a plant. The contract for street lighting now in force with the Toronto Electric Light Company expires in October, 1895, and

Chairman Lamb thinks that the city should move at once in the matter. It now costs the city \$107,774 per annum, and Alderman Lamb thinks the service could be supplied for very little over one-half this cost.

AN INTERESTING STATE OF AFFAIRS has developed in regard to the double tracking of the Niagara Falls Park and River Railway since the agreement was completed between that company and the park commissioners. Surveys, which have been made with a view of straightening out the road, show that the steel towers of the upper Suspension Bridge project four feet into the street, and that the southeast corner of the Clifton projects much more. To straighten the road as desired, it will require the removal of some 20 feet from the corner mentioned of the Clifton House, and the removal of the two bridge towers, at the expense, it is said, of the owners of the same. As to whether the bridge company can be compelled to remove the towers or not is a question which is to be settled in the courts.

English Notes.

TELEGRAPH REVENUE.—Notwithstanding the competition of the telephone, the telegraph revenue in this country continues to increase slowly but surely. For the year ending March 31 last the total receipts amounted to £2,450,000, an increase of £60,000, or 2.4 per cent.

THE CITY LIGHTING.—During the recent severe frost the water mains supplying the central station of the City of London Electric Lighting Company burst, and the boilers were in danger of being deprived of their natural provender. In this emergency the engineer in charge displayed considerable resourcefulness. He wired to the captain of the London fire brigade, asking for the loan of a fire engine. This was promptly granted, and the boilers were kept going by means of the, so-called, water of the Thames, which was pumped into them with the assistance of a steam fire engine. It may be remarked that the City of London Electric Lighting Company, like the Metropolitan Electric Supply Company, has an action pending against it for injury done by vibration arising from the working of its central station engines.

News of the Week.

Telegraph and Telephone.

THE CITIZENS' TELEPHONE COMPANY, of El Paso, Tex., is preparing to install 200 instruments.

HOLLAND, IND.—Dr. H. W. Stock, of Holland, is interested in a proposed telephone line between Huntingburgh and Holland.

HINGHAM, MASS.—The New England Telegraph and Telephone Company has asked permission to extend its lines and erect new poles, and the Board of Selectmen have taken the matter under advisement.

Electric Light and Power.

WELLS, MINN.—The matter of electric street lighting is being discussed.

THE DUBLIN IRON WORKS, Dublin, Ga., wants a small electric light plant.

HAWAIIEN, IOWA.—The matter of electric street lighting is being discussed.

DELL RAPIDS, S. D.—The City Council is considering a proposition for an electric light franchise.

LEXINGTON, N. C.—A joint stock company has been organized in Lexington, N. C., to put in an electric light plant.

SOUTHBORO, MASS.—The Town Council is being urged to take action in the matter of an electric light plant.

THE NATIONAL LIGHT AND FUEL COMPANY, Washington, D. C., wishes estimates for an electric light plant.

NAPOLÉON, OHIO.—An election will be held May 14 to vote on the proposed issue of \$60,000 waterworks and electric light bonds.

AN ELECTRIC LIGHT PLANT is to be constructed at Liberty, N. Y., and Wolcott & Daly can be addressed regarding the same.

WASHINGTON, PA.—The officials of the local electric street railway company are being urged to extend the line to the cemetery.

THE MOUNT STERLING ELECTRIC LIGHT AND POWER COMPANY, INC., has certified to an increase of capital stock from \$7,000 to \$12,000.

PARSONS, PA.—Taxpayers are asking the Borough Council to consider the matter of an electric lighting plant, to be owned and operated by the borough.

ROME, N. Y.—The Council will soon call for bids for 150 street lamps to be kept burning from sunset to sunrise, and such bids are to be received for 60 days.

HENDERSON, MINN.—The proposition to bond the town for the purchase of an electric light plant was carried by a large majority. C. Frankenfield is city clerk.

CROTON, N. Y.—Residents are discussing the matter of incorporation for Croton, to the end that they may have improved streets and a street lighting system.

SPRINGFIELD, MINN.—The citizens are in favor of putting in an electric light and waterworks system. The sum of \$11,000 in bonds for waterworks was voted last year.

RICHMOND, VA.—The city authorities have received a proposition from a capitalist, whose name is withheld for the present, in the matter of erecting an electric light plant.

RAT PORTAGE, ONT., CANADA.—Sealed proposals will be received till May 1 for lighting the streets by electricity; 22 arc lights are required. J. K. Brydon is city clerk.

MONTCLAIR, N. J.—At a meeting of the Montclair Town Council, the electric light ordinance produced much acrimonious discussion, and the ordinance was finally laid over for two weeks.

MILFORD CENTRE, OHIO.—Sealed proposals will be received to May 11 for the construction of an electric light plant for arc or incandescent lights, as per plans on file. J. G. Bennett is clerk.

RACINE, WIS.—City officials did not accept any of the bids for street lighting. A committee was appointed to make a thorough investigation into the matter of a municipal electric light plant.

HUDSON, N. Y.—The Citizens' Electric Light and Power Company has been granted permission by the Council to erect poles and string wires. Edward J. Hodge is secretary of the company.

PORT RICHMOND, STATEN ISLAND, N. Y.—It is likely that, owing to the strong opposition of Chairman Egbert, of the Village Trustees, the award of contract for electric lighting to Charles A. Ingalls will be reconsidered.

SOUTH NORWALK, CONN.—A resolution has been passed that the city of South Norwalk establish one or more plants for the manufacture and distribution of gas or electricity, and for furnishing light for municipal and general use.

SAN FRANCISCO, CAL.—Mayor Ellert has expressed himself in favor of a municipal electric lighting plant. Expert George P. Low will estimate the cost of wiring the City Hall and constructing and maintaining an electric light plant.

PALMYRA, N. Y.—The Palmyra Electric Light and Power Company will start work on its proposed electric light plant some time this month. The power will be brought from the Littleville plant, which is seven miles from Palmyra.

HAMILTON, OHIO.—The City Council has rescinded all contracts with the several electric companies, and citizens will be granted an opportunity to vote on the proposition to issue additional electric light bonds to the amount of \$50,000.

NEW BRIGHTON, STATEN ISLAND, N. Y.—Sealed proposals will be received to 8 P. M. May 1, for the erection, maintenance and operation of a system of street lights for one year, as per details to be had of J. F. O'Grady, clerk of the village.

VALPARAISO, IND.—Edwin Tice and Edgar S. Noe, both of Chicago, Ill., have been granted a 25-year franchise for erecting and maintaining an arc and incandescent light plant and telephone exchange, the plant to be in running order in six months.

CANTON, ILL.—The electric light company is preparing to enlarge its engine power, and it will lower the price for lighting. It will put in for leading merchants from 10 to 16 200-candle power arc lights, and will arrange for residence lighting on an extended scale.

KINGSTON, N. Y.—On account of trouble with the Kingston Electric Light Company, the company has been notified that after April 12 the city will not accept their lights, and proposals are now called for to light the streets and public buildings with electricity, gas or naphtha.

SALAMANCA, N. Y.—It has been found that the contract made by the town authorities with the electric light company is illegal technically, but it is not likely that any changes will be made by either party, provided the company makes certain required improvements.

MARBLEHEAD, MASS.—The selectmen have called a town meeting for Friday evening, April 20, to see if the town will instruct the electric light committee as to the location of the electric light plant, and also to see if the town will reconsider the vote whereby it voted to appropriate \$10,000 for the electric plant, to be assessed on the poles and estates this year.

NORTH TONAWANDA, N. Y.—The bill to be presented to the Legislature, authorizing the erection of an electric lighting plant for North Tonawanda, has been completed. It provides that whenever the majority of the village trustees shall deem it advisable they may submit the matter to vote of taxpayers, and in the event of a favorable vote they are to issue 30-year bonds.

SPRINGFIELD, ILL.—The street lighting committee will receive bids, to be submitted to Council, for a municipal electric light plant of 300 lights with 2,000 candle power capacity. For terms address the chairman of the street lighting committee, E. R. Sayler, who will also furnish plans and specifications. The local electric light company has been charging the city \$150 per lamp, but has agreed to reduce it to \$100, but the Council insists on \$80, failing which they will erect a plant for themselves.

NORFOLK, VA.—Prof. L. F. Rodinella, of Philadelphia, has lately completed plans and specifications for an additional dynamo house for the Electric Company of Virginia. The building will be of brick and iron construction, with a frontage of 85 feet and a depth of 56 feet, although the plans provide for extending the latter to 103 feet when the increasing business of the company demands. The plant will be immediately increased to 750 h. p., supplied by Corliss engines, belted to clutch pulleys on each section of the line shaft, so that any engine can be temporarily thrown out for rest, cleaning or repairs. The line shaft and pulleys are carried in pillow blocks on floor stands, and the arc and incandescent dynamos are so belted to the different sections, that by means of clutch couplings they can be thrown in as needed to supply the varying demands of different parts of the day. Orders have already been placed and work commenced on the foundations.

The Electric Railway.

SPOKANE, WASH.—The Spokane Street Railway will extend its lines.

LA CROSSE, WIS.—The La Crosse and Onalaska Electric Railway Company has increased its capital from \$30,000 to \$50,000.

SAN FRANCISCO, CAL.—The Market Street Railway officials are discussing the matter of an immense power house at Chamel and Bryant streets.

NEWPORT, KY.—A new electric road will be built from Eleventh and Brighton streets to the Rosedale racecourse. Work will be commenced within 60 days.

NEW HAVEN, CONN.—It has been decided to go ahead with the work of building the electric road between Savin Rock and Merwin's Point, to be finished June 15.

ALBION, N. Y.—A survey has been completed for the proposed elevated single-rail electric road, to be operated by storage batteries between Lake Ontario and Batavia.

THE DOM RAILWAY, of Austin, Tex., reported as purchased and converted into an electric railway, has been bought by the Fort Wayne Electric Company, Fort Wayne, Ind.

PITTSBURGH, PA.—The Real Estate Trust Company, of Philadelphia, Pa., has placed on record a mortgage against the Pittston Street Car Company for \$200,000. The money is to be used to equip the road with electricity.

CLAYTON, MO.—The Clayton and Creve Coeur Railway Company has applied to the County Court for a franchise to construct and operate an electric railway line from Clayton to Creve Coeur Lake.

PITTSFIELD, MASS.—A committee of residents of Lanesboro will consult with the officials of the Pittsfield Electric Railway Company in the matter of extending their lines to Lanesboro, about five miles distant.

THOMPSONVILLE, CONN.—The matter of an electric road from Thompsonville to Springfield is being discussed, and the Hartford "Courant" is authority for the statement that definite steps will ere long be taken.

RICHMOND, VA.—The Virginia Electric and Railway Company has applied for permission to construct a double-track elevated railway on Broad street, and the matter has been referred to the committee on streets.

BURLINGTON, VT.—The directors of the Burlington and Winooski Street Railway Company will increase their capital stock by \$200,000, and they will extend their lines this spring either to Queen City Park or to the Lake front.

NEW HAVEN, CONN.—The New Haven and Westville Railroad Company has applied for permission to equip with electricity for a trolley system; also for extensions to the line and double tracks throughout nearly the entire route.

KANSAS CITY, KAN.—The Kansas City, Rosedale and Merriam Park Electric Railway Company has petitioned the County Board for a franchise for an electric line on the Southern Boulevard, from Rosedale to the Johnson County line.

NEW YORK, N. Y.—The Sherman Park and Westchester County Railway, capital stock \$12,000, has been chartered to build and operate a street railway. The directors are Louis Smadbeck, William Fisher and Isidore B. Brooks, of New York.

PITTSBURGH, PA.—The Suburban Rapid Transit Company has applied for a franchise for a route which will include passage over the proposed new 22d street bridge, and the petition for their franchise has been referred to the committee on corporations.

MIDDLETON, CONN.—The Common Council has voted to grant the petition of the Meriden Horse Railway Company to equip its system with the overhead trolley system. A long fight on the part of the opponents of the trolley had been expected.

JAMAICA, L. I., N. Y.—Fred. W. Dunton, president of the Long Island Boynton Bicycle Railroad Company, will present at the next meeting of the Queens and Suffolk counties boards of supervisors a petition for right of way for his proposed bicycle railroad.

MIDDLETOWN, CONN.—Mayor Vinal has vetoed the resolution of the Common Council permitting the local street railway to equip with the trolley system. He claims that the petition is

not sufficiently specific and does not afford proper protection to the city.

PATERSON, N. J.—The Paterson "Call" is authority for the statement that Architect Coleman Gray, of Paterson, has been offered the position of supervising engineer upon a new electric railway, to be built in Rockland County, New York State. He has not yet accepted.

CORTLAND, N. Y.—H. L. Bronson, representing a Scranton syndicate, appeared before the village trustees with a petition for a franchise for an electric street railway, but the meeting adjourned without taking definite action. Mr. Bronson represented Page, Hand & Simpson, of Scranton.

BATAVIA, N. Y.—The Hon. J. W. Holmes has completed surveys for the proposed experimental line of the Beecher single-track railway from Waterport to Lakeside, and the work of construction will begin as soon as a company can be formed, which it is expected will be within a week.

SAN FRANCISCO, CAL.—J. L. Willcutt, manager of the Consolidated Street Railway Company, states that the actual building of the power house is to be done by the Pacific Improvement Company, and that R. P. Schwerin will have the matter in charge. Plans have not yet been completed.

NIAGARA FALLS, N. Y.—The bill incorporating the Niagara River Trolley Company has passed the Senate. The company contemplates a railway on cables stretched over Niagara Falls. George W. Pound, of Lockport, is the originator of the project; N. R. Campbell, of Niagara Falls, is also interested.

WASHINGTON, D. C.—General Catchings, of Mississippi, has introduced into the House a bill to incorporate a company which proposes to build a bicycle elevated electric railway between New York and Washington, to use the Brett system. Hamilton Diss-ton, the Philadelphia saw manufacturer, is one of the promoters.

ROCHESTER, N. Y.—The directors of the Grand View Beach Railroad have let the contract for their proposed power house to William Summerhays, Sons & Co., to cost \$30,000. It is the intention of the company to furnish light to Charlotte, Summerville and Windsor Beach, and also along the line of the railway. Work will be begun at once.

POUGHKEEPSIE, N. Y.—It is now stated that immediate steps will be taken to build the proposed electric line of the Poughkeepsie City and Wappinger Falls Railway, which will cost \$750,000. The following prominent residents of Poughkeepsie are interested: W. H. Wood, J. W. Hinkley, J. L. Williams, I. DeGross, C. H. Case, P. H. Troy and John Mylod.

HARRISBURG, PA.—Charters have been issued to the Houtzdale and Suburban Railway Company and to the Phillipsburg and Suburban Electric Railway Company, with same officers, and a capital of \$100,000 each. The president is A. Markle, of Hazleton, and the directors are John A. Seely, of Brooklyn, N. Y.; Charles A. Bragg, of Philadelphia, Pa.; E. S. Doud and J. Edwin Giles, of Hazleton, Pa.

Personal Notes.

MR. JAMES I. AYER, whose name has been so prominently before



the electrical public for some years, has accepted the position of general manager of the Royal Arc Electric Company, with home offices at 143 Liberty street, New York. As superintendent of the great arc lighting plant of the St. Louis Municipal Electric Lighting and Power Company, Mr. Ayer had a field which gave ample opportunities for the display of those qualities which have placed him among the foremost electrical engineers in America. The achievement of Mr. Ayer in planning, constructing and putting in operation this plant, the largest arc lighting installation in the world, within 11 months from the day he took hold of the work, ranks among the great feats in electrical engineering, and implies

a prosperous future for the company with which he has connected himself. Mr. Ayer was elected president of the National Electric Light Association in 1892, and presided at the St. Louis meeting in 1893—one of the most successful meetings, particularly from a technical standpoint, in the history of the association, and whose success was largely due to the marked organizing abilities of its president, and the great esteem in which he is personally held by a host of friends and acquaintances.

MR. E. S. FERRY, Fellow in Physics and Electrical Engineering at the Johns Hopkins University, has accepted a position in the engineering department of the Royal Arc Electric Company, New York. Mr. Ferry is well known for his researches on the subject of light, both at Cornell University and Johns Hopkins, and has made important contributions to the literature on the subject. He was formerly an instructor at Cornell.

Trade and Industrial Notes

PROF. E. P. ROBERTS is preparing plans for the electric plant of the Garfield Building, Cleveland, Ohio, in which 2,300 lights will be used.

THE WROUGHT IRON BRIDGE COMPANY, Canton, Ohio, has, during the past few months, been running their works on full time, notwithstanding the so-called stringency.

THE PURITY OIL FILTER MANUFACTURING COMPANY, 99 Water street, Pittsburgh, Pa., finds business excellent thus far in April. It has duplicated orders sold from one to two years ago four different times in ten days, showing that "the proof of the pudding is in the eating."

FRANK H. STEWART, 7298 Green street, Philadelphia, has removed to 41 North Seventh street. He reports having recently received an order for 225 15-ampere flush switches for one building in Philadelphia, and a number of orders for ceiling fans.

MR. D. C. SPRUANCE, late of the Helios Electrical Company of Philadelphia, has opened an office in the Betz Building, this city, and will devote his attention for the next few weeks to the organization of two electrical manufacturing companies, both of which will be located in Philadelphia.

THE VARLEY DUPLEX MAGNET COMPANY, 64 Cortlandt street, New York, has issued a catalogue calling attention to the merits of the duplex magnet, and including a price list with reference to cuts, showing plainly the dimensions of the various magnets kept in stock by the company.

THE VEGETABLE BOILER COMPOUND COMPANY, of Utica, N. Y., which, as implied by the name, manufactures a compound for the cleansing of boilers, is in receipt of many flattering testimonials, in which the writers state that the compound accomplishes even more than the manufacturers claim.

THE DAYTON (OHIO) GLOBE IRON WORKS COMPANY has issued a 106-page catalogue of power transmitting machinery, including gearing, shafting, pulleys, couplings, hangers, boxes, floor stands, collars, etc. A number of pages at the end are devoted to tables useful to mechanical engineers and millwrights.

MARK A. RIPLOGLE, Cedar Falls, Iowa, has issued a catalogue of governors for water wheels operating electrical machinery. By means of these governors it is claimed that the speed of a water power shaft can be regulated almost as closely as that of a steam engine shaft, and the practical results are just as good.

T. T. BURCHFIELD & CO., Philadelphia agents for M. A. Green engines, are putting up for the Ringing Rock Electric Railway Company, Pottstown, Pa., two 150-h. p. 15 by 14 inch direct connected engines with two 72 by 18 foot high pressure boilers, installed complete with pumps, heaters, injectors, etc., to be in running order by May 10.

THE UNITED COLUMBIAN ELECTRIC COMPANY, 280 Broadway, New York, has issued a catalogue describing in detail its improved twin series railway motor, and it will repay those interested in electric street railways to send for a copy. The explanations are clear, the engravings good and a table of comparative tests printed is very suggestive.

THE INTERIOR CONDUIT AND INSULATION COMPANY, 44 Broad street, New York, informs us that the Government architects, after thorough tests of its new iron armored conduit, have signified their approval of it, and have already taken measures to have Government buildings now in the process of construction entirely equipped with the iron armored conduit.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., has received an order from the Delaware, Lackawanna and Western Railroad Company for two engine house roofs, both roofs to be covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron. Also an order for an iron fireproof building for the laundry, kitchen, engine and boiler rooms of the Green Island Improvement Company's new hotel at Lake George, N. Y.

THE SUNBEAM LAMP MANUFACTURING COMPANY, 703 La Salle street, Chicago, has issued two circulars, which users of incandescent lamps would do well to send for. They contain a discussion of the points which affect the economical use of incandescent lamps, a table of some tests of lamps in actual service in Chicago, showing how inefficient lamps may be, and tables giving full electrical data of the various Sunbeam lamps manufactured.

THE E. W. BLISS COMPANY, 17 Adams street, Brooklyn, N. Y., are completing two large presses for shipment. One is a toggle drawing press weighing 140,000 pounds and driven by an engine attached to it. This press was ordered from England, and is to be used in drawing up heavy steel shells. Another press, for one of the largest tin stamping firms in this country, weighs 75,000 pounds, and will be used for drawing up heavy enameled iron ware of various descriptions.

THE HOPPES MANUFACTURING COMPANY, Springfield, Ohio, manufacturer of the well known "Hoppes" live steam feed-water purifier, has secured the contract for the purifiers for the new city electric light plant now being erected by the Public Light-

ing Commission of Detroit, Mich. The Hoppes purifiers were selected after very strong competition. The order calls for seven 200-h. p. purifiers to carry 165 pounds of steam working pressure. Each purifier is required to heat and purify 9,000 pounds of boiler feed-water per hour.

A. L. IDE & SON, of Springfield, Ill., report the following recent sales of Ideal engines to electrical companies: One 12 by 12 to the Franklin Electric Company, Franklin, Mo.; one 15 by 14 to the Monett Electric Company, Monett, Mo.; one 13 by 12 to the Chicago Edison Company, prepared for direct connection to an Edison armature for the Gottfreidt Brewing Company; one 6 by 6 to the Great Western Manufacturing Company, for Leadville, Col.; one 13 and 20 by 14 to the Western Electric Company, for Rutland, Vt., and two 8 by 10 to the Peninsular Electric Company, for Wayne, Mich.

CUSHING & MORSE, 225 Dearborn street, Chicago, are sending out an envelope, the addressed face of which is in itself a clever conception, enclosing several pieces of sticking plaster. On one flap of the envelope is printed "stick to us and we will stick to you," and on the other the following directions: "For faulty circuits, first cleanse the lines by removing all the old imperfect stuff, and substitute Kerite insulated wire. For leaky joints discard everything else and wrap with Kerite tape. To cure profanity use plenty of Kerite. To make a success of any electrical installation use Kerite. For cuts or bruises use enclosed plaster."

J. L. HAYES & CO., manufacturers of switches and tablet boards, Pittsburgh, report business exceedingly good. Among some of the recent orders received are the following: 125 fuse boxes for the new Postal Building, New York City; 106 tablets for the Carnegie Steel Company's new building on Fifth avenue, Pittsburgh; 2 switchboards, 4 by 5 feet, for the McIntosh & Verner Building, Pittsburgh; 1 switchboard, 7 by 4 feet, for the Second National Bank, Pittsburgh; a switchboard 5 feet square for the Morris & Cass Paper Company; 8 marble tablet tables, with 8 main line switches—16 switches in all—for the Huron Building, Pittsburgh.

MESSRS. FORD & BACON, late of the La Roche Electrical Works, of Philadelphia, have opened an office in the Philadelphia Bank Building, where they will conduct business as consulting and electrical engineers. These gentlemen are so well and favorably known to the electrical fraternity through former important positions held by both, that this introduction is scarcely necessary. Mr. Ford was formerly the Chicago representative of the Short Electric Company, and Mr. Bacon was connected with the Wightman Electric Company, of Scranton, Pa., for some time. Messrs. Ford & Bacon are thoroughly capable and reliable gentlemen, and any business entrusted to them will receive the very best attention.

STANLEY & PATTERSON, 32-34 Frankfort street, New York, have issued an attractive catalogue of the general electrical furnishings and supplies which they handle. This list is a very large one, including numerous styles of annunciators, alarms, bells, buzzers, switches, push buttons, electric bell pulls, gas lighting supplies, battery motors, small dynamos, primary batteries, miniature incandescent lamps, medical apparatus, electric door openers,

telegraph instruments, insulated wires and cables, cut-outs, lamp shades, light fixtures, magneto and electrical telephones, etc. This company is agent for the well known "Paranite" wires and cables. They are making a specialty of telephones and telephone supplies, and have on the market a magneto transmitter that is claimed to be one of the best in the market to-day. The catalogue is conveniently arranged and carefully indexed, and gives some idea of the scope of the company's business. Stanley & Patterson have had extended experience in the electrical field, and are meeting with well merited success.

THE PETTINGELL ANDREWS COMPANY, of Boston, Mass., an electrical supply establishment whose name is familiar throughout the country, and particularly in New England, entered upon the sixth year of its existence last month. During this period the company has earned the confidence of the electrical fraternity generally as the result of well directed energy and discreet business sagacity. It was the first electrical supply house started in New England, and has grown with the industry. It has recently decided to enter the railway field more actively, to which it has not heretofore given particular attention, and a special department has been created for this purpose. It will also, on or about May 1, remove into very handsome new quarters, more centrally located in the building at the corner of Federal and Franklin streets, directly in front of where it originally started in business. A better location is hardly to be found in the city of Boston, or a building more admirably adapted to the conduct of its business, bordering, as it does, on three streets—Federal, Franklin and Channing—thus giving to it abundance of light and magnificent sign display privileges. In its new home it will have four separate departments of business—the lighting supply, the railway supply, the motor and the telephone and telegraph. Beside these there will be a department for retailing small supplies. At present the company is the sole New England agency for the Okonite Company, Interior Conduit and Insulation Company, Bryant Electric Company's switches, sockets and cut-outs, Standard Paint Company's P. & B. compound and paints, P. A. line and feeder wires, O. K. line and feeder wires, P. A. incandescent lamps and the Medbury insulation for railway construction.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon Porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient and at prices lower than ever. THE HAYDEN-BOOKER MFG. CO., 2140 DeKalb St., St. Louis, Mo.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED APRIL 3, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

- 517,427. PROCESS OF MANUFACTURING ACTIVE MATERIAL FOR SECONDARY ELECTRIC BATTERIES; W. H. Boese, Berlin, Germany. Application filed June 27, 1893. This consists in mixing a metallic oxide with a sulphonic acid of anthracene and simultaneously removing electrolytically soluble compounds.
- 517,432. INCANDESCENT LAMP; A. C. Carey, Lake Pleasant, Mass. Application filed Feb. 3, 1894. An incandescent lamp having a butt of moldable, electrically non-conductive material, shaped to fit any socket, having external longitudinal grooves, contact pieces molded in its end, and leading-in wires connected with the contact pieces and laid in the grooves.
- 517,450. ELECTRIC BURGLAR ALARM; J. Frame and R. B. Morden, Cooper, Iowa. Application filed Dec. 26, 1893. This comprises a magnet controlling a release key to a clockwork mechanism for a mechanically operated alarm.
- 517,452. INSULATING COMPOUND; A. Gentzsch, Vienna, Austria-Hungary. Application filed Oct. 7, 1893. This consists of the extract from fossil resins from which the gas, vapors and oils have been removed.
- 517,455. SECONDARY CELL OR BATTERY; G. B. Henry, Hartford, Conn. Application filed June 21, 1893. The combination of plates with their terminals, and an electrolyte composed of a spongy mass of flax seed mixed with dilute sulphuric acid.
- 517,480. ELECTRIC SYNCHRONIZER FOR CLOCKS; H. S. Prentiss, Elizabeth, N. J. Application filed Nov. 3, 1892. A timepiece provided with a detent, a train and a cam mounted on one of the arbors of the train and engaging the lever to permit of its being actuated at the hour indicated by the time-piece.

- 517,498. ELECTRIC TRAIN LIGHTING AND BRAKING SYSTEM; G. W. Swartz, Florence, Ala. Application filed Sept. 1, 1893. The combination with the brake magnets and their armature, of a rod connected with the armature, and screw threaded nuts on the threaded portion above and below the armature, brake shoes pivotally connected with the rod, and links suspending the brake shoes from the frame of the truck.
- 517,502. CIRCUIT MAKER; J. Weaver, Canandaigua, N. Y. Application filed Sept. 30, 1893. This comprises a horseshoe-shaped bracket, circuit wires secured thereto, a contact piece, a horseshoe-shaped arch and a fusible strip secured to the arch at one end, its opposite end adapted to hold the contact strip normally out of contact.
- 517,520. MINER'S SAFETY LAMP; J. Graham and H. Chapman, Morley, England. Application filed Oct. 7, 1893. The combination of a burner, electric lighting means arranged adjacent thereto, the chambers carried by the lamp and the contact piece extending into the same.
- 517,531. INDUCTION ELECTRIC RAILWAY; C. E. Roehl, St. Joseph, Mo. Application filed May 4, 1893. The combination of primary coils located along the roadway, secondary coils carried by the moving vehicles and self-inductive resistances in series with the primary coils. (See illustration.)
- 517,547. BURGLAR ALARM SPRING; M. T. Gordon, Stapleton, N. Y. Application filed Dec. 12, 1893. This comprises a base plate and a contact plate secured thereto, but insulated therefrom, levers and springs co-operating therewith, means for limiting the outward movement of the levers, and means whereby the base plate and contact plate may be connected with electric conductors.
- 517,549. CONDUIT ELECTRIC RAILWAY; W. C. Keithly, San Francisco, Cal. Application filed Sept. 17, 1892. The combination of an underground conduit, a wire, a flanger hanger trol-

ley arm, a spring, and means for raising or lowering the trolley arm.

517,564. MICROPHONE; W. Deckert, Vienna, Austria-Hungary. Application filed March 1, 1893. The combination with a casing and cover, a mouthpiece, a diaphragm having a protecting coating against moisture on the side facing the mouthpiece, and an electrode. (See illustration.)

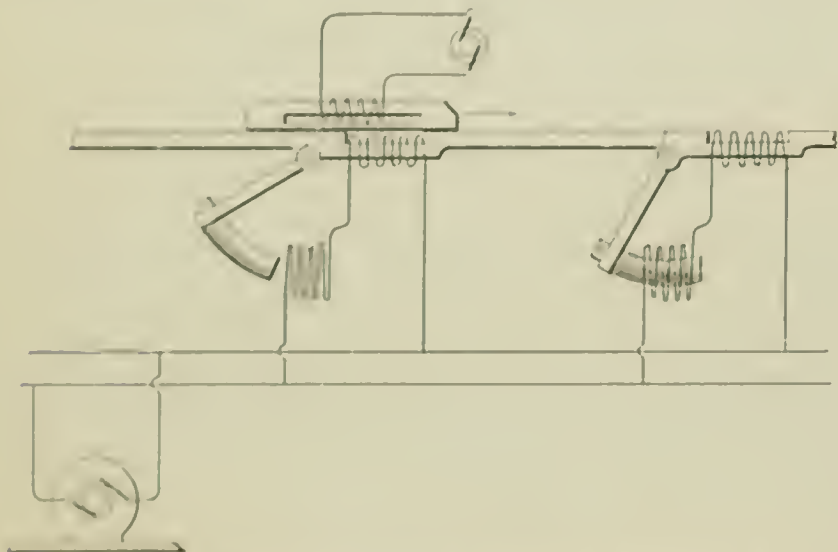
517,562. ELECTRIC SWITCH; R. Mackle, New York, N. Y. Application filed Aug. 7, 1893. This comprises a contact bar provided with a spring to return it to its starting point, in combination with an independent mechanical spring clutch for holding the bar at its final contact, and means for releasing the clutch actuated by shutting off the current.

517,591. INSULATING TUBE; M. Robinson, Newton, Mass. Application filed Jan. 6, 1894. A tube provided with longitudinal ridges throughout the entire length of the body of the tube.

517,621. INSULATOR; L. McCarthy, Boston, Mass. Application filed July 15, 1893. This comprises a case, metallic portions placed therein and separated from each other by an interposed layer of insulating material, an inwardly extending flange, a series of sheets of mica outside the flange on one of the insulated metallic portions and in contact around the metallic portion with the insulating material within the case, and a washer on the insulated metallic portion.

517,624. PIN FOR INSULATORS; G. H. Winslow, Pittsburgh, Pa. Application filed Oct. 25, 1893. The combination of an insulator provided with a threaded socket, and a reinforced pin threaded at one end for engagement with the insulator and so mounted on its support as to be capable of rotation. (See illustration.)

517,661. ELECTRICAL SWITCH; E. Ruebel, St. Louis, Mo. Application filed Sept. , 1893. This comprises a swinging arm pivotally mounted upon an insulated support, the arm being adapted to break the circuit when in its inoperative position and when raised to make contact with the terminal of an electrode.



No. 517,541. INDUCTION ELECTRIC RAILWAY.

517,668. ELECTRIC MOTOR; W. J. Still, Toronto, Canada. Application filed March 3, 1893. The combination with the magnets, armatures and commutator formed of metallic sections and insulating partition between the sections, of brushes insulated from the holder by insulating plates.

517,669. ELECTRIC MOTOR; W. J. Still, Toronto, Canada. Application filed March 3, 1893. The combination with the field magnets having curved ends and the armature revolving between the curved ends, of curved plates carried by the curved ends of the revolving armature.

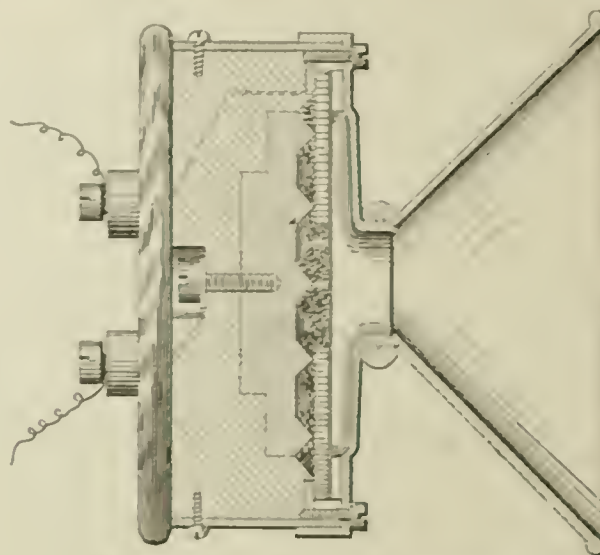
517,692. CONDUIT ELECTRIC RAILWAY; H. A. Gorcham, Decatur, Ill. Application filed Aug. 14, 1893. This comprises a conduit having a central rib or upward extension therein supporting and insulated from the trolley wire, slotted grates covering the conduit and communicating with a trench below the conduit, and valves in the lower surfaces of the conduit.

517,711. GOVERNOR FOR ELECTRIC MOTORS; J. F. Winter, Baltimore, Md. Application filed Sept. 21, 1893. This comprises a closed dustproof box, a shaft therein projecting outside, two sets of stationary contacts within the box and insulated where they pass through the walls of the box, and each set arranged in a part circle concentric with the shaft, and a shunt lever in the box and mounted on the shaft.

517,734. FEEDING MECHANISM FOR MAGNETIC SEPARATORS; G. Conkling, Glens Falls, N. Y. Application filed June 25, 1891. This comprises moving belts mounted one above the other, mechanism for operating the same, a chute conveying ore from one belt to the other and a fan blower adapted to deliver air into the chute whereby the velocity of the ore is increased.

517,743. ELECTRICALLY OPERATED RAILWAY SWITCH; W. S. Gavey, Brooklyn, N. Y. Application filed April 1, 1893. This comprises a swinging switch rail, electromagnets arranged to swing the same, shunt wires for each switch, the wires being in connection with the switch magnets and in different vertical planes, an overhead trolley, and contact carried by the cars to engage therewith, and contact pulleys adapted to contact with different shunt wires.

517,762. TELEPHONE; S. D. McKelvey, Canton, Ohio. Application filed Feb. 20, 1893. This comprises a transmitter, a vibratory structure to which the transmitter box is rigidly attached, the structure being of such character that the speaker may support his body upon and against the same, and a suitable receiver.



No. 517,564.—MICROPHONE.

517,764. MAGNETO TELEPHONE; S. D. McKelvey, Canton, Ohio. Application filed Sept. 13, 1893. A receiver having a shell formed in two equal and similar parts, which are united by a screw cap, and a handle engaging with the ends of the shell.

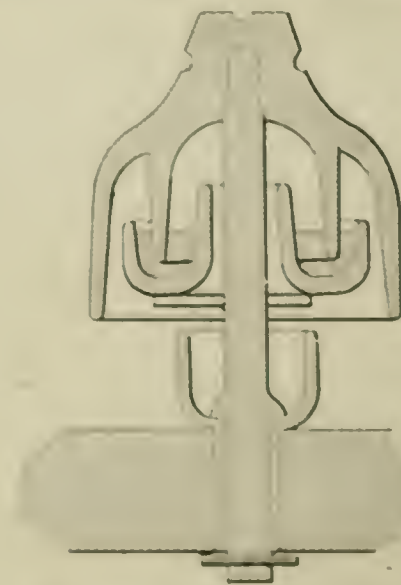
517,764. MAGNETO TELEPHONE; S. D. McKelvey, Canton, Ohio. Application filed Dec. 6, 1893. This comprises a diaphragm and a rigid arm pivotally connected thereto at one end and having its other end provided with divergent points, which are attached to the diaphragm in or between different nodal circles.

517,767. AMAGAMATOR; N. L. Raber, Corvallis, Ore. Application filed April 8, 1893. The combination in an amalgamator of the mercury trough or cup, the tube or cell therein and the lead in the cell.

517,770. RHEOSTAT; A. J. Shaw, Muskegon, Mich. Application filed Oct. 12, 1893. A resistance body consisting of a folded metallic tape having a layer of enamel interposed between the folds and serving both to insulate and mechanically to bind together the several folds or layers.

517,773. ELECTRIC SWITCH; C. F. Speed, E. W. Barker and C. P. Frank, Duluth, Minn. Application filed Dec. 1, 1893. The combination of a feed pole, two movable contact arms connected therewith, contact poles placed in proximity to the arms, an operating shaft, a sector mounted on the shaft and adapted to cause the engagement of the arms with the contact poles together or separately.

517,804. CONDUIT ELECTRIC RAILWAY; W. F. Jenkins, Richmond, Va. Application filed Aug. 10, 1892. The combination with a conduit of two horizontally projecting arms covered with insulation and bent to form depressions, the two conducting wires loosely laid therein, and a trolley having two terminal hooks at its lower end resting beneath the conducting wires.



No. 517,634. PIN FOR INSULATION.

517,812. SYSTEM FOR CONTROLLING ELECTRIC LIGHTS; W. F. Bradner, Denver, Col. Application filed May 12, 1893. The combination of a rotating ratchet composed of an insulating disc and two conducting plates applied to its opposite faces, the plates having lips bent to engage the teeth of the disc, the lips of each plate engaging every alternate tooth, and four contact brushes, two of which are continuously in engagement with the respective face plates of the disc, while the other two alternately engage the lips of the respective plates as the ratchet is actuated.

The Electrical World.

Vol. XXIII.

NEW YORK, APRIL 28, 1894.

No. 17.

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1881 " 28 " "	1888 " 175 " "
1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 289 " "
1884 " 82 " "	1891 " 325 " "
1885 " 100 " "	1892 " 316 " "
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RATIOS.

Through a slip of the pen in our last issue the statement appeared that if π instead of 10 were the basis of our numerical system, the ratio of the circumference of a circle to the diameter would be unity. The error was so apparent, however, that doubtless all of our readers noticed it. A ratio, of course, is independent of the system of units employed, for if one thing is, for example, five times as great as another thing, no matter what the units employed may be, the ratio is five. The ancient mathematicians instead of dealing directly with magnitudes, employed ratios whenever possible, as the absence of any scientific or accepted systems of units would otherwise have rendered their work unintelligible in parts. While in modern calculations the idea of ratios is always present, the possession of accepted units does away with the necessity of formally expressing it in all operations.

THE BATE REFRIGERATOR CASE.

The United States Circuit Court of Appeals of New York has certified the Bate refrigerator case up to the United States Supreme Court for decision, the inference being that as the point of law at issue would finally have to be adjudicated by the highest court the judges considered that valuable time might be gained by sending it there at once. As before explained, the issue involved is whether the date of application for a United States patent or the date of issue shall prevail in applying the statute limiting the life of a domestic patent by that of a foreign one. At present the law is that a domestic patent expires with any foreign patent issued prior to the date of issue of the former. Should the Supreme Court reverse the law in its decision on the present case, the effect will be to prolong the life of the Edison incandescent lamp and microphone and other important electrical patents to the full term of seventeen years. All previous decisions have been against this construction of the statute, and the opinion of those most competent to judge is that the case is a "forlorn hope," with little chance of a favorable decision.

TRANSMISSION DYNAMOMETERS.

One of the most necessary pieces of apparatus in every laboratory and one of the most desirable for the commercial testing room is a transmission dynamometer, as the efficiency of an apparatus that has the greatest importance is, as a rule, the ratio between the power transmitted and that supplied. It was owing to the absence of transmission dynamometers in tests that the electrical efficiency of a dynamo was for a long time accepted as a criterion of the true efficiency, whereas in fact such a dynamometer might have shown that a machine with a high electrical efficiency had really a relatively low commercial efficiency. In another column Dr. Duncan describes a transmission dynamometer, which, as stated, forms an exceedingly convenient apparatus for some purposes, and has the advantage of not requiring any material connection to the apparatus to be tested. This adds another to the list of valuable testing apparatus and methods devised by Dr. Duncan, which comprises among others an absorption dynamometer on the principle of Joule's apparatus, thermal methods of testing transformers and other electrical apparatus and the well known method and apparatus for obtaining instantaneous values of alternating current curves, which have served as the model for so many others.

THE MIDWINTER FAIR.

In this number we give the first installment of an article describing the technical features of the Midwinter Fair at San Francisco. The details of the method of using petroleum for fuel will be found instructive. Although the amount of fuel burned is equivalent to more than 30 tons of coal per day, during the evenings, when the load is about 2,500 h. p., only two men are required to be on duty—only one being in attendance on the furnaces—and the duties of neither are laborious. As the amount of coal that would have to be fired during this time would probably approach four tons per hour, the great saving in men and of muscular energy is apparent, while the improvement in cleanliness, space and absence of smoke is correspondingly great and particularly desirable in the present instance. As will be seen, but little change need be made with some forms of boilers to admit of the use of petroleum for fuel, and it would seem that the advantages offered are sufficient to justify an investigation with a view to displacing of coal by central stations that can ill spare the space now occupied by the latter and the necessary firing space in the boiler room. The question of forced draught during the hours of heavy load would also thus be neatly solved, as the mere turn of a valve wheel would give the necessary increase, as compared with the increased force of men and the use of blowers, with the accompanying deterioration of boilers necessary, when coal is the fuel.

ELECTRIC TRUNK LINES.

The long talked of electric road from Philadelphia to Harrisburg will, it is said, soon be built. This is the project headed by ex-United States Senator Patterson, formerly of South Carolina, and it is understood that sufficient stock has been disposed of to build the entire line, which, the officials state, will be finished within eighteen months. The surveys have all been made, and it has been decided to use the two-phased alternating current system for transmission and the continuous current for operating the cars. There will be a large central station with step up transformers and sub-stations with step-down transformers at distances of twelve to fifteen miles, where step down and rotary transformers will convert the alternating currents into continuous currents of 500 volts. The road will have four tracks, with a private right of way, which has, it is said, been secured for the entire length of the line. The line will be fenced in and have no grade crossings. There will be numerous branches, and two of the four tracks will be reserved for local business. It is proposed to equip the high speed through cars, which will be 68 feet long, with four 40-h. p. motors, and it is intended to run them at a speed of 40 or 50 miles per hour. This scheme seems to be the best studied of any yet proposed, but it will be seen that the local traffic feature is the one most prominent. Running through a rich and thickly settled district, the road, with its feeders, should have a large local traffic that in itself would justify its construction. The generation of all the power from one central station is a promising feature, and the outcome will be looked forward to with much interest. If successful the result may lead to the establishment of large generating stations to supply extensive areas with current not only for the various street railway lines within its limits, but also current for lighting from sub-stations in the included towns. Of other long-distance electric railway projects, the Chicago-St. Louis and the Indiana-Chicago schemes seem to have gone to sleep, but instead we have offered an electric elevated line from Cleveland to New York, of which, however, not much has been heard lately. The network in northern New Jersey is being gradually extended, and the rumor is periodically revived that connection will soon be made with the Trenton and Camden systems, and thus complete a through electric line from New York to Philadelphia. In some cases it will perhaps be found that projects for electric

trunk lines merely conceal schemes to secure rights for local traffic that could not otherwise be obtained.

NOMENCLATURE AND SYMBOLS.

Our English contemporary, the "Electrician," devotes one of its able, though "slashing," editorials to the subject of nomenclature and symbols, in which Hospitalier's system of symbols is criticised and the provisional names for the magnetic units adopted by the American Institute of Electrical Engineers referred to. While it is said in regard to the symbols proposed by Prof. Hospitalier that it is doubtful whether a thoroughly representative international congress could, by discussion or amendment, produce a much better set, yet for all that many writers will still decline to alter their custom and adopt the characters thus offered. While the refusal of such writers might be justified in regard to some of the symbols, such as I for current, it would not be justified in regard to the symbols for the magnetic quantities. The symbols proposed for these by Hospitalier are in accordance with the usage of the masters of electrical science, and the type, having faces similar to that of ordinary type, do not disfigure a page like the heavy gothic letters favored by English electricians. These symbols as proposed, it may be remarked, are not "ragged German capitals," but simply pen-text characters, and in manuscript or on the blackboard are written merely as script capitals. Owing to the time-honored use of C for current, it is now probably too late to have the symbol I adopted, but as the gothic letters have only had a limited employment and have little or no chance of universal adoption, it would be much to be deplored if English writers were to adhere to them instead of adopting the congress symbols, which, with their aid, would undoubtedly become universal. The principal objection of our contemporary to the provisional names of the magnetic units is aimed at the gilbert, which it pronounces useless, probably from erroneously considering that it is to displace the ampere turn. The product of the magnetic flux by the reluctance is the magneto-motive force, if names are given to the two former it would be absurd to leave the latter nameless, so that the three names will stand or fall together. Again, if the magnetic flux and reluctance are expressed in terms of the C. G. S. units, or in webers and oersteds, their product is magneto-motive force in C. G. S. units, or in gilberts, which can only be turned into ampere turns by multiplying by a factor; or, in other words, whenever we wish to determine magneto-motive force our result is first in terms of gilberts, and that it might be directly in terms of ampere turns we would instead have to apply a factor to the expression for flux or reluctance, which would be not only illogical but absurd. Our contemporary does not consider the strongest argument in favor of names for the magnetic units, which is that thereby a concrete idea is given to the different quantities. The mathematical physicist accustomed to deal with abstractions does not require to be thus assisted, but the ordinary electrician is accustomed to deal only with concrete ideas and names, and the idea of reluctance, for example, will not take the same hold on him as that of resistance until he can express it by a definite name divorced from abstract accompaniments, as he now expresses resistance in ohms.

Pumping by Electricity.

The Worcester (England) municipality will utilize its plant, put in for supplying electricity for lighting, to run electric motors for pumping purposes at its waterworks, instead of employing steam, as originally intended. There will be two 30 h. p. alternate current motors having a guaranteed efficiency of 90 per cent., working pumps capable of delivering 10,000 gallons of water per hour to an elevation of 300 feet through three miles of 10-inch pipe.

A Transmission Dynamometer.

BY DR. LOUIS DUNCAN.

The transmission dynamometer which I am going to describe has been found useful for some special experiments for a number of years. I have used an absorption dynamometer, consisting of a copper disc rotating in a magnetic field. The power was calculated from the pull on the magnet and the speed of the disc. The heat was absorbed by water running through the apparatus. This dynamometer is of a rather limited range, unless belting is resorted to. For the purpose of trying some experiments on the efficiency of air propellers, a transmission dynamometer was designed on somewhat the same principle. It consisted of a copper disc fastened to the propeller to be rotated and placed in the field of a rotating electromagnet. The apparatus was calibrated by turning the magnet at known speeds and measuring the pull of the disc, which was kept stationary. After this, to measure the power transmitted, it is simply necessary to know the speeds of the field magnets and the copper disc, and the pull is proportional to the difference of the speeds, and can be obtained from the calibration curve. The disc is so constructed that it can be cooled by allowing water to flow on it in such a manner as not to absorb power, and a temperature correction can be applied if necessary. The speed of the disc can be regulated by varying the speed of the magnets and the strength of the magnetic field. In this way power can be transmitted without the intervention of any belt or gearing, and it forms an exceedingly convenient apparatus for some purposes.

Johns Hopkins University, Baltimore, Md.

Incandescent Lamp Litigation.

Counsel for the General Electric Company appeared before Judge Colt, of the United States Circuit Court, held at Boston on April 14, in two incandescent lamp cases, one against the Davis Electrical Company, of Springfield, Mass., and the other against the Boston Incandescent Lamp Company. The General Electric Company was represented in both cases by Mr. Fish, and the Boston Incandescent Lamp Company by Judge Lowell and Son. The former case was an action for contempt, it being alleged that the Davis company, against which an injunction had been secured by the General Electric Company some time ago, was continuing to repair incandescent lamps by sealing into the top of the bulb a small piece of platinum and claiming thus to avoid infringement, on the ground that this made other than an "all-glass" chamber. The court failed to see the force of this claim, and issued an order in favor of the General Electric Company.

In the latter case an injunction was asked restraining the Boston Incandescent Lamp Company from manufacturing incandescent lamps. The lamps as manufactured by the Boston Incandescent Lamp Company do away with the use of leading-in wires, using as conductors two strips of a finely divided film of silver; these are made to adhere to the sides of a glass tube by means of printers' ink, which, when the tube is melted and pinched together, oxidizes and disappears. Iron wires are inserted in either end of the tube before it is pinched together, to which the carbon filament is attached.

Mr. Fish contended that the lamp infringes by having an all-glass chamber, a vacuum maintained inside, and a carbon filament, thus infringing the second claim of the Edison patent. Judge Lowell claimed that it did not infringe the patent, owing to the absence of leading-in wires sealed in the glass. Mr. Fish, in his reply, stated that the only difference between a wire and the finely divided film was in the distance between the molecules. It was also claimed by the

plaintiff that according to Prof. Cross there was nothing new or novel in using a finely divided film to transmit a current of electricity, it having been known as early as 1801, as well as the knowledge of the proper amount necessary to replace a wire of a given size. According to the affidavit of Prof. Walsh for the defense, it was claimed that the process of commercially leading the current into the lamp by means of a strip of finely divided metal was new and ingenious from a scientific point of view. The defense gave figures showing the great saving in expense in using the finely divided silver over the use of platinum, to meet the affidavits of the plaintiffs, which claimed the divided silver to be more costly.

The court took the case under advisement, saying it involved important points of law, and that it would try and reach a decision as soon as possible.

American Institute of Electrical Engineers.

The 86th meeting of the Institute was held at 12 West 31st street, New York City, April 18, President Houston in the chair. The secretary announced the death of Dr. Franz Schulze-Berge at Brooklyn on March 21, and stated that an appropriate obituary notice would be printed in the "Transactions."

Upon recommendation of the Committee on Units and Standards, an informal vote was taken expressing the sense of the meeting as favorable to the passage of a bill by the United States Congress legalizing the electrical units adopted by the Electrical Congress of 1893 at Chicago.

The paper of the evening was read by Mr. I. H. Farnham, of Boston, on the "Destructive Effect of Electrical Currents on Subterranean Metal Pipes," and was profusely illustrated with lantern slides. The final views, showing the electrolytic action of the current, were watched with great interest by an audience of over one hundred. The discussion was opened by Prof. Plympton, of Brooklyn, and participated in by Messrs. Kennelly, Emery, Waldo, Houston and others, the remarks of Mr. Kennelly on the bearing and weight of the various factors entering into the question being particularly well received. A communication upon the subject was also read from Mr. Lockwood. Other communications from Prof. Thomson and Mr. Lemp were received too late to be read at the meeting. The slides used have been sent to Mr. A. V. Abbott, at Chicago, who will represent the author at a meeting of the Western members, to be held at the Armour Institute, April 25.

At the meeting of council in the afternoon, the following associate members were elected:

A. T. Best, Florida; Charles A. Carus-Wilson, Montreal, P. Q.; Frank R. Colvin, New York; John C. George, Baltimore, Md.; James H. Gerry, 163 Grand avenue; James Wm. Gladstone, West Orange, N. J.; Henry M. Hobart, Schenectady, N. Y.; Ralph O. Hood, Boston, Mass.; William C. Hubbard, New York; Eugene Ingold, Pittsburgh, Pa.; Edwin S. Keefer, New York; Charles H. Macloskie, Chicago, Ill.; Samuel G. Neiler, Chicago, Ill.; Thomas L. Proctor, Newtown, L. I., N. Y.; A. L. Searles, New York; C. J. Toerring, Jr., New York, and Walter S. Wiley, South Omaha, Neb.

The following associate members were transferred to full membership upon the recommendation of the board of examiners:

S. Dana Greene, Schenectady, N. Y.; Rudolf Eickemeyer, Yonkers, N. Y.; John Thomas Morrow, Great Falls, Mont.; A. Langstaff Johnston, Philadelphia, Pa.; Joseph Edwin Crandall, Washington, D. C.

Mr. Elmer G. Willyoung, chairman of the local committee at Philadelphia, who was present, informed the secretary that active preparations were being made in that city for the coming annual and general meeting of the Institute, May 15, 16 and 17. The Engineers' Club has offered to throw open its house for the use of the Institute, and it is proposed to make the Bingham House the headquarters. Messrs. Houston and Kennelly offer the use to visiting members of their offices in the Betz Building, near the Pennsyl-

vania Railroad station, to which they may have their mail addressed. The first meeting of the Institute after its organization was held in Philadelphia in 1884, and its return to the Quaker City seems an appropriate celebration of its tenth anniversary, marking, as it does, the close of the year showing the largest growth in membership since its foundation.

The annual meeting will be held in the afternoon of May 15. At this session the results of the election of officers will be announced and the reports of the council and treasurer read. Other matters to be brought up will probably be the revision of the election rules and recommendations of the Committee on Units and Standards. The annual dinner of the Institute will occur in the evening. Wednesday and Thursday will be devoted to the reading and discussion of papers, the list reported by the committee being as follows:

Discriminating Lightning Arresters and Recent Progress in Means for Protection Against Lightning, Alexander Jay Wurts.

The Law of Hysteresis (Part III.) and the Calculation of Ferrie Inductance, Charles P. Steinmetz.

Alternating Currents and Fuse Wires, Dugald C. Jackson and R. J. Ochsner.

The Waste of Zinc in Open Circuit Batteries When Standing Idle, Henry A. Lardner.

Some Storage Battery Phenomena, W. E. Griscom.

Central Station Economy, C. Raghuald Van Trump.

A Review of the Progress of the American Institute of Electrical Engineers, Edwin J. Houston.

Standardizing Electrical Measuring Instruments: (a) By the Potentiometer Method, (b) An Improved Direct Reading Potentiometer, Elmer G. Willyoung.

Experiments with Two-Phase Motors, Louis Duncan.

Test for Closed Coil Arc Dynamo, R. B. Owens.

Relative Advantages of Toothed and Smooth-Core Armatures, Alton D. Adams.

Resonance Analysis of Alternating and Polyphase Currents, M. I. Pupin.

Unipolar Dynamos for Electric Light and Power, F. B. Crocker.

In the April number of the Institute "Transactions," Figs. 6 and 13 were transposed, and on page 204, third line from bottom, the word "positive" should be "negative."

Electric Traction in England.

(From Our Own Correspondent.)

With the revival in commercial enterprise generally, we are witnessing a similar revival in connection with electric railway enterprise in the metropolis. There are now some half a dozen schemes with parliamentary powers waiting to come before the public for the necessary money; one concern, the Central London Railway, has been in possession of parliamentary powers for over two years, and so far has done absolutely nothing towards carrying out the scheme, although they have indeed attempted to secure an extension into the next century of the term within which they must commence work. The week before last the public were asked to subscribe to the electric railway which is to run from Waterloo Railway station into the City, and has the financial and technical support of the London and South Western Railway Company. This week one and one-half million sterling is asked for the Charing Cross, Euston and Hampstead Railway, which is to be an electrical tubular railway about five miles in length, running from the Charing Cross terminus of the South Eastern Railway, due north across London, almost on the top of Hampstead Heath. As this line starts in the West End and terminates in a very favored residential district, crossing en route some very densely populated quarters, it seems to possess several of the most important requisites of a financial success.

It is interesting to note in this connection the immense gain obtained by the employment of motor cars in preference to electric locomotives. The weight of a two-motor car "train" on the Liverpool Overhead Railway is thirty-eight and one-fourth tons when full, and seating 114 passengers, the corresponding figures for the City and South London

Railway Company being thirty-seven and one-third tons, and 96 passengers. These figures work out that at Liverpool the weight of a full train per passenger is 752 pounds, whilst on the City and South London line the figure is 871 pounds. The gain is shown in another way by the fact that at Liverpool the maximum tractive force per ton of motive apparatus is 730, whilst on the City and South London line the figure is 367 pounds.

The "Times" has recently devoted a considerable portion of its space to a well-considered resume of the subject of light railways, giving a very complete analysis of what has been done on the continent of Europe, where it would appear that although the indirect gains due to the construction of such lines are thought to be considerable, there is no doubt about the fact that the direct losses in most cases are also considerable, especially where the state has had a very big finger in the pie. In Holland, where these light railways, which usually take the form of steam tramways, are, for the most part, carried out by private enterprise, and the tracks laid along the highways, a fair measure of pecuniary success has attended the undertakings. The "Times" advocates the construction of similar lines in English agricultural districts, with a view of affording some assistance to our farmers in bringing their produce cheaply to market, and I regret to say our leading journal displays a decided tendency towards the advocacy of state or municipally aided lines. If Parliament will permit powers to be obtained for the construction of light railways in a sensible and inexpensive fashion, if the Board of Trade will permit a suitable departure from its normal standard of railway construction, if the local authorities concerned will grant free use of the highways, and if the people concerned have a little capital and enterprise left in them, it is possible we might before long witness the construction of what, I think, you would call agricultural "freight lines." There are, however, too many "ifs" in the matter for one to anticipate anything in the shape of a "boom." Whenever these light railways come along, however, electrical engineers should certainly have the monopoly of the making of them.

Electric Canal Towing.

To the Editor of *The Electrical World*:

In your current issue of April 17, 1894, Volume XXIII., No. 14, page 471, is illustrated the "Electric Canal Towing System" of Mr. T. D. Davis, of Syracuse, N. Y.

Apparently the only claim that Mr. Davis makes for his system is that more boats can be moved through the locks.

While it may be questioned whether this claim can be upheld, it would be interesting to see how he figures out the gain to be equal to the cost of installing a single-track railway on each side of the canal, even though it be narrow gauge.

The system for the electric canal propulsion will probably be the two-wire trolley system, with a return to some form of "baby carriage trolley," such as was used in 1884 and 1885, with a flexible connection between the over-running trolley and the boats. The question of the number of boats to be taken in tow is evidently similar to the number of trail cars on an ordinary trolley road, and is simply provided for in the increased size of the motor on the "motor boat."

J. S. B.

Effect of Heat on Lead Pipes.

The London "Elec. Review," March 30, calls attention to the fact that heat, such as from exhaust steam, causes lead pipes to expand, after which they do not contract, thus causing bad warping. Perhaps a similar effect will take place with lead covered cables.

The Mid-Winter Fair.—I.

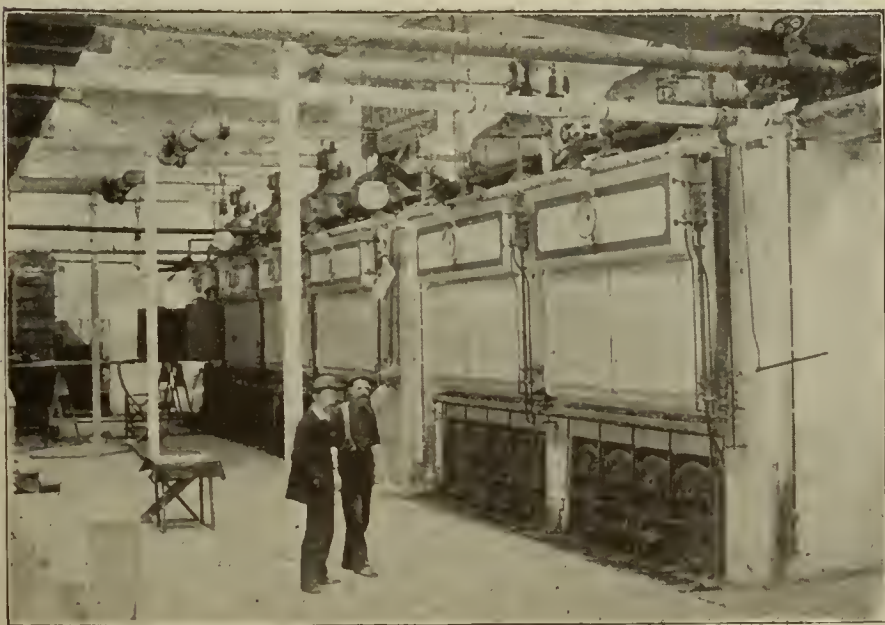


THE California Midwinter International Exposition has proved in many respects even a greater success than had been anticipated; and while it does not lay claim to the magnitude and magnificence of its greater rival, the World's Columbian Exposition, it possesses a peculiar interest of its own. The electrical features are well worthy of attention, and perhaps the most fitting introduction to a consideration of them is a description of the heart and soul of the installation—the steam plant.

The steam plant at the Midwinter Fair consists of eight Heine sectional boilers of 375 h. p. each, or a total of 3,000 h. p. They are arranged along one side of the boiler room, which is an annex to the Machinery Hall, in two groups of four boilers each, with a space of several feet between the two groups.

Each boiler has one large furnace 9 feet 1 inch wide, 16 feet deep and about 5 feet high, with four doors and draught openings to each. Crude petroleum is used as a fuel, and to adapt the boilers to this the bridge walls and grate bars have been removed and the entire bottoms of the furnaces covered with fire bricks. Pieces of broken fire bricks are also thrown in to make a mass that will retain heat for a considerable period. The bottom of a furnace is much lower than would be the case with coal as a fuel, it being but little above what is the bottom of the combustion chamber and ashpan when these boilers are arranged for coal burning. The very large furnace formed is necessary with oil fuel, because the combustion is entirely in the form of flame, there being no incandescent mass to radiate heat, as with coal.

The door openings are closed with a screen of loosely laid red bricks, except a peephole about 3 inches square through which the furnace can be examined; and this screen is so effective in preventing radiation into the fireroom that even when one is looking through the peephole but little heat



GENERAL VIEW OF BOILER ROOM.

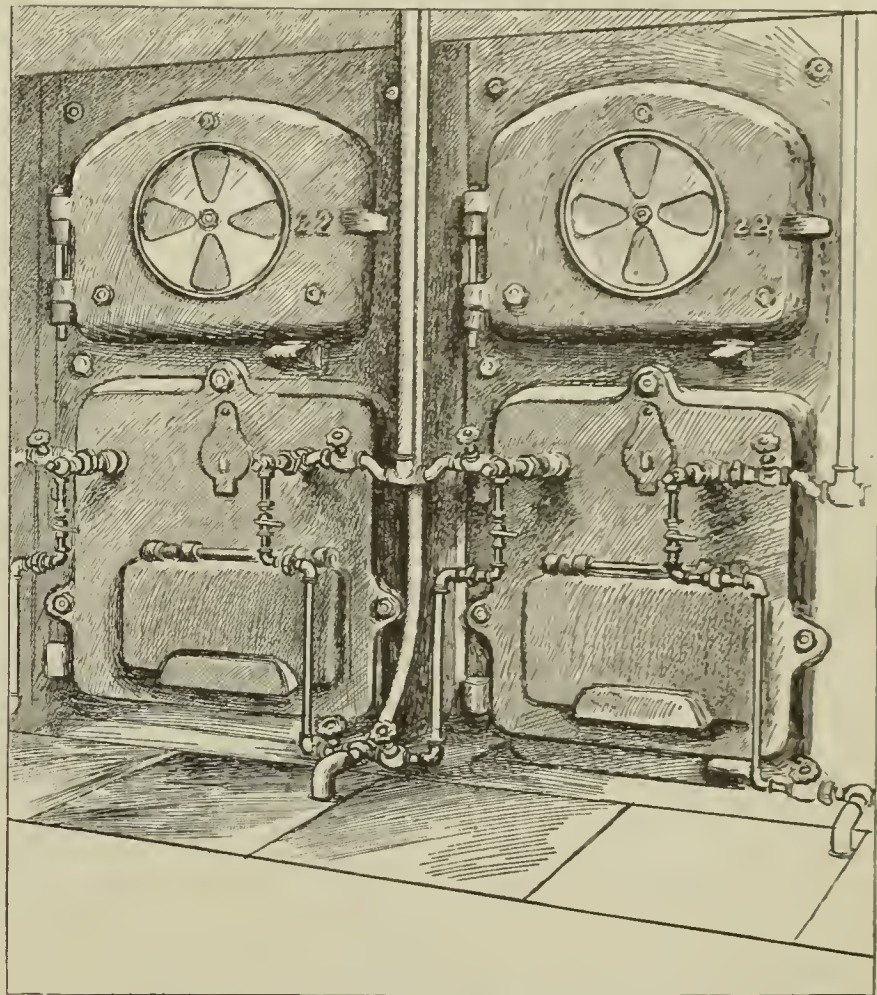
can be felt, though the temperature of the furnace is very high.

Each boiler is fitted with eight Graves burners for crude petroleum. These burners are very simple, and the results obtained with them seem to show that little room is

left for improvement. They were tried by the Heine company at Chicago, but the results obtained are said to be far less satisfactory than in this plant.

This burner was patented in 1890, the moving cause for the invention being that the inventor, Mr. Graves, had a brickyard, and thought he could turn out a better product by using a fuel that burned with the largest possible amount of flame. Gas would give this, but was expensive, so he turned to the use of oil. He failed to find a burner that suited him, and devised the one which now bears his name. The accompanying sketch will make the construction and operation plain.

The burner consists of a cast iron body, *A*, which is threaded on an enlargement, *B*, and screwed into the furnace front so that the nozzle extends a short distance into the fur-

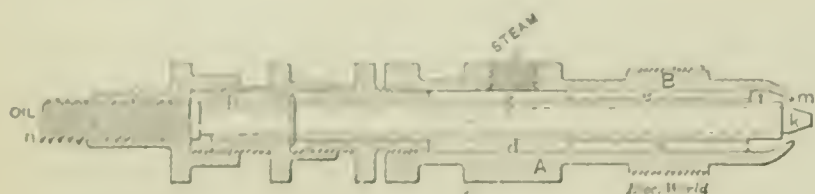


VIEW OF BOILER FRONTS SHOWING OIL TUBES.

nace. Live steam is admitted through *c* into a chamber, *a*, at the after end of the body, and is conveyed by a half-dozen whirling motion, which causes a thorough mixture with the rifle grooves of great pitch, *ee*, to the annular space *f* at the nozzle, from whence it enters the furnace with a rapid, oil. A piece, *i*, screws into the base of the body casting and acts as a guide for a thin brass tube, *g*, which is brazed to a piece, *h*, which screws on *i*, as shown, and has an extension, *p*, threaded with a right-hand thread. The length of the tube *g* is such that by screwing *h* back a free passage is made for the steam to escape through the nozzle, and by screwing *h* forward the end of the tube closes the nozzle and entirely shuts off the steam. Between these two extremes the flow of steam can be regulated to any extent. A piece, *l*, screws on *p*, as shown, and has an extension, *o*, which is tapped with a left-hand thread having the same pitch as the right-hand thread on *p*. It is made of considerable length, as shown. A pipe, *s*, screws into *o*, and is brazed to a brass tube, *k*, which passes through the tube *g* and extends a short distance beyond the nozzle, *m*. The end of tube *k* is contracted to 1-8-inch diameter, as shown. By turning *l*, the tube *k* is fed forward by the motion of *l*, and also in virtue of its left-handed thread, as it is prevented from turning by being screwed to the pipe line. In order to allow for the

forward motion of *s*, it is secured to the pipe line by a double elbow connection, thus forming a swinging joint. The primary object in threading *s* was to produce a steam-tight joint in *o*, but in addition it feeds *s* forward twice as fast as the nut *l* travels. The steam-tight joint is more efficient and more easily made than would be a shoulder on a ground joint in *l*.

The oil enters tube *k* through a 1-4-inch pipe under a pressure of 12 pounds per square inch, and discharges through the 1-8-inch nozzle with force sufficient to throw a stream about four or five feet when no steam is turned on. Steam enters at *c* through a 3-8-inch pipe, the full boiler pressure being used. The high temperature in the body and about the tube raises the oil to nearly the temperature of the steam before it escapes into the furnace. The steam having a high rotary motion, the oil is completely vaporized



SECTIONAL VIEW OF OIL BURNER.

and the combustion is perfect, no combustible residue whatever being left in the furnace or on the tubes. The flame fills the entire furnace, showing the necessity of ample room.

When the boiler is set up and the desired oil pressure is attained in the pressure tank the positions of tubes *g* and *k* are adjusted with reference to each other and to the nozzle of the burner, and no further change is necessary, so long as the pressures of oil and steam are not altered.

In starting up, steam is admitted to the chamber and the tubes heated; then oil is turned on, and the hot spray formed is ignited by means of a piece of burning waste. The oil and steam supply are regulated by means of cocks in their respective pipes, and in a few seconds the combustion can be changed from the condition of banked fires to the full power of the furnace. When starting up a boiler a slow fire can be started, and will maintain itself for hours without any attention whatever.

In case of accident to a tube or failure of the water supply, so that the tubes are in danger of burning, the fire can be instantly extinguished, as there is no heavy body of incandescent fuel to be handled, as with coal. These excellent qualities are, of course, inherent in the use of oil as a fuel and have nothing to do with the type of boiler used.

In this plant the eight burners to each furnace, each supplied with oil at 12 pounds pressure through a 1-4-inch pipe and steam at boiler pressure through a 3-8-inch pipe, are sufficient to maintain 400 h. p.

The method adopted in the Heine boiler for carrying the hot gases over the tubes would seem to be advantageous when oil is used as a fuel, because by removing grate bars and bridge wall the large furnace needed is formed. As is well known, in the Heine boiler the forward portion of the tubes over the grate bars and bridge is shielded from the direct action of the flame, and the products of combustion pass to the back of the combustion chamber, then up into the tube space, where they are again forced forward by means of a second deflecting plate over the top of the tubes. At the forward end of the tubes they escape to the space beneath the drum, then aft again to the stack. This construction allows the forming of one large combustion chamber of the entire space beneath the tubes without interfering in any manner with the remainder of the setting, and complete combustion can take place before any portion of the vaporized oil can be chilled by contact with the tubes.

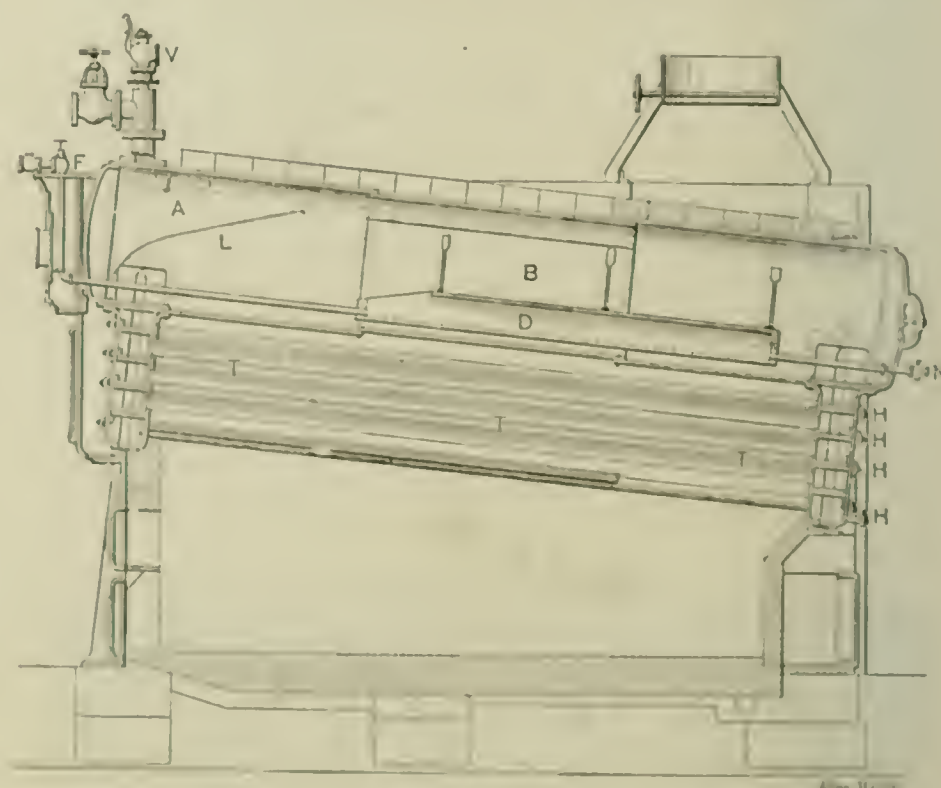
Other forms of sectional boilers can no doubt be arranged

for equally efficient use of oil fuel, but some change in the setting would seem to be necessary in order to produce a combustion chamber of requisite size.

The Southern Pacific Railroad Company has built a branch line to the Fair grounds, the track ending in the rear of Machinery Hall. Just outside the boiler room a large pit was dug and lined with wood, and in this are two iron tanks, each holding 7,500 gallons, or a total of 15,000 gallons. Tank cars are run to the pit and the oil piped into the receiving tanks. Each tank is fitted with a float, the stem of which extends above ground and indicates the quantity of oil on hand. Tank cars are supposed to come at intervals sufficiently close to keep the receiving tanks practically full, but in case of delay the tanks hold enough for three days' use, about 5,000 gallons being used each twenty-four hours.

In the space between the boilers in the middle of the fire-room are located two Dow pumps, size B, which supply the oil to the boilers. They have 4-inch suctions, and each is large enough to supply fuel for 4,000 h. p. of boilers. But one is used at a time, the other being held as a reserve in case of breakdown. The arrangement of pipes and valves is such that either pump can draw from either or both storage tanks, thus making a stoppage almost impossible. For the light load after midnight a small Dow pump (No. 2) is used. The pumps discharge into a vertical tank, 12 inches by 6 feet, against an air head, a steady pressure of 12 pounds being maintained automatically by means of a pump governor connected with the air head, and shutting off steam from the pump when the pressure rises.

The governor is very sensitive and the pressure kept very



SECTIONAL VIEW OF BOILER ARRANGED FOR OIL FUEL.

steady; it is registered by a gauge connected with the air head. The oil is carried to about the middle of the pressure tank, and the height is shown on a glass gauge.

There is a constant small air leak, which would soon destroy the air head if it was not compensated. To supply this loss a snifting valve on the pump is regulated so that a small quantity of air is taken in with the oil at each stroke, the amount required varying with the load. A little attention to this valve from time to time keeps the air head nearly constant. The arrangement is so nearly automatic that during the hours of heaviest load in the evening but two firemen are required to be on duty, one of whom keeps watch of the oil supply and furnaces and the other the water, and during the rest of the twenty-four hours, from midnight until 6 P. M., one man can easily care for the whole plant and have plenty of time for reading the daily papers.

Cleanliness is conspicuous, no coal or ashes being about

the floor; the boilers are painted white and stay so, and the firemen wear white uniforms.

If coal was the fuel, six or eight men would be required for heavy load. The wages saved amount to a considerable item, and probably something is saved on fuel, as coal is expensive. Besides this, the use of oil fuel adds greatly to the value as an exhibit, as the clean fireroom attracts many visitors.

From midnight to about 6 A. M. the average load is about 200 h. p., during the day from 800 to 1,000 h. p., and during heavy load in the evening about 2,500 h. p.

The oil discharge from the pressure tank is 3 inches diameter until it reaches the line of the boiler fronts, where it branches into two pipes, each 2 inches diameter, one leading aft and one forward, and each furnishing fuel for four boilers. A shallow concreted trench runs the whole length of the fire-room and drains at each end into catch pits, where any leaking can be collected. The trench is covered with light iron covers, and the oil pipe can be examined readily. Ordinarily, the leakage is insignificant, but the pits are provided in case a pipe bursts, when the escaping oil would be collected and returned to the storage tanks.

The feed-water heater is a 4,000-h. p. Webster vacuum heater, made by Warren Webster & Co., of Philadelphia. It is rectangular and has within it a series of plates set alternately so that water will descend by passing from plate to plate in a thin sheet. The water inlet is 5 feet, and water is supplied from the water company's mains at a pressure of 80 pounds.

The main exhaust rises close to the heater and has a single branch lead extending to the heater, which forms a closed trap for the steam that enters it. Cold water is admitted at the top, and as it passes downward from plate to plate it condenses the steam, which fills all the space between the plates. A partial vacuum is thus formed, in virtue of which the exhaust steam continues to enter the heater instead of passing to the air.

The steam enters at the bottom and the water, as it descends, becomes warmer and warmer until at discharge the hottest water is in contact with the hottest steam, and a high

pump are used. The Smith-Vaile and one Dow are duplex, one Dow simple, and the other is a marine feed with bypass valve.

Each boiler has an 8-inch steam pipe, and the pipes from two adjoining boilers unite in a single lead to the main steam pipe. This pipe extends along one side of the main building, with leads taken off where necessary. Traps are provided at intervals for taking off the water of condensation.

The location of machinery is not such as to render a steam loop either necessary or possible.

The plant is under the immediate care of Mr. E. C. Meier, who erected it for the Heine company and designed the arrangement for feeding the oil. Passed Assistant Engineer Hunt, U. S. N., is chief of the mechanical department of the Fair, and this plant was erected under his supervision.

It was only with great difficulty that a steam plant of any kind was obtained for the Exposition. At first the manufacturers of San Francisco refused to do anything unless the committee would agree to use only machines made on the Pacific Coast. The Exposition was projected in August and in October two boilers, one of 40 h. p. and the other 100 h. p., had been offered, but were never set up. In October Colonel Meier, president of the Heine Boiler Company, made a very liberal offer of four boilers of 1,500 h. p., which were in use in Chicago. Four others would have been offered, but the ones intended were in the hands of the receiver of a power company that had failed, and they could not then be obtained. The Climax company came forward with an offer of 1,000 h. p., but later they withdrew, and the Heine company, finding it could have the four boilers previously unavailable, added them to the other four, thus making 3,000 h. p., which constitutes the entire plant.

Destructive Effects of Electrical Currents on Subterranean Metal Pipes.*

BY I. H. FARNHAM.*

After describing experiments showing the manner in which pipes laid in damp ground are corroded by electroly-

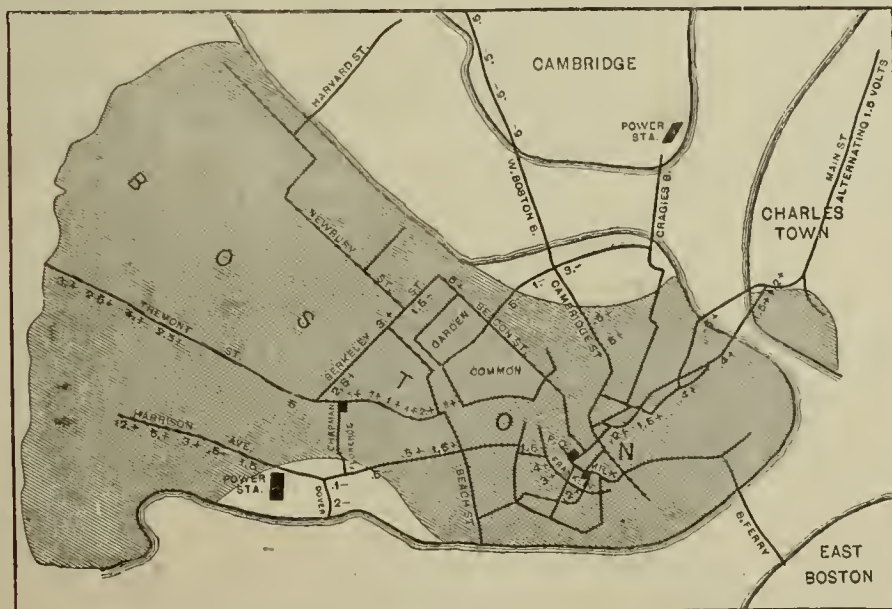


FIG. 1.—NEGATIVE POLE OF GENERATOR TO LINE.

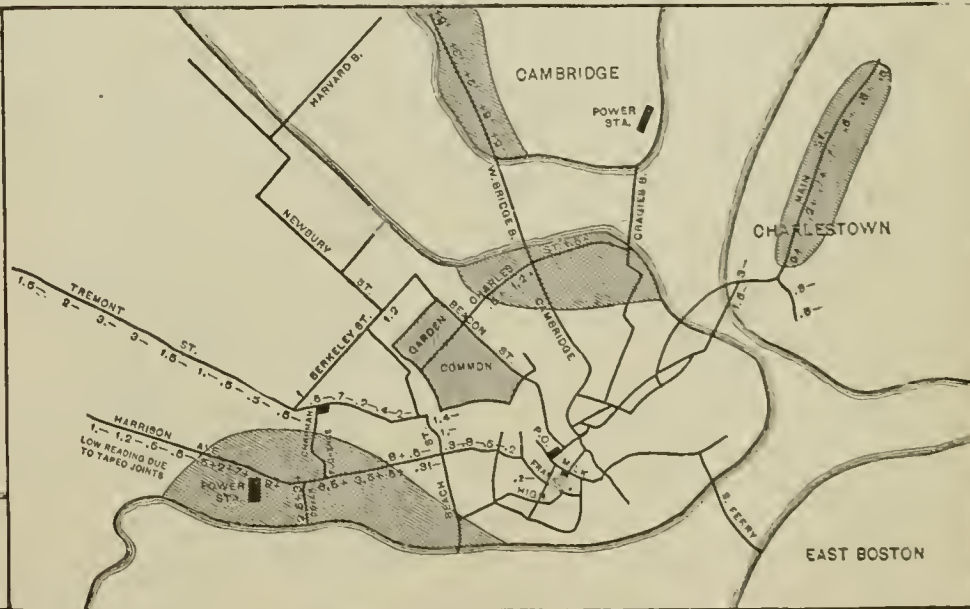


FIG. 2.—POSITIVE POLE OF GENERATOR TO LINE.

temperature of feed water is attained, in this case about 200 degrees Fahr.

Water is carried at a definite height, indicated by a glass gauge, and is maintained by means of a float, which controls a regulating valve in the supply pipe.

The quantity of exhaust steam entering the heater depends upon the vacuum, and this in turn depends upon the feed supply.

The discharge is 8 inches, and in case of accident the water company's mains can be connected to the feed pump suction and cold-water supplied to the boilers.

For feeding three Dow (S. F.) pumps and one Smith-Vaile

sis, Mr. Farnham gives the result of his investigations of the effect on telephone cables in Boston of the ground currents of the West End Street Railway. Measurements were made between the cables at all manholes and the earth near the cables, and it was found that the negative pole of the generator being connected with the trolley line, within a radius of about 2,000 feet from the Albany street power house the cables were negative to the earth, ranging from zero to two volts; outside of this neutral line they were positive to earth, ranging from zero to 12 volts, until a point near the East

* Abstract of a paper read before the New York meeting of the Institute of Electrical Engineers, April 18, 1894.

Cambridge power house station, when they again passed a neutral line and became more and more positive as that power house was approached. From the data of measurements, maps, Figs. 1 and 2, were plotted showing the voltage between the cables and the earth throughout all the section of the city, the hatched portions being where the cables were found positive to earth and denoted "danger territory."

With the negative pole of the generator to the trolley, Fig. 3 shows the passage of the current from the generator to the rails, and the passage of a portion of the current from the rails to the cables within the neutral or zero line, and from cables to rails outside of this zero line. The danger of elec-



FIG. 2. NEGATIVE POLE TO LINE.

FIG. 1. POSITIVE POLE TO LINE.

trollysis is only where the current leaves the cable or pipe through the moist earth, hence the danger district was at this time outside of the zero, or neutral line, as shown both on the map, Fig. 1, and Fig. 3.

Fig. 2 is a map showing the condition when the positive pole of the generator was connected to the trolley line, the shaded portion again showing the danger district, corresponding to the white, or safe, districts in Fig. 1, the only variation being that the neutral or zero line was thrown out a little further from the Albany street power house than it was before. It was also noted that the cables near the power house which had been from one to two volts negative to earth before the change of currents were now from one to nine volts positive to earth.

Fig. 4 is a representation of the current when flowing from the positive pole to line, and it will be readily understood that the electrolytic action will be thus confined to the territory comparatively near the power house, where current is leaving the cables to reach the negative or rail side of the dynamo.

Among the proposed and applied remedies for preventing the destruction of the cables were the following:

First—The removal of the cables from the wet bottoms and sides of the so-called manholes. It was found, however, very difficult to place and retain the cables free from the wet sides, and the action of the mouth of the ducts would nevertheless continue.

Second—The cables were connected to ground plates in the manholes with the idea of transferring the electrolytic action to these plates, but although many ground plates giving a surface of several square feet each were connected with the cables over large portions of the city, it was found that nearly the same pressure existed as before.

Third—Prof. Elihu Thomson suggested placing motor generators along the line to be operated by the railway current and automatically regulated to generate a voltage equal but opposite to that existing between the cable and ground.

Fourth—Insulating the cables and pipes from the earth was proposed, but was found impracticable.

Fifth—Breaking the metallic continuity of the cable sheath and pipes was proposed, but as the severe action was found in comparatively isolated spots, it follows that any system of breaking the metallic continuity would have to be studied with regard to the entire complicated system of pipes, cables and rails ramifying through the streets of the city.

Sixth—It was suggested that the railway current might be so frequently alternated as to possibly prevent serious action on the pipes and cables, the oxygen liberated by the current being dispersed by the reversal before it could at-

tack the metal. Good results were derived from an experiment conducted on these lines with frequent reversals, but with 24-hour periods it was found that no good was derived, and it was concluded that it would be impossible to reverse the heavy railroad currents at frequent enough intervals.

Seventh—Mr. Fred. S. Pearson suggested that the positive pole of the generator should be connected to the line and also that large bare conductors radiating from the power station into the danger district should be laid and connected at frequent intervals to such cables and pipes as were in danger. Both of these suggestions were adopted and with the most successful results.

Mr. Farnham gives the following as the conclusions resulting from his investigations:

First—All single trolley railways employing the rails as a portion of the circuit cause electrolytic action and consequent corrosion of pipes in their immediate vicinity, unless special provision is made to prevent it.

Second—A fraction of a volt difference of potential between pipes and the damp earth surrounding them is sufficient to induce the action.

Third—Bonding of rails, or providing a metallic return conductor equal in sectional area and conductivity to the outgoing wires, is insufficient to wholly prevent damage to pipes.

Fourth—Insulating pipes sufficiently to prevent the trouble is impracticable.

Fifth—Breaking the metallic continuity of pipes at sufficiently frequent intervals is impracticable.

Sixth—It is advisable to connect the positive pole of the dynamo to the trolley lines.

Seventh—A large conductor extending from the grounded side of the dynamo entirely through the danger territory and connected at every few hundred feet to such pipes as are in danger, will usually ensure their protection.

Eighth—It is better to use a separate conductor for each set of pipes to be protected.

Ninth—Connection only at the power station, to water or gas pipes, will not ensure their safety.

Tenth—Connection between the pipes and rail, or rail return wires, outside of the danger district, should be carefully avoided.

Eleventh—Frequent voltage measurements between pipes and earth should be obtained, and such changes in return conductors made as the measurements indicate.

Hamburg Electric Tramway.

(From Our Own Correspondent.)

The official inauguration of the electric tramway in Hamburg, equipped on the Thomson-Houston system by the Union Elektricitaets-Gesellschaft, of Berlin, took place on the 29th of March, and was attended by a large number of gentlemen connected with the tramway interests of that country—directors, engineers and managers, besides the representatives of several important municipal bodies.

The programme was as follows: Starting at 10 A. M. from the Damnthor Railway station, the party proceeded upon a round of inspection on several electric cars on the Ringbahn section and out to Falkenried, the depot of the line; at noon the harbor was visited, where a steamer was in waiting to convey the company round the quays; finally the power station, located in the Poststrasse, was thoroughly inspected. Unanimous satisfaction was expressed with all that was seen. The guests, numbering about one hundred, were afterward entertained at dinner by the Union Elektricitaets-Gesellschaft.

The total length of the road, when completed, will be between eleven and twelve miles, and the number of motor cars 42, 32 for regular service and 10 in reserve to meet

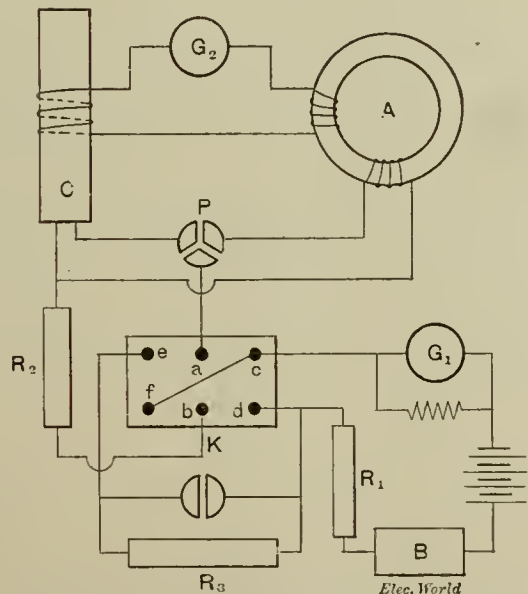
extra heavy traffic requirements on holidays, etc. The Ringbahn section of the system, covering some five miles of track, with 16 motor cars, has been in regular operation since the first week in March, and the rest of the line is expected to be in running condition by about the middle of this month. The generating plant is contained in the municipal central station, the low voltage lighting current being taken up by Schuckert continuous current converters and delivered at a potential of 500 volts to the tramway circuit. In addition, there is installed as reserve set a Thomson-Houston 100-kw. railway generator, driven by a McIntosh & Seymour tandem compound condensing engine. The trolley wire is run at a height of 18 to 20 feet above the track, attached to brackets on steel poles erected along the road, or else run on the cross suspension method. At such locations where the streets, by reason of their narrowness, or the conditions of traffic, preclude the use of poles, rosettes fixed to the houses on either side of the street, as in Bremen, are employed. Each car is equipped with 1 15-h. p. motor, controller, lightning arrester, etc., and is lighted by 5 16-c. p. incandescent lamps. At points where telephone wires cross the tramway, neat wooden moulding is run along the top of the trolley wire to prevent the telephone wires, in case of their falling by any means, coming in contact with the former. This method has been in use in Bremen for some time and proved satisfactory.

Magnetic Qualities of Iron.*

BY J. A. EWING AND HELEN G. KLAASSEN.

The experiments to be described in this paper deal mainly with the cyclic effects of magnetizing force. They are intended to contribute some additions to existing data, to answer one or two specific questions, and to exemplify one or more novel methods of experimental inquiry.

We have devised and used throughout all these experiments a method which, while requiring only one current and one magnetizing coil, retains the advantage that each point in the cycle is reached by a single step from the end of the cycle.



METHOD TO DETERMINE MAGNETIC QUALITIES OF IRON.

The diagram shows the arrangement used.

The magnetizing current passes from the battery through the adjustable resistance R_1 and the galvanometer G_1 to a key, K , and thence through the resistance R_2 to a two-way plug P , which allows it to be sent either into the magnetizing coil of the ring A , which is the sample under test, or into the primary of a special induction coil, C , which is used for standardizing the ballistic galvanometer. A and C each have a secondary coil; the two secondaries are kept in series with one another, and their circuit is completed through the ballistic galvanometer G_2 . A Kelvin balance, B , which is short-circuited when it is not required, serves

*A portion of a paper recently read before the Royal Society.

to determine the constant of the current galvanometer G_1 . The key K is a rocker, working in mercury cups, which, when rocked to the left, connects a with e and b with f , and, when rocked to the right, connects a with c and b with d . In the latter position of the key the full strength of the magnetizing current is in action, and hence if the plug P is set so as to send the current into A , the sample is magnetized to a degree which represents one extremity of a magnetic cycle. Between the cups e and d of the rocking key are a short circuit plug and also an adjustable resistance, R_3 . When this short circuit plug is inserted, the key K is simply a reversing key, and then, when rocked to the left, it reverses the magnetization of the ring, carrying it at once to the opposite end of the cycle. But when, instead of a short circuit between c and d , there is a resistance, the rocking of the key to the left applies to the sample a magnetizing current opposite in sign to the primitive current, but less than it in amount, and consequently carries its magnetism to the end of the cycle, but to a point which falls short of the end by an amount depending on the magnetism of the resistance R_3 . The peculiarity of the method is that, by a single movement of the key, the magnetizing current is at once reduced in amount and reversed in sign.* By giving R_3 a series of values, each movement of the key to the left determines a new point on the curve, while each movement to the right brings back the magnetization to its extreme value. In this way as many points are found as may be required to define that part of the curve which lies between the zero of magnetizing force and its extreme negative value. To find points lying between the positive extreme and the zero of magnetizing force, a different process is adopted. The key is kept to the left, and a sudden reduction of the current (without change of sign) is effected by withdrawing a plug from the resistance box R_2 . This gives a point in the first quadrant of the descending curve, and a series of such points are found by selecting successive values of R_2 , the magnetization of the sample being, however, restored to its initial full value before each such step.

Aurora and the Telegraph Wires.

The following query has been addressed by Mr. Preece to the editor of "The Times":

"Sir: There was an extremely brilliant display of aurora between 10 and 10:45 P. M. on Friday, the 30th ult. It was accompanied, as usual, by very strong earth currents on all telegraph lines. But at 10:20 P. M., when all the telegraph circuits were idle, a peculiar frizzling and bubbling noise was heard upon a telephone inserted upon a long Irish wire at Llanfairpwll in Anglesey. At 2 A. M. on Saturday, the 31st ult., 'twangs' were heard, as if a stretched wire had been struck. These were followed by a kind of whistling sound. Were these signals from space, or mere disturbances of atmospheric electricity?"

A Well Deserved Sentence.

An English electric belt quack doctor, who was said to be earning (?) \$15,000 to \$20,000 per year, has just been sentenced to five years' imprisonment. What a blessing it would be if we had such courts and laws in this country.

Electric Plows.

The firm of Siemens & Halske is said to be experimenting with an electric plow on the estate of Mr. Siemens.

* Since this description was written, a paper has been communicated to the Royal Society by Dr. John Hopkinson and Messrs. Lydall and Wilson, in which ballistic experiments are described where the method was essentially the same as that used by us. A single movement of a key reversed the magnetizing current and introduced resistance. (Roy. Soc. Proc., vol. LIII., p. 352.)

Rope Driving—XI.*

BY J. J. HATHOR.

As it has been previously noted, it is desirable in all cases of rope transmission to so arrange the drive that the slack side of the rope shall be on the upper part of the pulley, thus increasing the arc of contact as the two sides will then approach each other when in motion.

In order that the desired tensions, T_1 and T_2 , shall be attained in the two parts of a rope, the deflections or sag must be of predetermined values. The centre line of the rope will lie in a curve, which may be determined with no appreciable error by assuming the rope to have no elasticity and to be of constant cross section, under which condition the curve will be that known as the catenary, the transcendental equation of which is

$$y = \frac{c}{2} \left(e^{\frac{x}{c}} + e^{-\frac{x}{c}} \right).$$

Let the form of curve in which the rope hangs be represented by $P O' P'$ (Fig. 33), in which O' is the lowest point

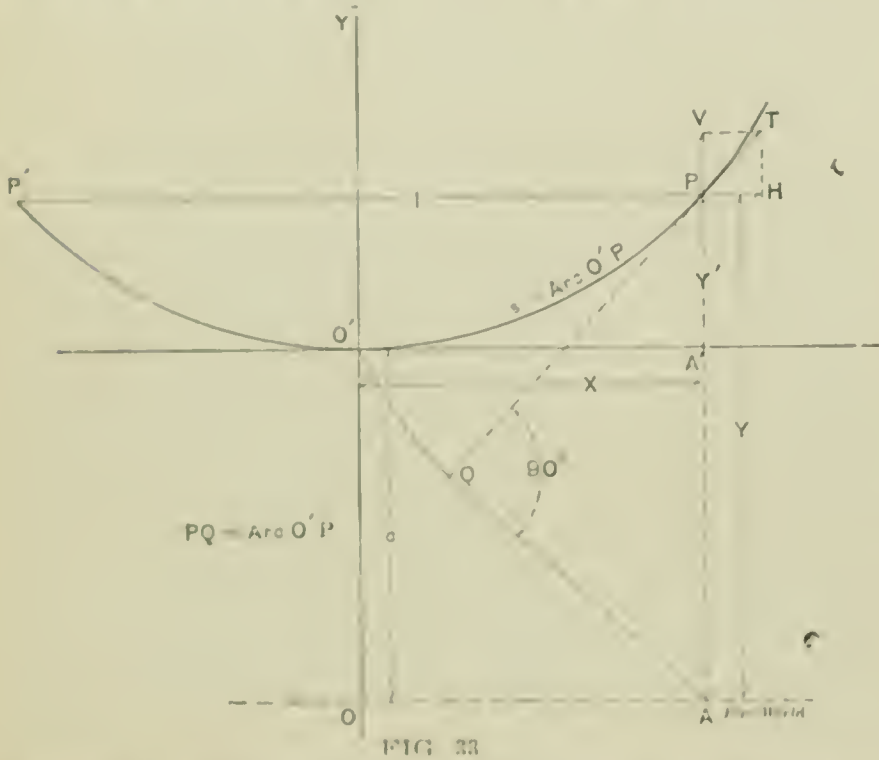


FIG. 33.

of the rope. Take O' as the origin of co-ordinates, and let $x = O' A'$ and $y' = A' P$ be the abscissa and ordinate of any point P in the curve, and let l be the distance between the points of support.

Since we have assumed the rope to be perfectly inelastic, the tension at any point of the curve must be in the direction of the rope. Let T be the stress in the rope at P , the vertical and horizontal components of which are represented by V and H respectively. Assume the length of curve $O' P = s$. Since the weight of a unit length of rope $= w$, the vertical component of the tension T is evidently equal to one half the weight of the rope between the points P and P' , or $V = \frac{1}{2} w P O' P' = w s$. To determine the length of curve, produce the tangent through the point P and rectify the curve $O' P$ on this tangent, making $s = P Q$. Erect a perpendicular to $P Q$ at the point Q , meeting the vertical from P at T ; then will $O' T$ drawn through A parallel to $O' A'$ be the directrix to the catenary and $Q A$ will equal $l - c$. Hence

$$P Q = P A' = Q A.$$

$$s = (c + y')^2 = c^2 + 2cy' + y'^2, \text{ therefore } T = ws = w\sqrt{(c + y')^2}.$$

At the vertex O the tension is horizontal and equal to the weight of a length, c , of the rope; but this tension is the same as the horizontal component at the point P ; hence $H = wc$. Since $T = \sqrt{V^2 + H^2}$, we obtain the following value for the tension in the rope:

$$T = w\sqrt{y'^2 + 2cy' + c^2} = w(c + y').$$

In order to determine the parameter c , let the equation of the curve $y = \frac{c}{2} \left(e^{\frac{x}{c}} + e^{-\frac{x}{c}} \right)$ be developed in the following series:

$$y = \frac{c}{2} \left(1 + \frac{x}{c} + \frac{x^2}{1.2 c^2} + \frac{x^3}{1.2.3 c^3} + \dots \right) + \frac{c}{2} \left(1 - \frac{x}{c} + \frac{x^2}{1.2 c^2} - \frac{x^3}{1.2.3 c^3} + \dots \right).$$

Since the character of the curve is such that the quotient $\frac{x}{c}$ is a proper fraction, the series will be converging; stopping at the third member as giving sufficient accuracy, we have

$$y = \frac{c}{2} \left(2 + \frac{x^2}{c^2} \right) = c + \frac{x^2}{2c}; \text{ therefore}$$

$$x^2 = (cy' - c).$$

Substituting the value of $y' = y' + c$ in this equation, we obtain $x^2 = 2cy'$, which is the equation of a parabola re-

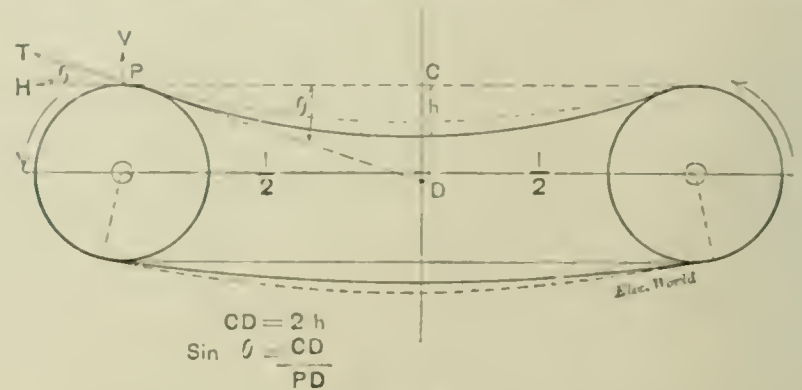


FIG. 34.

ferred to its axis and the tangent to its vertex. Now let $\frac{l}{2}$ (Fig. 34) equal the half distance between supports $= x$; and $h =$ sag of the rope $= y'$; then from the previous equation we obtain $\left(\frac{l}{2}\right)^2 = 2cy'$; hence the parameter, c , $= \frac{l^2}{8h}$. Substituting this value of c in the equation for the tension T previously obtained, we have

$$T = w \left(\frac{l^2}{8h} + h \right),$$

in which w equals the weight of a unit length of rope $= 0.32 d^2$; that is, the tension at any point in the rope is equal to the weight of a portion equivalent in length to the parameter plus the ordinate y' of the point. From this equation we may obtain the sag of the driving or driven portions of the rope by substituting for T the values of T_1 and T_2 —the deflections corresponding to which may be represented by h_1 and h_2 (Fig. 34). T_1 will evidently be constant and equal to $200 d^2$ if our preconceived conditions are maintained, but the value of T_2 will be variable, increasing with the speed.

Practically it will be impossible to maintain a constant tension in the rope, so that the amount of sag obtained by calculation is liable to vary with the conditions of service. The tension may, however, be approximately determined by the deflection. Assuming the distance between supporting points of the rope equal to the distance between centres of pulleys and solving for h , we obtain

$$h_1 = \frac{1}{2} \frac{T_1}{w} \pm \frac{1}{2} \sqrt{\frac{T_1^2}{w^2} - \frac{l^2}{2}},$$

$$h_2 = \frac{1}{2} \frac{T_2}{w} \pm \frac{1}{2} \sqrt{\frac{T_2^2}{w^2} - \frac{l^2}{2}}.$$

The positive and negative signs before the radical in these equations indicate two values for h , the lesser of which only is to be used. As pointed out by Reuleaux, between the two lies a value $h = \frac{1}{2} \frac{T}{w}$, which is obtained when the quantity under the radical $= 0$; that is, when $T = \frac{w l}{\sqrt{2}}$.

* For geometry of this curve see "The Ellipse or Polygon" in Bowser's "Analytic Mechanics," p. 216 et seq.; also Price's "Mechanics," vol. 1.

This deflection is interesting, as it denotes the minimum stress which may exist in the rope.

Since the sum of the tensions increases with the speed the sag of the rope when at rest is not directly obtainable from the previous values of h_1 and h_2 .

The tension necessary for adhesion, which constitutes a part of the stress, T_1 , is dependent upon the speed at which the rope is intended to be run, so that in order to determine the sag h_0 when at rest for a given maximum tension T_1 the initial tension must be obtained for any given speed, and this value substituted in the general formula

$$h = \frac{T'}{2w} \pm \frac{1}{2} \sqrt{\frac{T'^2}{w} - \frac{l^2}{2}}.$$

Assuming the tension on the tight side of the rope to be made up of three parts, namely, the driving force, P , the centrifugal force, F_0 , and the tension, T_3 , necessary to balance the strain for adhesion, we obtain $T_1 = P + F_0 + T_3$; in like manner the tension on the slack side of the rope may be assumed to be produced by the strain necessary for adhesion, plus the strain due to centrifugal force, that is: $T_2 = T_3 + F_0$.

It is evident that if the normal tension T_1 be diminished by the centrifugal force the remaining stress will be equal to the tension necessary for adhesion plus the driving force; hence if we obtain the value of the ratio $\frac{T_1}{T_2}$ from $\epsilon \phi^a$, in which the stress due to centrifugal force is neglected, we shall have in T_2 the initial tension necessary for adhesion or $T_2 = T_3$. If T_1 is assumed to be constant, then T_3 will be constant for a given coefficient of friction and arc of contact; therefore $\frac{T_1 + T_3}{2}$ will equal the tension in the rope when the latter is at rest.

The following simpler method for obtaining the sag, though less exact, is sufficiently accurate for any practical case that may arise, for it must be borne in mind that any theoretical calculation for the deflection of a running rope can at best be only an approximation, as it is exact only when the rope is running at its normal speed, transmitting its full load and strained to its normal tension. Let l be the distance between two shafts which are at the same level (Fig. 35), and let h be the deflection of the rope; also

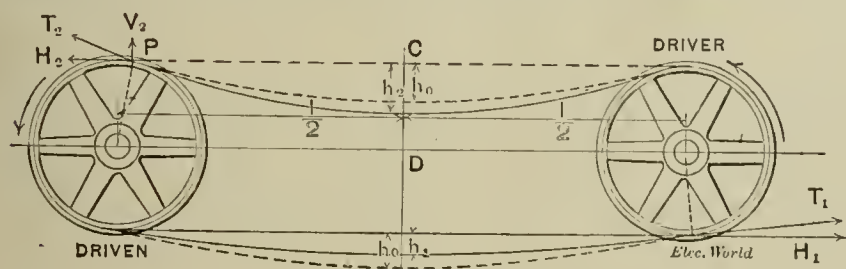


FIG. 35.

let $CPD = \theta$ be the inclination of the rope at P , from which

$$\sin \theta = \frac{CD}{PD} = \frac{2h}{\sqrt{\left(\frac{l}{2}\right)^2 + (2h)^2}} = \frac{4h}{\sqrt{l^2 + (4h)^2}},$$

and hence, since F is the vertical component of the tension T in the rope and equal to $\frac{W}{2}$, where W is the weight of rope between supports, we shall have

$$T = \frac{F}{\sin \alpha} = \frac{W}{8h} \sqrt{l^2 + (4h)^2} = W \sqrt{\frac{l^2}{64h^2} + \frac{1}{4}}.$$

As h is small compared to l , we may neglect $\frac{1}{4} h^2$, then if we assume the length of rope to be equal to the distance between the shafts, we shall have, approximately,

$$T = \frac{Wl}{8h} = \frac{wl^2}{8h} \text{ where } wl = W; \text{ hence the sag of the rope}$$

at the centre will be $h = \frac{wl^2}{8T}$, in which $w = 0.32 d^2$.

TABLE I.—DEFLECTION OF ROPE.

Calculated from $h = \frac{w l^2}{8 T}$.						
Distance between pulleys in feet.	Deflection in feet in slack side of rope when $T_2 = T_1 - P =$				Deflection in tight side of rope when $T_1 =$	Deflection in both sides of the rope when initial tension $T_0 =$
	$86 d^2 \mid 91 d^2 \mid 100 d^2 \mid 112 d^2$					
	Corresponding to velocity in feet per minute of:					
	2000	3000	4000	5000	200 d ² pounds.	141 d ²
40	0.74	0.70	0.64	0.57	0.32	.45
60	1.67	1.58	1.44	1.28	0.72	1.02
80	2.97	2.81	2.56	2.28	1.25	1.82
100	4.65	4.40	4.00	3.57	2.00	2.84
120	6.70	6.33	5.76	5.14	2.88	4.10
140	9.12	8.61	7.84	7.00	3.82	5.58
160	11.90	11.25	10.24	9.14	5.12	7.27

From this formula the following table has been computed and the curves plotted, as shown in Fig. 36. T_1 being

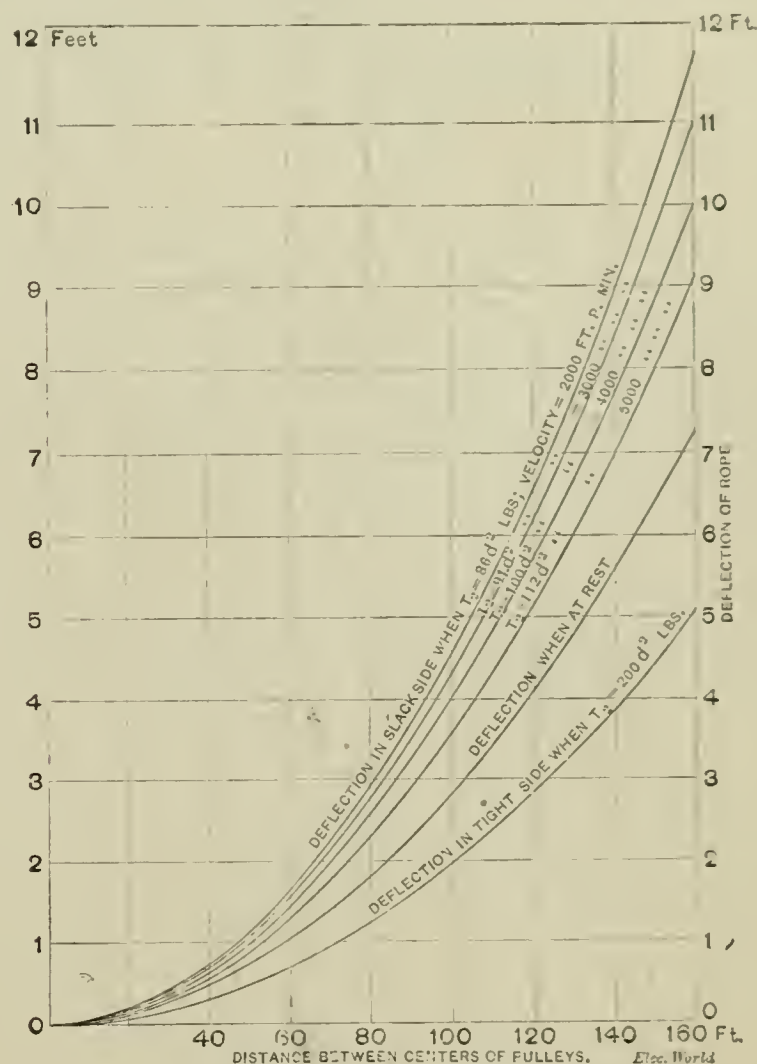


FIG. 36.

assumed as constant and equal to $200 d^2$ pounds. The tension T_2 , which varies with the speed, has been separately determined for the several cases considered from

$$\frac{T_1}{T_2} = \epsilon \phi^a (1 - Z).$$

in which the coefficient of friction, $\phi = 0.31$ and $\alpha = 2.88$; hence

$$\log \frac{T_1}{T_2} = 0.4343 \times 0.9 (1 - Z).$$

The deflection on the tight side will then be $h_1 = \frac{0.32 d^2}{8 T_1}$ $= \frac{0.32 d^2 l^2}{8 \times 200 d^2} = 0.0002 l^2$; and on the slack side $h_2 = \frac{0.04 l^2}{T_2}$, in which T_2 has the values given in the table.

As previously pointed out, the initial tension in the rope when at rest may be obtained by neglecting F_0 , in which case we have $\log \frac{T_1}{T_2} = 0.4343 \phi \alpha$, from which we find $\frac{T_1}{T_2} = 2.46$, or $T_2 = 82 d^2$; and since $T_2 = T_3$, when there is no centrifugal force acting, the initial tension, which we may call T_0 , will equal

$$\frac{T_1 + T_3}{2} = \frac{200 d^2 + 82 d^2}{2};$$

hence $T_0 = 141 d^2$. From this we may obtain the deflection when the rope is at rest, as noted in the last column

of Table I., which has been computed from $h_0 = \frac{0.32 d^2 l^2}{8 T_0} = 0.000254 l^2$, where l is the distance in feet between centres.

To draw the curve of the rope in order to determine the space it will occupy, assume it to hang in a parabola with

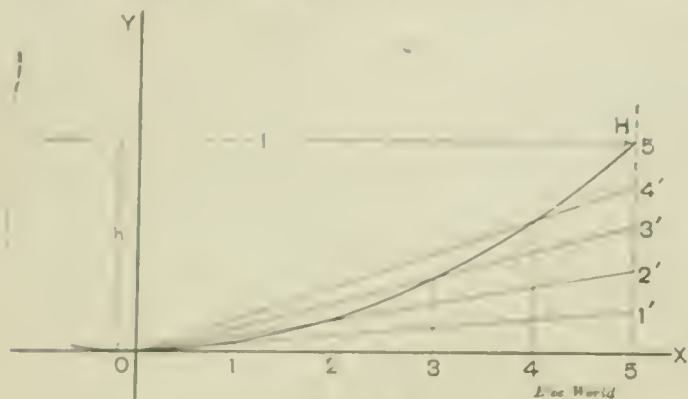


FIG. 37.

origin at vertex and lay off the X and Y axes, as in Fig. 37.

Let $ox = \frac{1}{2} l = \frac{1}{2}$ distance between points of suspension of the rope, and let $5 H = h$ equal the sag of rope. Divide $5 H$ into a convenient number of equal parts; also divide ox into the same number of equal parts; erect perpendiculars from the points of division 1, 2, 3, ... and join 1', 2', 3', ... with the origin o . The curve drawn through the points of intersection will represent one branch of the parabola desired.

Where the pulleys are placed at different heights we have an inclined transmission, and the curve in such cases is unsymmetrical, as in Fig. 38.

This curve is best solved by an approximation similar to

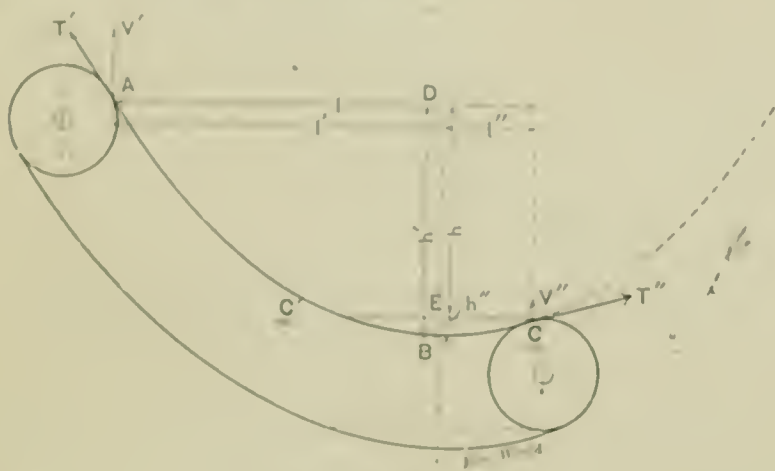


FIG. 38.

that already given. It will be noticed that the curve of the rope ABC is made up of two unequal parts, AB and BC , whose horizontal projections are l' and l'' and their corresponding deflections h' and h'' . The given difference in height between the points of support of the rope is $ED = h = h' + h''$, and their known horizontal distance is $l = l' + l''$. From the preceding formula for the deflection we have $h' = \frac{w l'^2}{8 T'} = \beta l'^2$ and $h'' = \frac{w l''^2}{8 T''} = \beta l''^2$, in which β

is taken as a coefficient depending upon the value of the tension in the rope $\frac{0.32}{8 T}$.

Since $h = h' + h''$ and $l = l' + l''$, we have $h = \beta (l'^2 + l''^2) = \beta (l'^2 + (l - l')^2) = \beta l (l - l')$, therefore $l - l' = \frac{h}{\beta l}$. But $l' = l - l''$ and $l'' = l - l'$, hence $\beta l l' = \beta l^2 - h$, and the required distance $l = \frac{h + \beta l^2}{2 \beta l}$. In the same way $l' = \frac{\beta l^2 - h}{2 \beta l}$, and the deflections are

$$h' = \beta \left(\frac{h + \beta l^2}{2 \beta l} \right)^2 \text{ and } h'' = \beta \left(\frac{\beta l^2 - h}{2 \beta l} \right)^2.$$

in each of which equations β has a separate value, depending upon the tension in the rope. It is evident that the tension T' at A will be greater than that at C on account of the greater weight of rope lying in the upper branch of the parabola.

If T' is known, the lesser tension, T'' , can be determined by assuming the length of the rope to be the same as if the points A and C (Fig. 39) were at the same height and l feet apart. From previous considerations it is seen that the tension at any point of the rope in a parabola is equal to the weight of rope equivalent in length to the parameter c added to the ordinate of the point; hence if h'' equals the ordinate of $C = h' - h$ (Fig. 39), we shall have

$$T'' = w (c + h''), \text{ and}$$

$$T' = w (c + h').$$

$$\text{Since } c = \frac{l^2}{8 h'}$$

$$T'' = w \left(\frac{l^2}{8 h'} + h' \right) \text{ and } T' = w \left(\frac{l^2}{8 h'} + h' \right).$$

therefore $T'' - w h' = T' - w h''$; substituting for h' its value, $h + h''$, there is obtained

$$T'' = T' - w h.$$

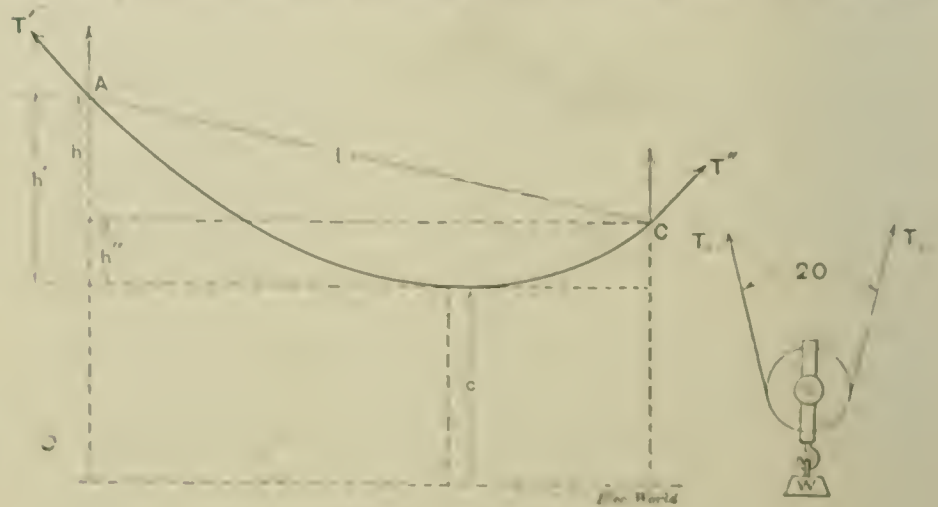
When a tension carriage is used, the necessary weight can be ascertained from the formula for back tension, $T_2 = T_1 + F_0$; if we assume $F_0 = 0$, we shall have the initial tension necessary for adhesion equal to the tension in slack side of rope—that is, $T_2 = T_1$ —but $T_2 = \frac{T_1}{2.46}$ (from $\log \frac{T_1}{T_2} = 0.434 \phi \alpha$, neglecting effect of centrifugal force); therefore the

$$\text{initial tension in the rope is } T_2 = \frac{T_1}{2.46} = \frac{200 d^2}{2.46}.$$

When diameter of rope =

inch	the initial tension =	31½ pounds.
¾	"	45½
1	"	82
1¼	"	127
1½	"	184
1¾	"	250
2	"	325

With a horizontal arrangement of ropes, part of this tension is provided for by the weight of rope itself, but with a vertical drive the weight of rope tends to reduce the initial tension, therefore the actual weight to be placed on the ten-



FIGS. 39 AND 40.

sion pulley will depend upon the arrangement of drive, and must be calculated for each particular case. It is to be noted that with a vertical tension carriage the weight of carriage and sheave must be considered as a portion of the weight producing tension in the rope.

If w equals the total weight necessary to maintain the tension T_2 in each part of the rope leading off from the tension pulley, then when these two portions are parallel, we shall have $W = 2 T_2$; but if the rope leads from the tension pulley so that it includes an angle 2θ between its sides, as shown in Fig. 40, then the weight W will be less, and may be found from $W = 2 T_2 \cos \theta$.

(To be continued.)

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

COMPILED FROM
PRINCIPAL FOREIGN
ELEC. WORLD, N.Y.

ELECTRICAL JOURNALS
BY CARL HERING

ELECTRO-PHYSICS.

Thermo-Electric Cells.—In a note in the Lond. "Elec. Eng.," April 6, some data regarding such cells by Mr. Gockel are given; he confirms the statement that the worst conductors are thermo-electrically the most active and that some show a maximum thermo-electric force at the concentration of maximum conductivity.

Electromagnetic Rotation.—According to the Lond. "Elec. Rev.," April 6, Humburg concludes that the electromagnetic rotation is independent of dissociation; that is, that electrolytic dissociation has no appreciable effect on magnetic rotation.

Conductivity of Solutions.—Some figures by Mr. Holland are given in the Lond. "Elec. Eng.," April 6, for the change of conductivity of a solution by the addition of a non-electrolyte.

Discharges in Gases.—In the Lond. "Elec. Rev.," April 6, there is a short review of a Physical Society paper by Mr. Baly on the behavior of gases under the influence of an electrical discharge; also an article by Mr. Taylor on the "Electrification of Gases and Liquids"; also a brief summary of the results of Dr. Lenard, obtained from his experiments on "Cathodic Rays in Gases."

MAGNETISM.

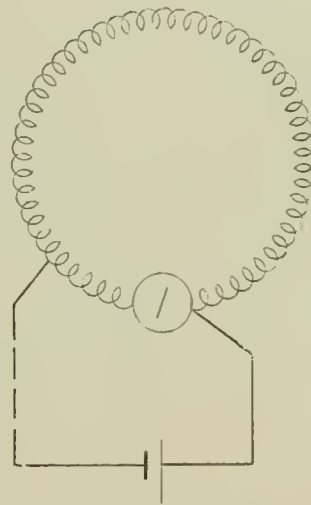
Magnetic Qualities of Iron.—A Royal Society paper by Prof. Ewing and Miss Klaassen is reprinted in the Lond. "Elec.," April 6. The description of the method is given in full in another column of the present issue. A large number of hysteresis curves are given; a curious feature is shown in the relation of the successive cycles to one another, which, however, is of quite general occurrence; the extremity of each cycle lies outside of the rising curve of the immediately higher cycle, provided there is no very great difference in their range of magnetism; it does not happen for the lowest cycle; the first two tests were made with iron wire rings, the results showing how small the loss of energy through hysteresis becomes when the limits of magnetization or of magnetic force are restricted within certain values; the next three tests were made with sheet iron, for which some curves are given; the article is to be continued. In the second part the heating effects of the reversals were investigated by securing a thermo-balance between two equal rings, and was intended to answer the question whether the heating in the core of a transformer is the same when the transformer is loaded as when it is not, the conclusions being that it is the same. The paper is abstracted by Mr. Appleyard in the Lond. "Elec. Rev.," April 6.

Permeability of Oxygen.—Mr. Hennig's researches are described briefly in the Lond. "Elec. Eng.," April 6; he determined the relative permeability of oxygen and air by Toepler's method, which is briefly described; his result is

0.096×10^6 for the difference or the permeabilities reduced to one atmosphere pressure, a result which agrees moderately well with four other determinations which are given.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Universal Galvanometer Shunt.—The Lond. "Elec.," April 6, discusses the arrangement of Ayrton and Mather described in their paper, published in these columns last week.



UNIVERSAL GALVANOMETER SHUNT.

The accompanying cut is given as showing the principle much more clearly, the contact with the permanent shunt being moved round to different parts of it; attention is called to the fact that the main current must be kept constant; an objection to the system is that the definite multiplying powers are not marked as with ordinary shunts. It is remarked that it is not half the main current which passes through the galvanometer if half the wire is intercepted between the battery contacts; the whole of the shunt should theoretically have an infinite resistance as compared with the galvanometer resistance, and the external resistance must be practically infinite as compared with that of the shunt; it is thought that such shunt boxes would not have a very extensive use, partially because of the want of absolute multiplying power, such as 1, 10, 100, etc.; they could be used only with galvanometers of very low resistance, and there would be a doubt about the limits of error when it is desired to measure the main current. An addendum to the paper, published in The Electrical World last week, appears in the same issue and in the Lond. "Elec. Eng." They discuss mathematically whether the change in the resistance of the current is greater with this method or with the ordinary method, and they show that whatever be the values the change will be less in their method; also that if the resistance of the shunt is exactly equal to the galvanometer resistance multiplied by the shunt power, there will be no change whatever produced in the resistance of the circuit. In the discussion Mr. Higgins announced that he had used this system for twenty years; Mr. Crompton suggested that

it would be simpler to use a graduated wire and shunt it, thus making it a potentiometer method, Prof. Ayrton replied that the graduated wire would not answer with galvanometers of a high resistance.

The Mho.—The "Elek. Zeit.," March 29, contains an article by Mr. Teichmüller, an engineer of a well-known German wire company, in which he discusses the various ways in which the conductivity of metals, particularly that of copper, is expressed, pointing out the great want of uniformity; he gives the various figures for pure copper as obtained by different experimenters, showing the difference, and therefore the objection to using pure copper as a basis; it would, besides, introduce a new unit; he discusses the various methods in use for indicating conductivity and points out the objections to each of them, one of the least objectionable being the reference of copper to mercury, and the most objectionable to base conductivities on that of pure copper; he urges that no new unit should be adopted that is not based on the absolute system; he then discusses the term "mho," to which he makes no objections, and which he seems to advocate, urging that before its introduction its use should be clearly understood; specific resistance given in mikrohm centimetres correspond to megamho centimetres, a name which he hopes will soon come into use; numbers given in megamho centimetres and in mhos per metre per square millimetre differ only by a factor of 100, so that no errors need be feared, which he shows by giving a number of corresponding values; 1.6183 mikrohm centimetres (international) are equal to 0.616 megamho centimetres, or to 61.6 mhos per metre per square millimetre. In conclusion, he gives a table of 17 different values in each of six columns, giving for each conductivity the corresponding values in megamhos (international), the per cent. value in terms of chemically pure copper according to Matthiessen, according to Siemens and according to Lagarde, the conductivity in relation to mercury and the corresponding specific resistance in mikrohm centimetres, 100 per cent. Lagarde corresponds to 103.9 Matthiessen, 104.0 Siemens, 0.625 mikrohm centimetres at 0° C., 61.3 as compared with mercury and 1.534 mikrohm centimetres; for 100 per cent. Matthiessen the figures are 96.3 Lagarde, 100.1 Siemens, 0.628, 59.05 and 1.953.

Photometry.—A lecture by Captain Abney is abstracted briefly in the Lond. "Elec. Rev.," April 6; nothing new is given; he recommends the arc as a standard, as it is a light of the same kind; a square inch of the crater would be equal to 284,000 candles; he remarks that at any one moment there is about a millionth of a grain of carbon in a candle flame.

Nickel Plated Instruments.—Dr. Ebling, of the German Imperial Institute, according to an article in the "Elek. Zeit.," March 29, and an abstract in the Lond. "Elec.," April 6, calls attention to the danger of nickel plating delicate electromagnetic instruments on account of the magnetism of the nickel; he finds that nickel plating, even when so thin as to be quite transparent, has a very marked magnetic effect.

DYNAMOS AND MOTORS

Magnet Winding.—In a paper of Prof. Ayrton he states that the resistance of a coil of wire occupying a given form and volume is proportional to the square of the number of turns; and that this is absolutely true, either when the thickness of the insulating covering is negligible compared with the thickness of the copper, or when the ratio of thickness of the insulating coating to the diameter of the copper is constant for each gauge of wire. Examples are given in a Physical Society paper of galvanometers published in the "Phil. Mag.," July, 1890, where some other cases are given in which the power is five halves instead of two. (The law is given in connection with galvanometers, but there appears to be no reason why it does not apply also to magnet coils.)

Theory of Alternating Current Motors.—The "Elek. Zeit.," March 29, contains an article by Dr. Behn-Eschenburg, which is supplementary to his former article, in which he gives an approximate theory, neglecting certain factors; in the present mathematical paper he gives the exact calculation, together with results from which those formulas are deduced; the article is quite long, and is almost entirely of a mathematical nature.

TRANSFORMERS.

Heating of Transformers.—In some researches by Prof. Ewing and Miss Klaassen, described by Mr. Appleyard in the Lond. "Elec. Rev.," April 6, they investigate the question whether the heating in the core is the same when the transformer is loaded as it is when it is not loaded, the conclusions being that the heating is the same in both cases. Further references to this article are given under the heading "Magnetism."

ARC AND INCANDESCENT LIGHTS.

Origin of Incandescent Lamps.—"Ind. and Iron," April 6, publishes a letter by Mr. Maxim which is interesting reading; he claims to have discovered the process of treating the filaments in hydrocarbon vapors, but lost the U. S. patent by a fraud, and that it was due to his testimony that the patent became public property.

Illumination.—Dr. Fleming, in a recent lecture, states that bright moonlight is about one-fiftieth of a candle-foot and diffused daylight from 20 to 40 candle-feet.

ELECTRIC RAILWAYS.

Polarity of the Earth's Return.—In the Lond. "Elec.," April 6, Mr. Dubs states that in connecting the negative pole of a railway circuit to the earth the current will enter water pipes by small amounts all along the line, but will leave it at the nearest point to the station, where the current density may become large enough to produce considerable electrolytic corrosion; if the positive pole is connected to earth there will be no corrosion near the station, while the currents which leave the pipes, being divided over a very large surface, will not produce any appreciable action; the latter was confirmed by the results of a two years' trial with the Marseilles railway, where no difficulty whatever has been found in connection with electrolysis. With the negative pole to earth the protection at the point nearest the station may be obtained by a good, reliable and well insulated metallic connection with the generator and the water pipes.

Weight of Trains.—According to the Lond. "Elec.," April 6, a train of the Liverpool line weighs, when fully loaded, 38 1-4 tons and seats 114 passengers; those on the City and South London line weigh 37 1-3 tons and seat 96 passengers; in the former the weight per passenger is 752 pounds, while in the latter it is 871, due to the fact that in the latter locomotives are used.

Genoa Railway.—A translation is given in abstract in the Lond. "Elec. Eng.," April 6, of the description of the Genoa railway, which differs in a number of respects from the systems as used in this country.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Parallel Working of Long Lines.—The second day's discussion of Mr. Mordey's paper, abstracted in the Digest last week, is given more fully in the Lond. "Elec.," April 6. A written communication from Prof. Forbes giving a mathematical examination of parallel working of alternators having no self-induction is given in the Lond. "Elec.," April 6.

Statistics for Great Britain.—In a recent lecture by Dr. Fleming he stated that there are now 700,000 incandescent lamps in use in London and 425,000 in the provinces; in London there are 13 companies, and in the United Kingdom 60 to 70 towns have a public electric supply. The total length of the underground mains now laid is about 700 miles.

Train Lighting.—The "Elek. Zeit.," March 29, states that the German railways are not ready yet to adopt the electric lighting of trains, partially on account of the greater cost and because they claim that there has not yet been sufficient experience with this system.

Coatbridge Station.—The London journals of April 6 describe this station, which is of interest in that gas engines are to be used entirely, in connection with the alternating system, the gas being made in producers connected with the station. It will give a good opportunity to test the practicability or possibility of running alternators in parallel when driven by gas engines.

Livel Refuse Destructor.—"Ind. and Iron," and the Lond. "Elec. Rev.," April 6, contain articles on this destructor.

WIRES, WIRING AND CONDUITS.

Steamship Wiring.—The discussion in the Lond. "Elec. Rev." is continued in the issue of April 6, in which, however, nothing new is given.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Best Resistance for Receiving Instruments on Leaky Lines.—In an illustrated paper by Prof. Ayrton and Mr. Whitehead, published in the Lond. "Elec. Rev." and Lond. "Elec. Eng." April 6, the subject is discussed mathematically for the case of a single leak, a uniformly distributed leak, and in general leaks following a certain law, the result in all the cases being that "whatever be the nature of a leak on a telegraph line—whether the leak be a single one or be distributed along the line according to any law of distribution—the same rule holds true for the best resistance to give the receiving instrument, viz.: the receiving instrument at either end should have a resistance equal to the apparent resistance of the line when tested from that end and put direct to earth at the other end." It is assumed that the resistance of a coil of wire occupying a given form and volume is proportional to the square of the number of convolutions.

A Sensitive Microphone.—In an article by Mr. Soulby in the Lond. "Elec. Rev.," April 6, he describes a simple form of a very sensitive adjustable microphone; it consists of two blocks of carbon secured to a vertical sounding board and a round cylinder of carbon connecting one with the other and suspended by light threads, the inclination of the sounding board being adjusted so that the cylinder is just in contact; numerous experiments are described showing its extreme sensitiveness; among others it was stated that a rushing sound was heard when the hand was placed on the sounding box, which was said to be that of the rapid circulation of the blood through the veins.

Duplex Telegraphy.—An application of the Mance battery resistance test to duplex telegraphy is described and illustrated in the Lond. "Elec. Rev.," April 6.

Telephone Charges in Europe.—In an editorial in the Lond. "Elec.," April 6, some corrected and supplementary figures are given.

Railroad Signals.—An article by Mr. Prash describing, with the aid of a number of illustrations, a new controlling signal system for railroad signals is published in the "Elek. Zeit." March 29.

ELECTRO-CHEMISTRY.

Purification of Sewage.—A brief abstract of Dr. Kelly's report of the Wortling tests is given in the Lond. "Elec." April 6. Chemically, the electrolyzed sea water contained only one-sixtieth of the equivalent of chlorine that exists in a saturated solution of ordinary bleaching powder; in two days' standing 5 per cent. of the strength of the solution disappeared; it does not contain free chlorine, nor does it give an acid reaction; when compared with a strong solution of bleaching powder, it will not act as powerfully—neither in reducing the offensive odor, nor in the breaking up of the solidity of the sewage, nor in corroding the vessels; copper, brass, bare and galvanized iron were appreciably corroded,

but there was no effect on cements. The bacteriological experiments show that the Hermite process, as there carried out, is incapable of sterilizing sewage; cultures in gelatine of the ordinary sea water, the Hermite fluid and the freshly treated sewage gave the following results: Bacilli in great numbers were found in the ordinary sea water, but the Hermite fluid proved to be perfectly sterile, showing that direct electrolysis caused sterilization; the freshly treated sewage produces enormous colonies of microbes. It concludes that the Hermite process is not a success.

Mr. Cooper for Mr. Hermite claims that these conclusions are utterly opposed to results found by many of the most eminent experts, and that he believes that there must be some mistake in taking the samples. The report is published in full in the Lond. "Elec. Eng." April 6, and contains considerable data.

Electrolytes and Non-Electrolytes.—In a brief mention in the Lond. "Elec. Rev.," April 6, of some experiments of Mr. Jones it is stated that he was led to the unexpected conclusion that non-electrolytes exhibit abnormal depressions of a character similar to those of electrolytes.

Nickel Plating.—The "Elek. Zeit.," March 29, reprints about a dozen different recipes for good nickel baths, collected from different sources and intended for various purposes.

MISCELLANEOUS.

Electro-Physiology.—"La Nature," March 10, contains a well illustrated article by Mr. Guillaume, a translation of which, together with all the illustrations, is given in the Lond. "Elec. Rev.," March 23. It describes the recent experiments of Dr. d'Arsonval, which, it is claimed, form a counterpart of Tesla's experiments; the apparatus is simpler and produces less powerful effects, but it is within the reach of all laboratories; it is claimed that the physiological actions of currents of all frequencies were solved in France long before Mr. Tesla's publications in America. Such currents are produced by connecting the secondary of a Ruhmkorff coil to the inner coatings of two Leyden jars, the discharge between the two balls of which is oscillatory; the ends of a short coil of 10 spirals of thick wire are connected to the outer coatings of the jars, and in these currents of high frequency are generated; if a wire short circuits this coil long sparks are produced at the junction; if the short circuiting takes place through the body there is no shock, not even the slightest tingle; to show that this current passes through the body, the body may be connected through an incandescent lamp, which lights up brilliantly; the current is said to pass over the surface of the body, and while there is some truth in this, it is not the only cause of its harmlessness; Dr. d'Arsonval has shown that the neuro-muscular phenomena increase with the frequency up to 3,000, remain stationary to 5,000, and then decrease and cease altogether; a frog's leg is insensible to Hertz's alternator; if the current is closed through the hands, the skin becomes insensible, which lasts from a few minutes to half an hour; if the body is insulated and only one pole held, heat is produced, accompanied by copious perspiration, and considerable vascularization of the cutaneous surface; if a little wound is made in the foot of an animal, so that the blood escapes by drops, the hemorrhage becomes very abundant under this current, showing that there is a powerful force at work to dilate the vessels; the current passes through the body, but the nerves have become insensible. He has shown that death from alternating currents is due, in the first place, to asphyxia, and that artificial respiration may be resorted to, and in the second place the excessive heat produced by the muscles brings about the coagulation of the blood; by an illustration he shows that a series of lamps may be lighted with a current passing through the body; a lamp connected with a ring of copper placed on the head may be lighted by a coil placed around the head somewhat

lower, an experiment which is said to show that the head is traversed by similar currents; in another illustration the terminals of the lamp are held in the hand, which, with the arms, forms a circle around the solenoid; in another experiment the lamp is similarly held by a person placed inside of a large solenoid. To measure the relative intensities of these currents he passes them through a small solenoid around a mercury thermometer, the reading of which is said to be proportional to the current if the frequency does not vary too much.

Electricity in Pipe Laying.—The Lond. "Elec. Rev.," April 6, describes briefly the application of a sort of locomotive of three-horse power, which was used in Paris in the laying of water pipes of very large diameter and weight, in underground culverts; the pipes were lowered through the man-holes on to the locomotive, on which they were then carried through the tunnel to the proper places; the locomotive was run with 40 accumulators; a steam locomotive would not have been applicable without special means of ventilation, and then only with great inconvenience.

Formation of Amalgams.—According to a note in the Lond. "Elec. Rev.," April 6, the manufacture of amalgams may be greatly facilitated by the influence of high tension electricity, such as that from Leyden jars; it was found that the per cent. of amalgam formed was more than three times as great when such currents were used as when no current was used.

Electrical Exhibition.—According to the Lond. "Elec.," April 6, it is proposed to hold an international electrical exhibition in Paris in 1895, to be opened in July; it is to be held in two large exhibition buildings in different parts of the city, placing the generators in one and the motors in the other, and connecting the two by electric railways and electric launches.

Exhibition Report.—The "Elek. Zeit.," March 29, announces that the final report of the expert tests made at the Frankfort International Exhibition of 1891 has at last been published. No data are given in that notice.

Suggestions for Transit Systems.

BY S. D. MOTT.

There is a persistent municipal opposition to poles, wires or electric conductors of any kind on or over the streets of most American cities. This, as most of us know, was brought about originally by reason of the fatal accidents due to the existence of old, dilapidated wires, in many instances not in use, and which should have been removed, forming circuits with the heavy currents necessary to the

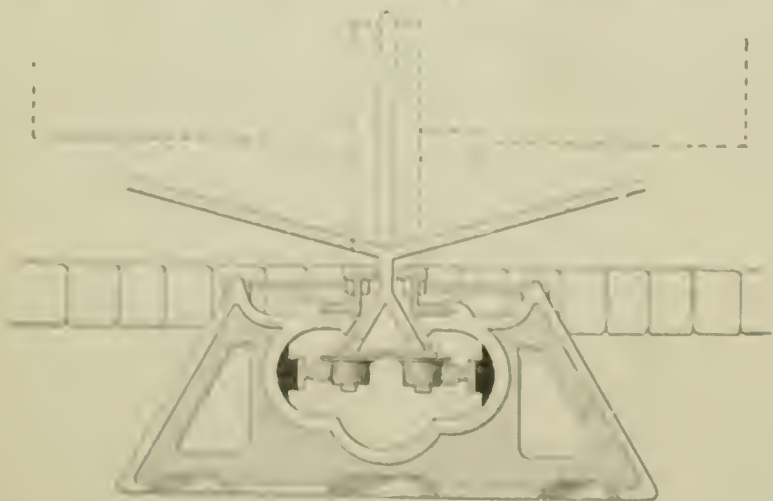


FIG. 1.

commercial introduction of electric lighting and power transmission. Be the causes what they may, and there are others contributing to this crystallized common sense, the "deadly trolley" and the assumed equally dangerous charged rail when street traction schemes are under consideration, the scoop net premiums offered by interested

corporations, etc., indicate a public demand for a departure from the present established system of city surface transit and a more satisfying solution of a pretty tough problem

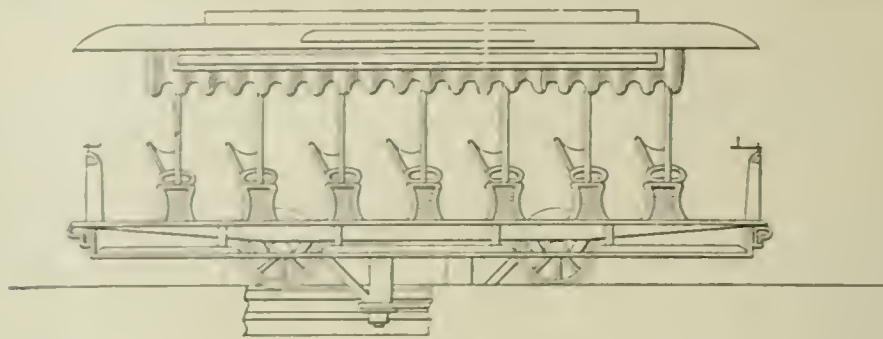


FIG. 2.

at best, when the exacting conditions of service are considered; something, anything that will make electric traction what it ought to be, and I believe will be, when its period of evolution has passed, the most perfect system of land propulsion ever devised by the mind of man. The accompanying sketches suggest a system of street surface lines

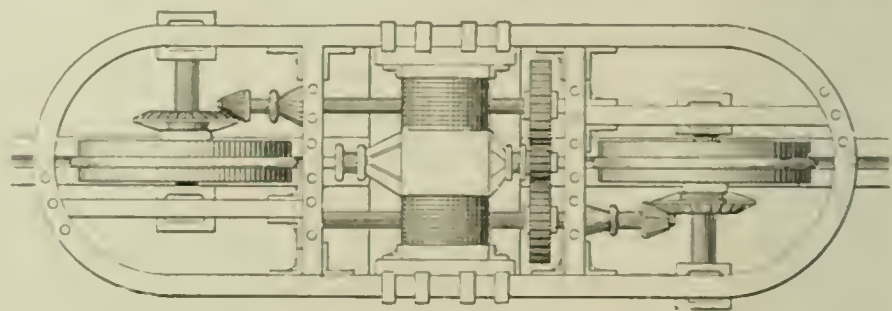
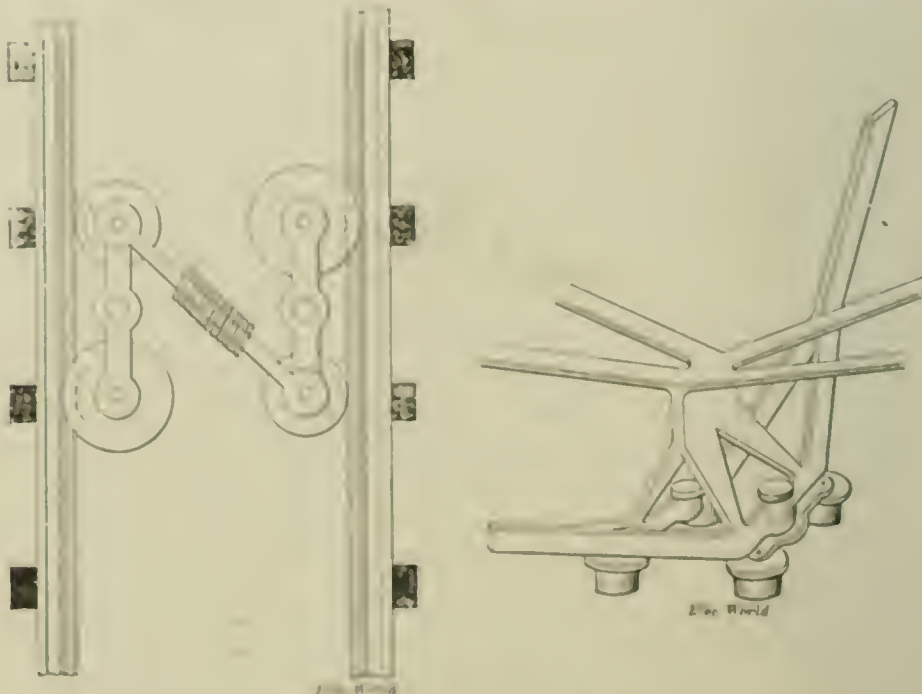


FIG. 3.

which has marked characteristics—I may add, too marked, and the proposition too much of an innovation to meet with business encouragement—but I believe that a street system built substantially on these lines is practicable.

The ideal characteristics mentioned are an entire absence on the street of rails (as such), poles, lines, or electric cur-



FIGS. 4 AND 5.

rent; phenomenal conditions; can they be realized? They can certainly best be realized when using electricity as a motive agent.

I venture the prediction that the engineering world will have their ideas modified before a great while respecting the principles governing, as also advantages accruing from, what may be described as bicycle propulsion.

We have bicycle surface lines on a restricted scale at present, both steam and electric, for long distance service, why not a bicycle street system? The drawings attempt to show such a system, and although they are some nine years of age, I take it they are sufficiently clear to need no careful detail description.

The two or more supporting and guiding wheels are made with a centre flange and double tread, and are fashioned wide and strong. The lateral support of car, such as is needed when at a standstill, is furnished by the horizontal sub-surface rails (Fig. 1) within the conduit, which rails are also the working conductors.

The trolley wheels are mounted with the idle wheels and coiled spring in such a way as to give a certain amount of flexible lateral play and at the same time always keep their contact. The harder the trolley is forced to the right from any cause the more firmly the collector on left is pressed against the conductor and vice versa. This will be readily understood by inspection of Fig. 4. Fig. 1 is a cross-section of roadbed showing the arrangement of conduit, shape of

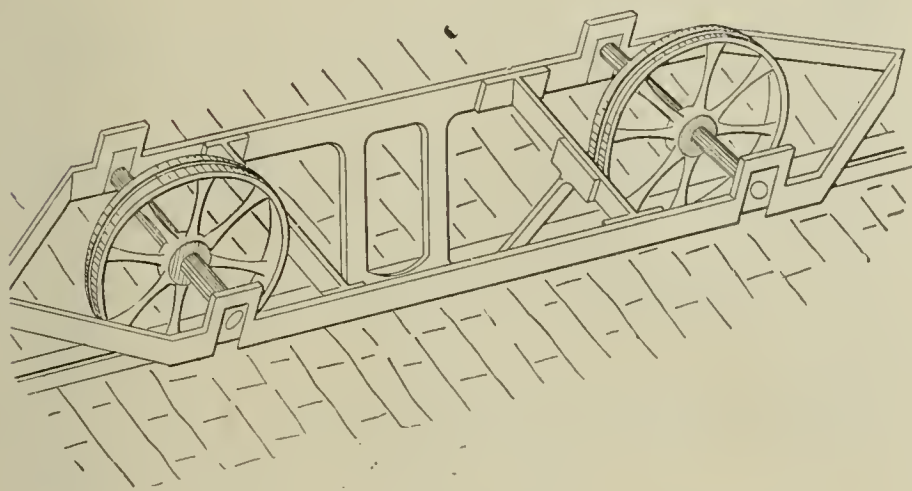


FIG. 6.

rails, and position of sub-surface devices, etc. Fig. 2 is a side elevation of car showing its general appearance equipped for service with part longitudinal section view of the conduit.

Fig. 3 is a plan view, showing a car equipped with a double driving motor and its reducing gear. Fig. 4 is a plan view of twin trolley or collectors.

Fig. 5 is a perspective view of a form of plow and collectors, and Fig. 6 is an isometric perspective of rolling stock without the car equipment.

This system should operate with far less friction than the ordinary road, besides the advantage gained from absence of street obstruction and disfigurement, and it should take curves more naturally and with less friction by proper alignment of roadbeds than the ordinary broad gauge vehicle.

Tests of Car Heaters.

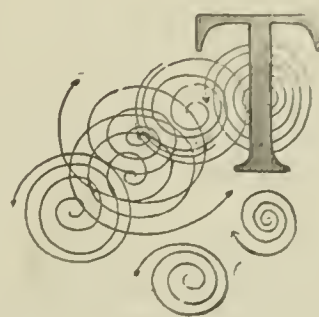
The Atlantic Avenue Railway Company during the month of February made a number of tests on electric car heaters in cars of different construction, and we are enabled to give some of the data in the table below:

Cars.			Temperature.— Fahrenheit.		Wind. Velocity, miles.	Electrical Data.—		
Doors.	Side windows.	Contents, cu. ft.	Outside.	Inside.		Volts.	Amperes.	Watts.
2	12	850.5	28°	51°—59°	25	433	5.3	2,295
2	12	850.5	7°	34°—44°	28	436	5.3	2,325
2	12	808.5	28°	47°—52°	25	436	5.0	2,180
2	12	913.5	35°	40°—64.5°	3	431	6.3	2,745
4	16	1,012.37	7°	41°—50°	28	422	7.2	3,038
4	16	1,012.37	28°	48°—60°	25	427	7.24	3,160

Four electric heaters were used in the first three cars on the list and six in the others, connected in series in each case. The temperature is that shown by a thermometer in the centre of the car. The average temperature is somewhat higher than the mean of the maximum and minimum temperatures given, particularly in the case of the fourth car, in which the temperatures did not fall below 51 degrees after the first half hour. The time of the trips during which the above data were taken varied from one hour to two hours and twenty-five minutes. The heaters used were those of the Central Electric Heating Company.

The Calculation of Alternating Current Motors.—VIII.

BY E. ARNOLD



THE coefficients b_1 and b_2 have regard to the leakage. All the lines of force which do not cut the windings of the armature or inductor, A , do not assist in the creation of a torque. Leakage takes place at the outer circumference of the field, F , as well as at the side surfaces; furthermore, part of the lines pass through the iron pieces, which enclose the wires and do not keep the induction in the armature. In Fig. 17 this leakage is indicated by dotted lines. Part of the lines of force pass through the air space δ , without cutting the windings of the armature. The leakage is larger the greater the induction B , the greater the air space δ , and the greater the

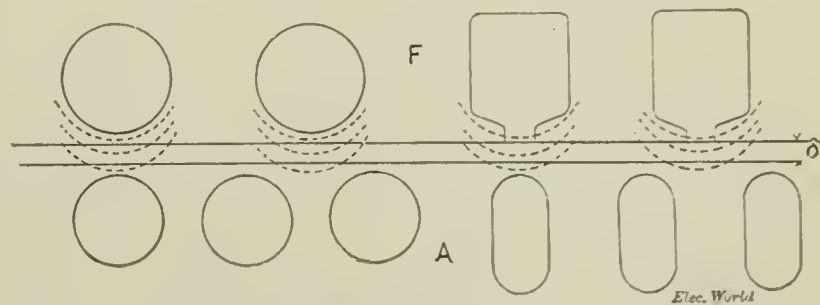


FIG. 17.

saturation of the iron core. We put $b_1 b_2 = b$, and obtain from equations (87), (85) and (82) the following *important equations for the calculation of a motor*:

$$\bar{E}_2 = b \frac{N_2}{N_1} \bar{E}_1 v. \quad (88)$$

$$I_2 = \frac{b}{R_2} \frac{N_2}{N_1} \bar{E}_1 v. \quad (89)$$

$$W = b^2 \frac{S_2}{R_2} \frac{N_2^2}{N_1^2} \bar{E}_1^2 v (1 - v). \quad (90)$$

$$R_2 = b^2 \frac{S_2}{W} \frac{N_2^2}{N_1^2} \bar{E}_1^2 v (1 - v). \quad (91)$$

$$\bar{D} = b^2 K \frac{S_2}{R_2} \frac{N_2^2}{N_1^2} \bar{E}_1^2 \frac{v}{p_1}. \quad (92)$$

$$n_2 = \frac{50 n_1}{K} (1 - v). \quad (93)$$

These formulae are simple and intelligible. For $v = 1$, the relation between the secondary and the primary potential is, according to equation (88), the same as with a transformer, equal to the transforming ratio multiplied by the coefficient of the fall of potential, b . With a definite slip, v , assumed beforehand, the current strength in the armature and the output in watts of the motor can be calculated from equations (89) and (90). But as the output in watts is usually given also, the resistance R_2 , belonging to one phase of the armature is found from equation (91). As follows from

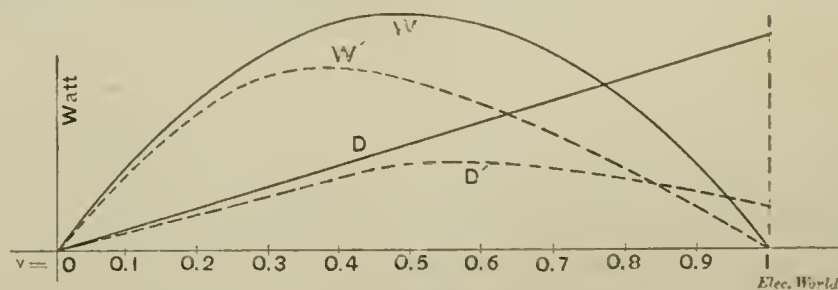


FIG. 18.

the equations, the watt output becomes a maximum for $v = 0.5$ and the torque for $v = 1$, supposing that b does not change. If we set down the values of the slip as abscissae and the watts as ordinates, under the supposition that $\bar{E}_1$ is constant, the values of the torque and the output of the motor will change with the ordinates of the curves D and W

Fig. 18. For greater values of v , or the difference $(p_1 - p_2)$, however, the term $(p_1 - p_2)^2 \left(L_1 \frac{v^2}{2} \right)$ in equation (81) is not to be neglected, and the value of b diminishes with increasing slip. The curves W and D will, therefore, take a course which may about coincide with the dotted lines. In practical cases, moreover, E_1 does not remain constant, and the curves W and D will, therefore, fall away toward the axis of abscissae even more rapidly.

As seen from equation (90), the slip for a given output of the motor can be made to vary by changing the resistance R_2 or the primary potential E_1 . It is, therefore, possible, by altering these values, to regulate the speed of the motor. This regulation can reach from the position where $p_2 = p_1$ only as far as the torque increases. Had we a perfect rotary field, and were b constant, a speed regulation nearly from $p_2 = p_1$ to $p_2 = 0$ would be possible. Through the influence of the variation of b and the presence of periodic fields, the maximum of the torque does not lie at the place where $v = 1$, but appears shifted toward the position where the value of $v = 0$. The more the leakage increases with the slip, the greater the self-induction of the armature; the more strongly the periodic fields are developed and the more the potential E_1 falls off, the nearer the maximum of the torque will lie to $v = 0$.

In dependence upon the current strength, there result the following equations, with the same approximation:

$$D = \frac{m^2 s_2 p_1 M^2 I_1^2}{4 R_2} v. \quad (92 a)$$

$$W = \frac{m^2 s_2 p_1 M^2 I_1^2}{4 R_2} v (1 - v). \quad (90 a)$$

The *watt loss* in the armature is

$$W_s = s_2 R_2 I_1^2;$$

the *watt loss* in the primary windings,

$$W_p = m R_1^2 I_1^2.$$

If we designate the losses due to hysteresis, Foucault currents, friction of bearings and air resistance by W_h , the efficiency of the motor becomes

$$\eta = \frac{W}{W + W_s + W_p + W_h}. \quad (94)$$

THE CALCULATION OF THE EXCITING CURRENT AND OF THE LOAD CURRENT.

The relation of the exciting current to the current at full load is the factor which characterizes the value of a non-synchronous motor. Letting I_ω represent the useful current, or that which would, without shifting of phase, deliver the watts consumed by the motor, and I_0 the exciting current, we have

$$I_\omega = \frac{W}{\eta m E_1}. \quad (95)$$

The load current

$$I_1 = \sqrt{I_0^2 + I_\omega^2}. \quad (96)$$

$$\cos \phi_1 = \frac{I_\omega}{\sqrt{I_0^2 + I_\omega^2}}. \quad (97)$$

If the primary E. M. F. be kept constant, the output of the motor will regulate itself, not, as in direct current motors, by the change in I_1 alone, but as I_0 remains constant, by a simultaneous alteration of the phase-shifting ϕ_1 , as Fig. 19 shows for two strengths of current I_0 and I_1 .

The output of the motor is fixed by I_ω , but in the consideration of the primary copper, the conductors and the generator I_1 is determinative. If, therefore, in an alternating current motor plant the conducting network and generators or transformers are not to be overloaded with useless currents, the motors must be constructed for small exciting currents, for otherwise the usefulness of the whole plant would become questionable. The shifting of phase must be taken

into account in designing the conducting network and the generator.

In order to keep the exciting currents small, a narrow air space, δ , and low magnetic saturations are to be chosen. As the number of ampere turns per one centimetre of the circumference of the field is limited on account of increasing

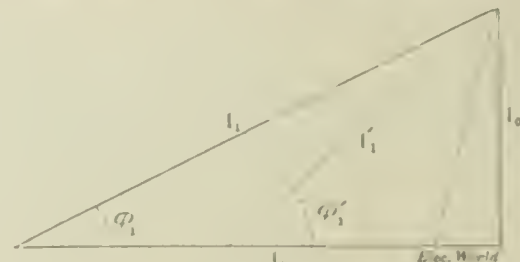


FIG. 19.

leakage, low saturations can be reached only by enlarging the dimensions of the iron of the motor. The attainment of low exciting currents is therefore substantially a question of cost.

With motionless armature and open armature windings, the motor will take up only the exciting current. But when running with no load, the current differs little from the exciting current, I as ω is very small in this case. We find, therefore, from equation (73) that the exciting current, when $p_2 = p_1$, is

$$I_0 = \frac{2 E_1}{m p_1 L_1}. \quad (98)$$

For rotary current motors $m = 3$, and

$$I_0 = \frac{E_1}{3 \pi n_1 L_1}. \quad (99)$$

According to Fig. 16, letting

U be the circumference of the armature in centimetres.

$F_1 = 0.85 h_1 l_1$, the effective cross-section of the iron of the field.

$F_2 = 0.85 h_2 l_2$, the effective cross-section of the iron of the armature in squared centimetres.

δ = the air space in centimetres.

$F_0 = \frac{U l}{4 K}$, the cross-section of the air space per magnetic circuit.

l_1 approximately $= \frac{U}{2 K}$, the course of the lines of force in the field iron.

l_2 approximately $= \frac{U}{2 K}$, the course of the lines of force in the armature iron.

K , the number of pairs of poles.

Then will

$$L_1 = \frac{2 \pi N_1^2}{10^9 K \left(\frac{2 \delta}{F_0} + \frac{l_1}{\mu_1 F_1} + \frac{l_2}{\mu_2 F_2} \right)}. \quad (100)$$

The value of μ_1 and μ_2 can be calculated from any magnetization curve, as

$$\mu = \frac{\text{induction per square centimetre}}{\text{magnetizing force}} = \frac{\mathfrak{B}}{\mathfrak{H}}.$$

According to my tests, equation (99) gives results agreeing almost exactly with the experiments.

The current without load, or exciting current, can be determined in yet another way, though with less certainty, by basing the calculation on the intensity of the rotary field, according to equation (85). Representing the magnetizing forces for the field and armature iron, respectively, by H_1 and H_2 , which are to be taken from a magnetization curve, there will result, since the number of ampere turns =

$$\frac{1}{2} m I_0 N_1.$$

$$I_0 = \frac{1}{6} \frac{K (2 \delta \mathfrak{B} + \mathfrak{H}_1 l_1 + \mathfrak{H}_2 l_2)}{m N_1}. \quad (101)$$

As the number of poles, $2 K$, grows with the number of cycles, n_1 , the speed of the motor remaining constant, it can

be seen that the current, when running without load, must increase with the number of poles, and therefore with the number of cycles. This influence of the number of poles can be most effectually met by having smaller strengths of field, or relatively, by increasing N_1 .

If I_0 is calculated and I_ω determined from equation (95), the load current, I_1 , will follow from equation (96).

The load current thus calculated will be somewhat smaller than the actual one. This is in consequence of the leakage increasing with the current strength, whereby the primary shifting of phase is made larger (vide equation (104)). Letting I_1' represent the actual load current, we shall have with close approximation

$$I_1' = \frac{\sqrt{I_0^2 + I_\omega^2}}{b^2}. \quad (102)$$

If I_0 and I_1 be observed and I_ω calculated, the corresponding value of b can be derived from the above equation.

If the shifting of phase ϕ_1 be altered by apparatus which does not belong to the motor, equation (102) does not hold good. It shows, however, the influence of the leakage.

(To be continued.)

Improved Tandem Compound Engine.

The M. A. Green automatic cut-off engines, manufactured by the Altoona (Pa.) Manufacturing Company, have established a deservedly high reputation, and in this issue we illustrate the tandem compound type.

One of the important features of this type is that both pistons can be removed by merely taking off the low pressure cylinder head and the nuts that hold the intermediate or packing head in position. It is not necessary to remove the low pressure piston from the rod or disturb any part of the valve gear or displace the cylinders.

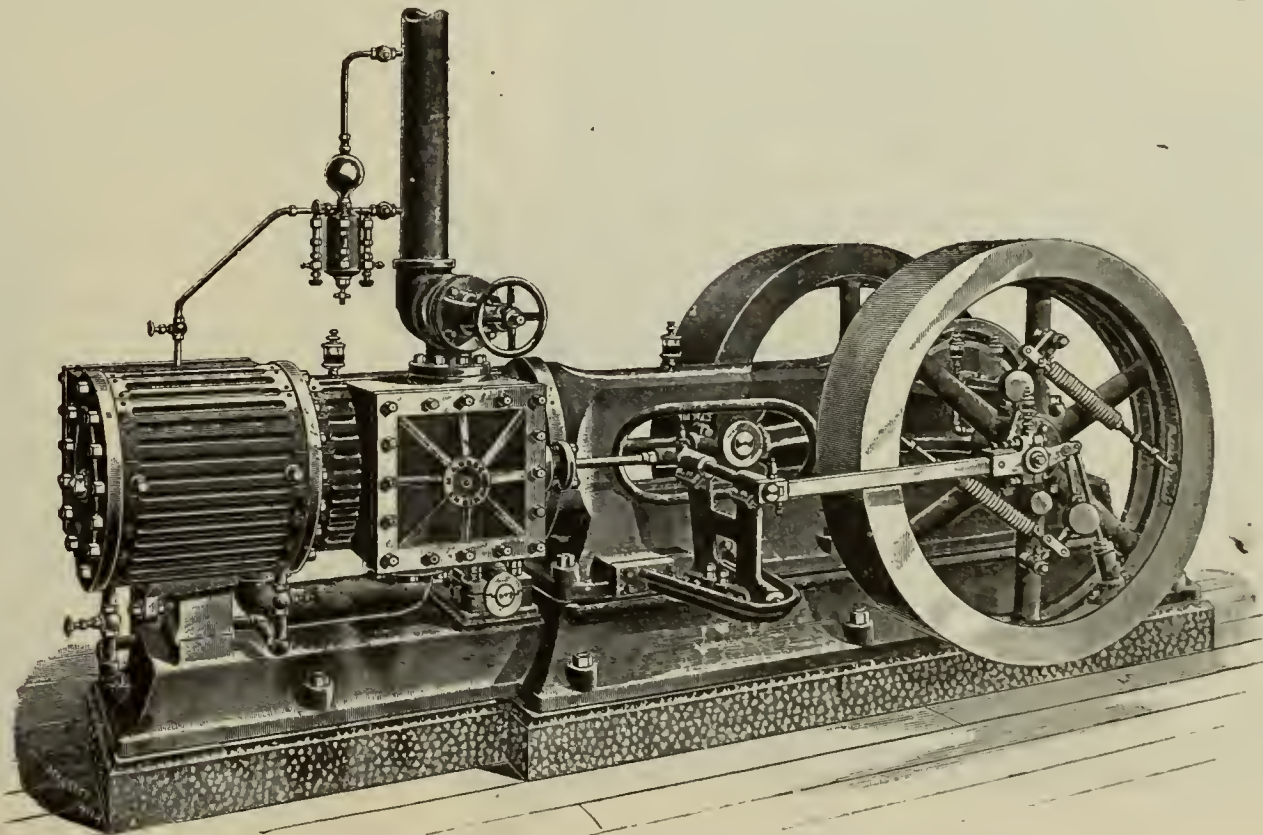
Another valuable feature is that there are no stuffing

is made for the natural shrinkage of the babbitt shells, so that they may absolutely fit the main bearings on the outer and inner diameters, requiring no spotting or fitting. The smooth surface on the babbitt is thus retained as it comes from the moulds, experiments having shown that the surface or skin produced on the babbitt by casting them in smooth moulds wears much longer and smoother than if that portion of the babbitt were scraped off.

The valve is remarkable for its simplicity and ease of operation, being as perfectly balanced as a piston valve and at the same time is at liberty to leave its seat, even more easily than an ordinary "D" slide valve; for the moment the pressure in either cylinder increases a small percentage over that of the steam pressure, the valve will rise, thus relieving the pressure and resuming its seat as soon as the pressure again becomes normal.

The governor of this engine will, under wide variations of load, regulate within 1 per cent., and much closer if desired. The parts of the governor have anti-friction bearings, which do away with the annoyance of oil. The main bearings also have oil receivers, which return any drippings of oil back into a reservoir in the bed. The discs are completely covered with a hood, so that the engine is absolutely free from the annoyance of throwing oil. It will be noticed that only the high pressure cylinder valve is operated by a governor, while the low pressure valve is operated by an adjustable eccentric, which has a constant cut-off of from one-third to three-quarters. Experiments have shown greater economy and smoother running with this arrangement than if the low pressure valve were operated by an automatic governor.

The crank shafts are made from a fine quality of forged steel, and the cast iron discs have heavy counterbalances, so as to thoroughly balance the weight of the reciprocating parts, and are bored true and thoroughly fitted to the arms



TANDEM COMPOUND ENGINE.

boxes between the two cylinders. The packing that is in the middle head is a newly designed double metallic packing, which will last from four to five years and require no attention whatever. The stuffing box on the high pressure cylinder is also packed with a new improved metallic packing, which will last about the same length of time.

The bearings are bored by a special boring mill, which insures the utmost accuracy in the alignments. Special babbitt shells are used for the main bearings. The centre core of the mould for casting the shells is increased a fraction in diameter over that of the shaft, and the outer shell of the mould is also a fraction larger. By this method allowance

of the crank shafts by an improved method, which produces a practical fit, bolts or babbitt or similar expedients not being used for this purpose. The shaft is extra large in diameter, and has long bearings; the crank pin is the full diameter of the shaft, and all the bearings are ground true.

The connecting rod does away with bolts and keys on the centre crank engine, enabling a bevel block to be used to make the adjustment with one screw. This block being the full breadth of the rod, not only forms a firm backing, but admits of nice adjustments. The wheels have extra heavy rims with split hubs. This removes all danger of breakage of wheels by unequal shrinkage, and further enables the shaft

to be clamped more thoroughly, and the heavy runs insure smooth rotary motion.

Through one of the annoying accidents that sometimes occur in a printing office, some copies of our last issue were run off the press with the wrong illustration accompanying the description of this engine in that issue.

Mechanical Stoker.

While in recent years the land steam engine has been vastly improved, the consumption of water per horse power having been reduced from over 30 to as low as 15 pounds in some of the most economical types, proper attention has not been given to the boiler room. With even the most economical type of engine, no better results may be attained in fuel consumption than with an ordinary cheap engine if in the latter case proper attention is given to the method of feeding fuel into the furnace. The ideal method of firing a boiler is by mechanical means, because the fuel can only thus be supplied in exact accordance with the requirements for economy, and provisions made in conformity with scientific principles for its proper combustion. As a consequence, we are always pleased to refer to improvements in stoking apparatus, and we illustrate herewith the Jones underfeed mechanical stoker, manufactured by the Jogada Furnace Company, Portland, Ore., which possesses several features of interest.

Fig. 1 shows the working parts of the stoker, but with the hopper not in position over the opening for it that is shown. Fig. 2 shows the ram which forces the coal into the furnace. The part of the stoker shown in Fig. 1 only occupies about a third of the width of the furnace, and grate bars are laid on each side, one of the bearing bars upon which the ends rest being shown on the side. The coal is forced by the ram along the central channelway, and the top of the fuel gradually falls over on either side to the grate bars. A blower furnishes the air necessary for combustion at a pressure of about four inches of water, entering the central mass of coal through openings or tuyeres.

To explain the operation of the stoker, we will commence with no steam on the boiler. The retort is first filled with coal, level with the top of the tuyere pipes, and fire then started on the side grates as usual until steam is raised. The ash pit doors that admit air to the side grates are then

bright, clear fire, free from smoke, and the complete consumption of the fuel. The retort being practically airtight from below, and the fuel being in a compact mass in the retort, the air will find its way in the direction of the least resistance, which is upward, and consequently combustion takes place only above the air slots, so that the castings of the retort are always cool and not subject to the action of the fire. The incoming fresh fuel from the retort forces the resulting ash and clinker over the top of the tuyere pipes, on to the side grates, from whence they may be removed at any time without in the least interfering with the fire in the centre of the furnace. A heavy body of coke is at all times car-

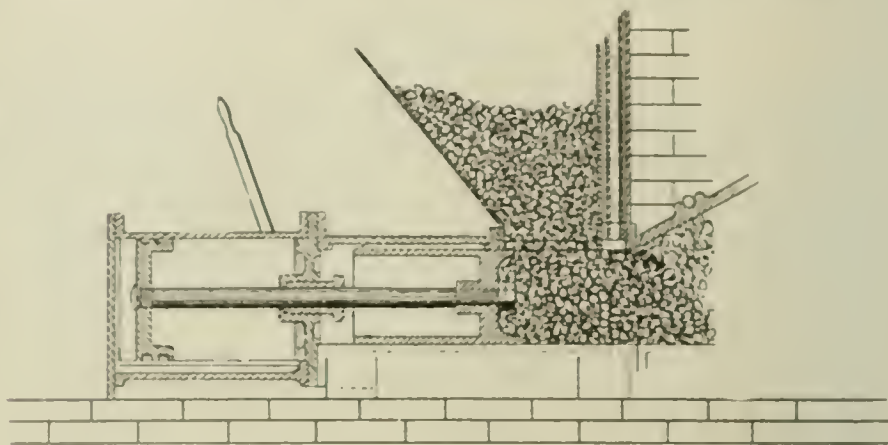


FIG. 2.—MECHANICAL STOKER.

ried in the furnace, and the amount of coal consumed regulated entirely by the quantity of air forced in the furnace. The furnace is never charged with more than 100 pounds of coal at a time, it being better to put in small charges and at as regular intervals as possible, thereby giving the coal ample time to coke before being forced above the air slots and into the fire.

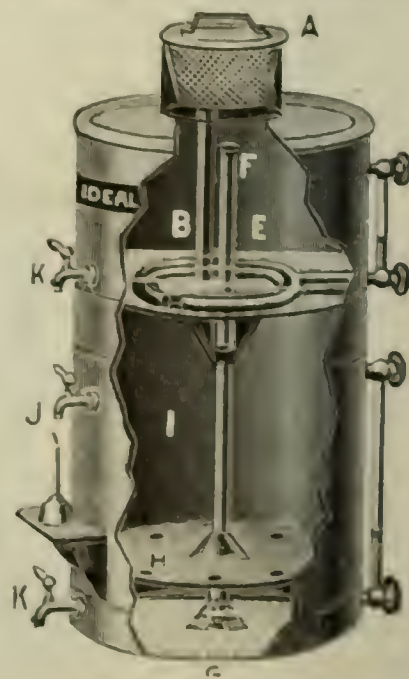
Purity Oil Filter.

The oil filter we illustrate, manufactured by the Purity Oil Filter Manufacturing Company, 90 Water street, Pittsburgh,



FIG. 1.—MECHANICAL STOKER.

closed, and the coal is placed in the hopper outside of the boiler front. The steam ram is then withdrawn by shifting the lever, when the desired quantity of coal falls from the hopper in front of the ram, and upon the return stroke is forced into the retort. Air under pressure is next admitted into the tuyere pipes, which issues through slots over the top of the fuel in the retort, but under and through the burning fuel. The result is that the heat from the burning fuel over the retort slowly liberates the gas from the green fuel, and being thoroughly mixed with the incoming air before it passes through the burning fuel above, results in a



OIL FILTER.

Pat. and known as the Imperial Ideal Steam Oil Refiner, is a well designed oil purifier based upon correct principles.

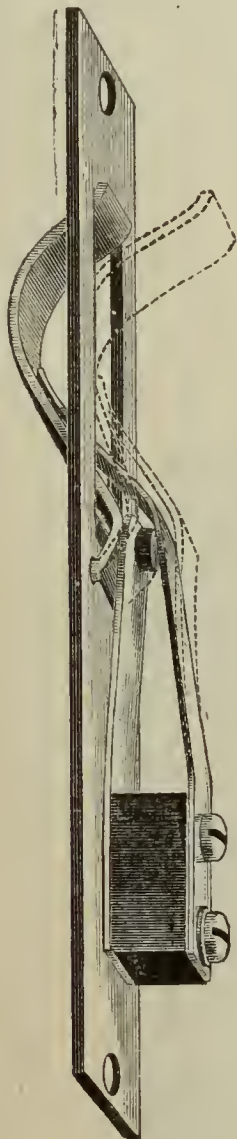
The refining chamber sets on top of the storage or purified oil chamber, giving it the appearance, when in operation, of an oil tank. As each day dirty or drip oil is poured into the refining chamber, the oil previously there is raised, as the dirty oil is the more dense. When the chamber is filled, the lightest and purest of the oil is on top. During the filling of this chamber, the oil is subjected to a little steam heat, which so reduces its viscosity that all matter heavier than the oil sinks to the bottom. As the drip oil is

poured in, the purified oil overflows at pipe *F* and passes to the bottom of the purified oil chamber, rising through water again. When the oil reaches the faucet, *J*, it is as cool as the air around the shell and ready for use again.

In ordinary steam purifiers or filters, the oil is liable to be found boiling when wanted for use, with all the air cells burst, thus destroying its lubricating qualities. Even should the oil in this filter boil and burst the air cells, it becomes reoxidized and cooled as it passes from one chamber to the others through the air, as it is four or five days from this time until it reaches the faucet for use. The pan, *H*, in the purified oil chamber is for the purpose of catching all precipitation that may occur during the time the oil is cooling. When the refining chamber is lifted off, the pan can be drawn out slowly without emptying the cooling chamber, bringing all dirt from this part, thus enabling it to be kept clean. The oil is passed through nothing but water, and consequently there is no expense for filtering material.

A New Window Spring.

The window spring illustrated below is the latest production of Messrs. Geary & Mossep, and is now being manufactured by them in the factory of the Arnold Electric Company, at Chester, of which Craig R. Arnold is the selling agent, with offices at Chester and 308 Walnut street, Philadelphia.



WINDOW SPRING.

The great trouble heretofore experienced in the manufacture of such a simple device as an electric window spring has been their unreliability on account of rust and corrosion of the contact parts. They have been of such irregular shapes that more or less difficulty is experienced in fitting them into the window frames, and heretofore considerable movement of the window has been required to make contact in the spring on account of the great movement necessitated by the design of the tongue or circuit closing part.

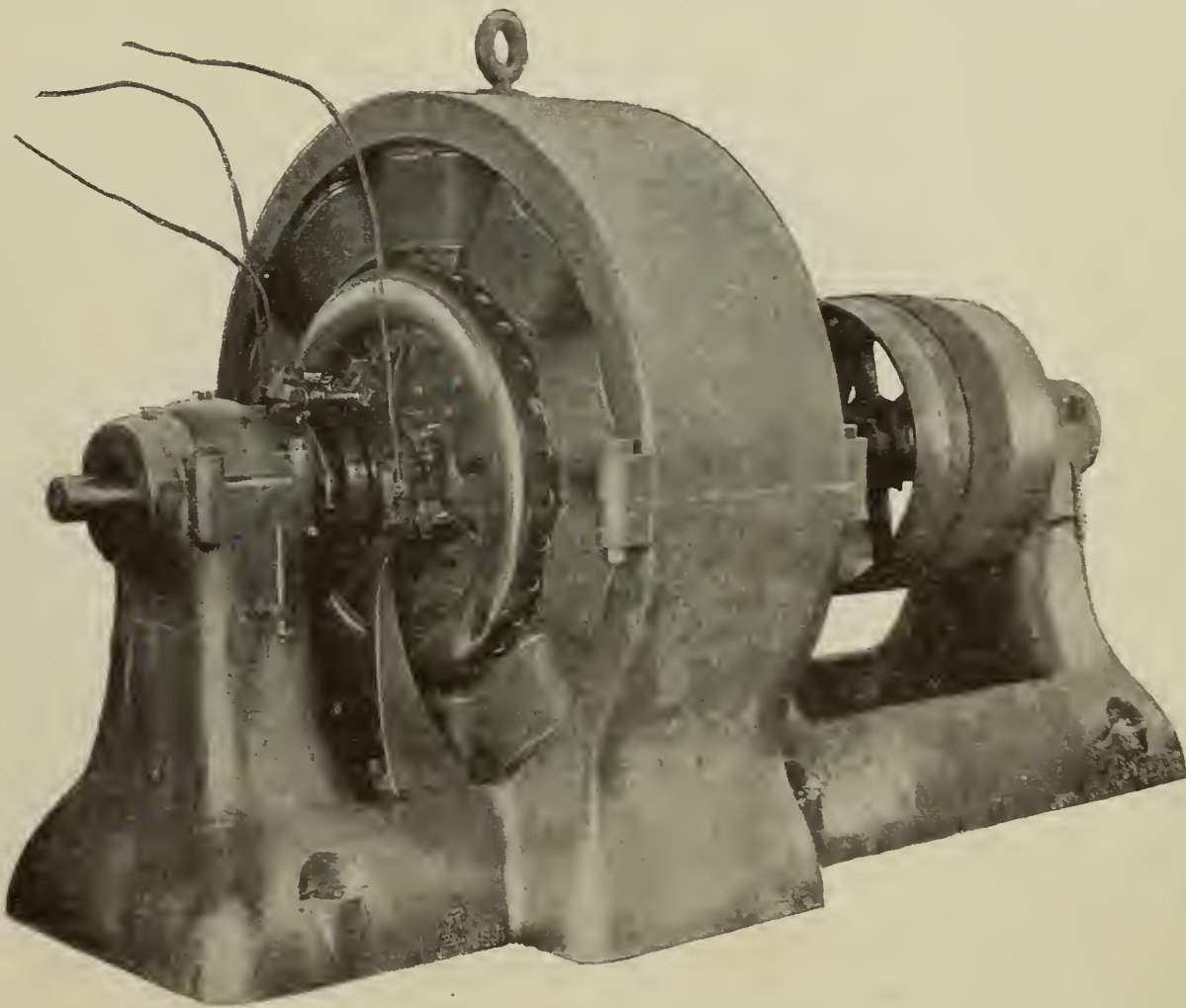
In this spring brass screws are used, and the springs are made out of a high grade of German silver, thereby over-

coming the features of rust and corrosion. It will be seen from the cut that the tongue is made to hinge on the frame by two little extensions or lugs engaging in two holes in the frame. This construction admits of the tongue being removed and a new one substituted without the use of any tools or the removal of any pins or screws.

New Three-Phased Apparatus.

The apparatus employed by the General Electric Company in its three-phased power transmission work has all been designed with a view to obtain high commercial efficiency and close regulation. The illustration shows a 300 kw. three-phased generator. The armature and field coils are all highly insulated, so that the danger of accidents is reduced to a minimum, and fairly high voltages may be used with the certainty of obtaining a thoroughly reliable machine. The bearings are self-aligning and self-oiling, and the armature being carefully balanced upon rigid supports, the machines run with scarcely a tremor. The magnetic circuit and the windings are so proportioned that the machines run exceptionally cool and require little or no attention to the rheostat, even under considerable changes of load.

In the large direct driven machines, and in all cases in which light weight is essential, the magnetic circuit, aside from the armature, is of cast steel. The standard periodicity employed is 60 cycles per second, or 7,200 alternations per minute. This is sufficiently high to permit the use of incandescent and arc lamps and the employment of all standard transformers. It is also low enough to allow the



THREE-PHASED GENERATOR.

use of induction motors under the most advantageous conditions, and to avoid trouble from self-induction and capacity effects on the line except at very great distances.

Certain of these machines are arranged to run at 33 cycles, which periodicity is that adopted for very long work, in order to reduce the induction and capacity effect on the line, and in plants where the use of rotary three-phase continuous current converters is of prime importance. All of these three-phase generators can be arranged for direct driving from Pelton wheels, and the larger units lend themselves with facility to direct coupling to turbines. They have an

efficiency of at least 90 per cent., rising to 95 per cent. in the largest sizes.

With slight changes they can be used as self-starting synchronous motors. They come up to speed under light loads without the intervention of clutches or starting motors. They are fully as efficient as the generators, run in absolute synchronism with them, even under heavy overload. Synchronous motors are of especial value in power transmission, as by strengthening their fields it is possible to compensate for loss of voltage due to induction in the line. A three-phased motor of 15 h. p., in use at Concord, N. H., was illustrated in *The Electrical World* of March 17, 1894.

These motors are substantially equal to good shunt wound motors, but have no moving contacts, the only connection with outside circuit being through the three binding posts on the top of the motor. The magnetic part of the field and armature is constructed of annealed laminated iron. The current from the outside circuit passes through windings imbedded in the stationary field punching. The winding of the armature has no connection with the electric circuit, but is short circuited on itself through a small number of heavy copper bars united at the ends by connectors. It is furnished with a starting resistance placed within the armature spider. At starting, a sliding collar along the shaft is kept out of contact with the switch, serving to short circuit the resistance. When the motor is nearly at speed the contact ring is slid along the shaft, engages the switch points and short circuits the armature. This renders possible a large starting effort with a current limited by the resistance, which is so adjusted as to give a starting torque equal to the running torque at full load with somewhat less than the full load running current.

The massive character of the armature winding, in which the E. M. F. is only from 10 to 25 volts, renders burn-outs almost impossible, and the absence of commutators and collecting rings obviates the danger of sparking. It is claimed that these induction motors are electrically equal to direct current machines of the same capacity. They are recommended for all units below 100 h. p., above which synchronous motors would be preferable.

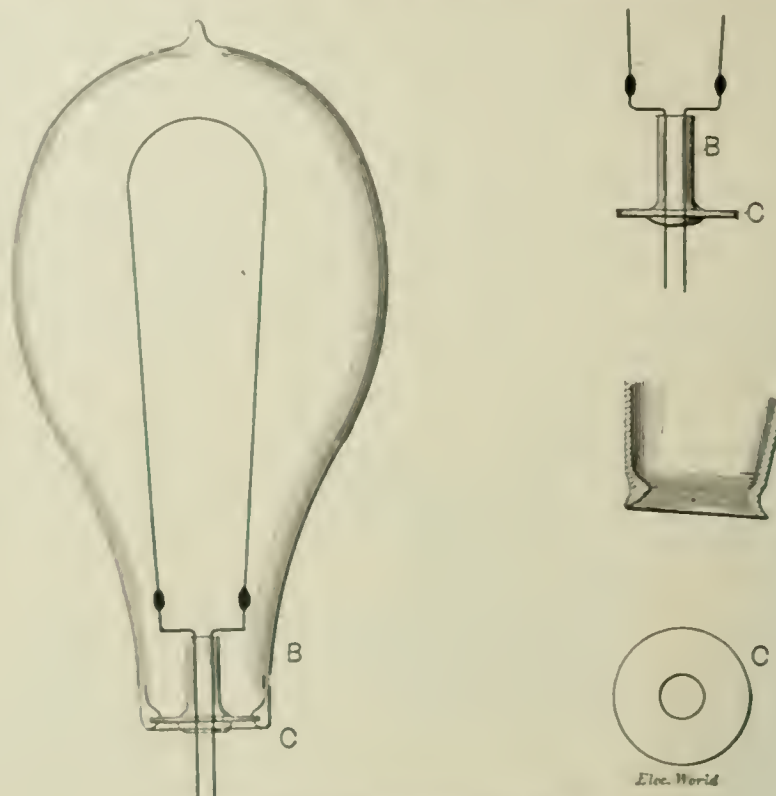
New Incandescent Lamp.

The peculiarity of the incandescent lamp we illustrate, recently patented by George C. Swan, Brockton, Mass., lies in the use of a flat platinum or other metallic disc, which is sealed in the neck of an ordinary lamp bulb and carries the stem, which is fused to the edge of a hole in the disc. The illustration shows the disc separate, and sealed, with the stem, into the neck of the bulb. It is claimed that this form of lamp is simple and easy of construction and exceedingly durable. The disc being flat, while it will expand and contract with the glass to which it is fused, lying as it does between the outer surface of the stem and the inner surface of the bulb, and being joined to each at practically right angles with its surface, it cannot work loose nor can it so yield as to cause any change in the cubical contents of the bulb, so that when the lamp is once made, its contents always remain exactly the same and its work therefore is constant.

It is apparent that in this lamp when the filament is broken the bulb can be broken so as to leave the disc carrying its leading-in wires still fused together. A new filament can be easily affixed to the leading-in wires and the stem and disc used a second time as a completed article for introduction into a new bulb. Moreover, it will be seen that the stem is not a mere globule of glass but is a support of suitable length carrying the leading-in wires and supporting them for a greater part of their length, thereby bringing the lower ends of the filament well within the bulb, so that but a small portion of the light from the filament is lost, and at the same

time forming a more perfect seal than when a short stem or button is used.

One of these lamps has been steadily burning for 3,000 hours without showing the slightest discoloration, and the

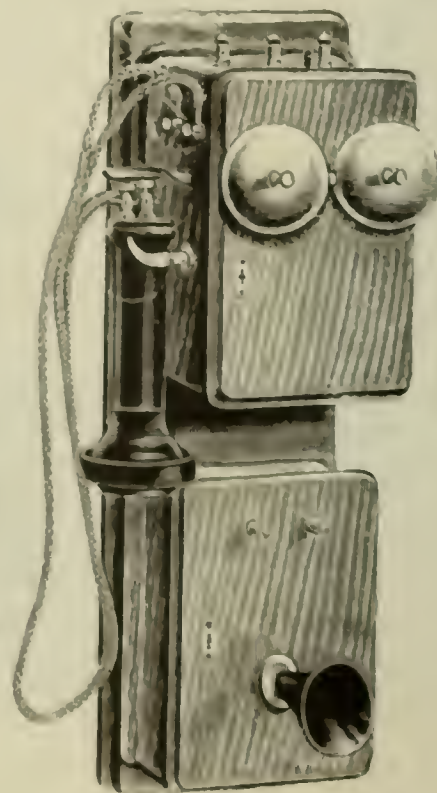


NEW INCANDESCENT LAMP.

carbon still maintains its initial candle power. None of those made has thus far burned out. Less than one cent's worth of platinum, it is claimed, is used in the disc.

Telephone Outfit.

We illustrate a telephone outfit manufactured by the Manhattan Electrical Supply Company, 36 Cortlandt street, New York, which, it is claimed, can be used on lines over 100 miles long under favorable conditions, and with most excellent results on lines under ten miles in length. The trans-



TELEPHONE OUTFIT.

mitter has a mouthpiece mounted on the door of the case, and the magnets are so arranged that the vibrations of the diaphragm are amplified and the speaker's voice reproduced at the distant station in an unusually clear and loud tone. The switch, when in normal position, cuts in the resistance of the call bell circuit, which is broken when the receiver is moved from the hook. By an ingenious device in wiring the resistance of the telephone is cut out while ringing the signal bell.

High Speed Automatic Engine.

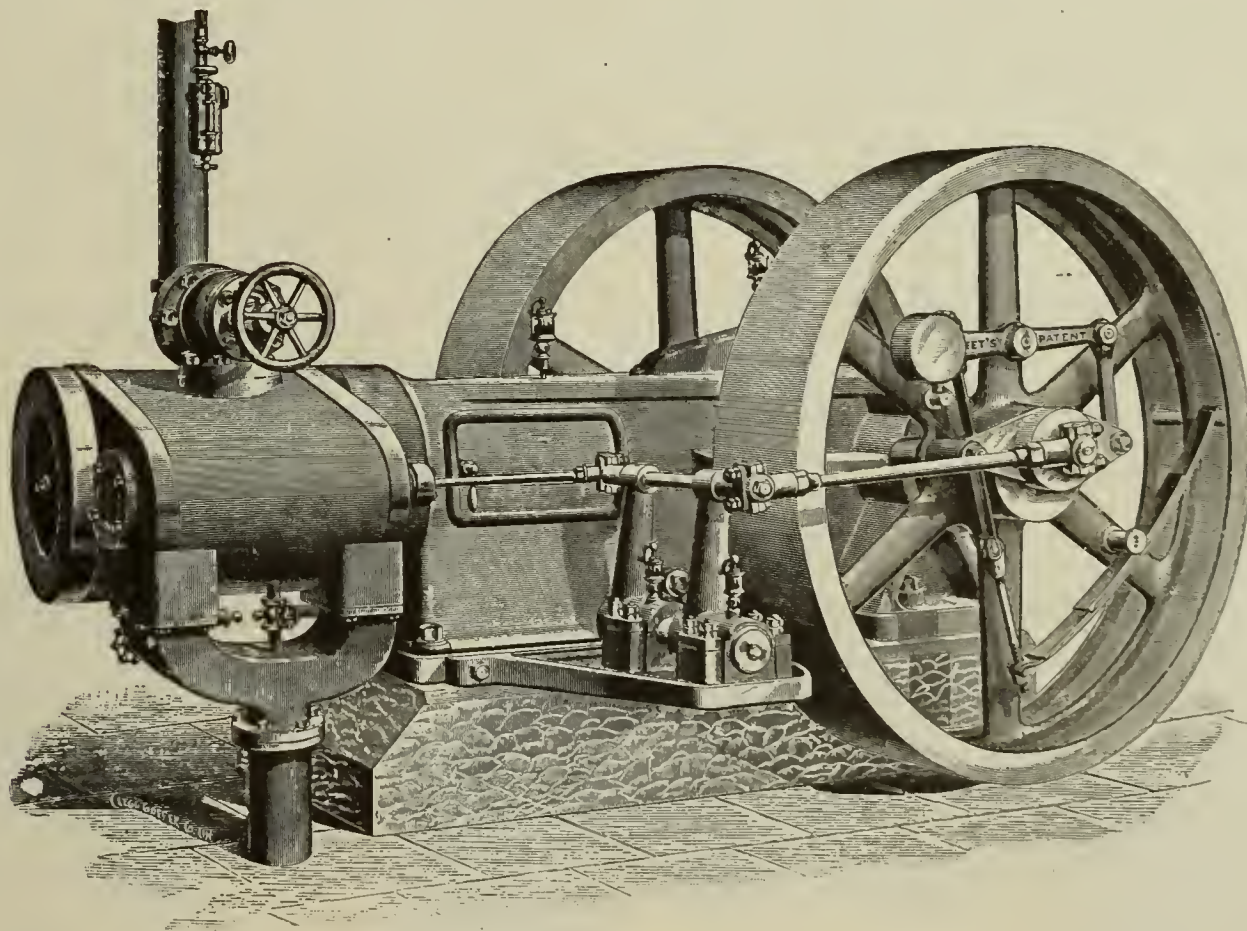
The engine we illustrate, manufactured by the Cooper-Roberts Company, Mt. Vernon, Ohio, is of the self-contained type, the frame being so formed as to allow the working parts to be encased, thus keeping them free from dirt, and preventing waste of oil.

The valve is of the hollow piston type, with self-expanding rings, making it steam tight; this type was adopted for the reasons that it is balanced, simple, requires less attention than any other balanced valve, and has no loose parts.

The wheel governor is of the well-known Sweet type, and consists of a single ball linked to the wrist-plate and connected to a spring by a metal strap, and so located and weighted as to counterbalance the wrist-plate and its attachments. When the speed of the engine reaches the point where the centrifugal force of the governor ball overcomes the resistance of the spring, the ball moves away from the centre of rotation, and, in doing so, carries the wrist-plate nearer the centre of the shaft, shortens its throw and the travel of the valve, and reduces the volume of steam admitted to the cylinder.

The ball is malleable iron, cast hollow, and loaded with lead and shot; being heavy, located some distance from the centre of the wheel, and running at a high velocity, it has great centrifugal force and requires a strong spring to resist it. This forms a powerful governor. The metal band connecting the governor ball to the spring is for the purpose of reducing the number of pieces, avoiding friction, and relieving the central pivot of a large part of the strain.

Unless a shaft governor is practically balanced, the un-



HIGH SPEED AUTOMATIC ENGINE.

balanced weight will constantly tend to move the whole system, more or less, at each revolution, which tends to wear the joints, and, under certain conditions, disturb the adjustment of the valve. Very few of the shaft governors are balanced, the eccentric or wrist-plate being an unbalanced element. The speed of the engine may be changed to a slight extent by increasing or reducing the amount of shot in the ball.

An Indicating Push Button.

A novelty in the line of indicating push buttons, illustrated below, has recently been patented by Dr. C. D. Hunking, of New York City, in which a magnetic needle

indicates by its movements the condition of the circuit. It is, in fact, a galvanoscope and push button combined and designed for use wherever the simple push button is needed. The magnetic needle with which it is supplied gives visual notice when the current passes so that the operator of the push button can see at a glance whether or not the circuit is in the proper condition. If the circuit is incomplete, the



INDICATING PUSH BUTTON.

needle will remain stationary. If a constant current is passing, the needle will take an angular position and keep it until the current is broken. An interrupted current, as when an electric bell is in the circuit, will be indicated by a vibratory movement of the needle, which will deviate to the right or to the left, according to the direction of the current. The button is manufactured by Stanley & Patterson, 34 Frank-

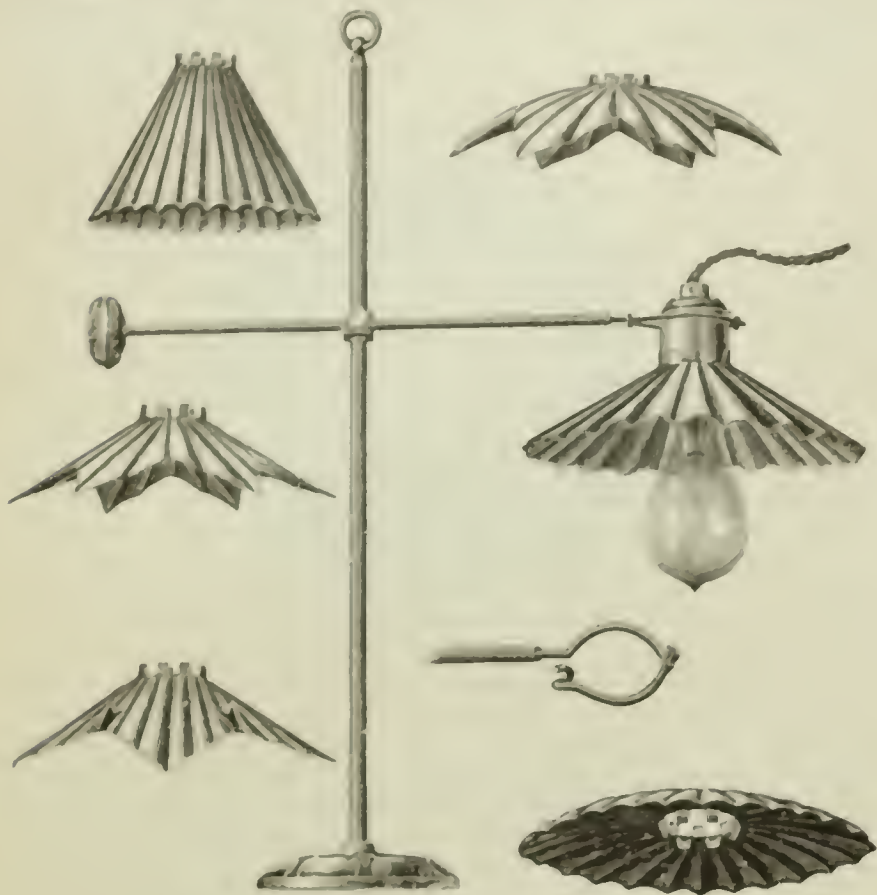
fort street, New York, in burnished bronze metal, and can be made in all the ordinary materials, shapes and sizes.

A New Metallic Shade and Stand.

The accompanying illustration shows a new metallic shade and a new lamp stand, invented and manufactured by Mr. E. D. Cooke, Unity Building, Chicago. The shade is made of one piece of thin, polished and lacquered brass, and furnishes a handsome reflector, as well as an ornament to the electric lamp and socket. The shade is practically indestructible. No collar is necessary to be used with it, as the central clasps or spring fingers (the lower ones having curved ends, which clutch over the annular projection at the

bottom of the socket), hold the shade centrally and securely in place. This shade may be made of varied metals, such as copper, nickel-plate and aluminium, and the forms and outer rims may be fashioned in great variety.

The stand is made to meet the demand for a light, neat

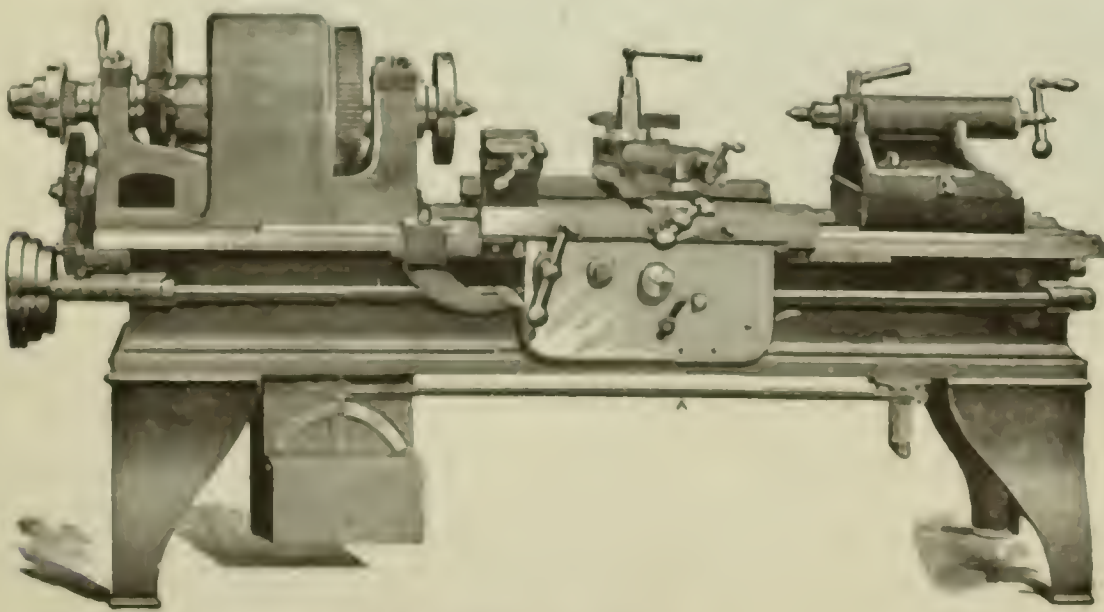


NEW SHADE STAND.

and detachable article, which will hold any electric drop lamp at such elevation or angle as may be convenient to the eyes. This stand is provided with a balancing cross-piece, at one end of which is a knob, and at the other a detachable spring wire tie clasp, which holds the socket securely in place. The set screws, front and back, allow the lamp and shade to be elevated and turned to any desired position.

Motor Driven Engine Lathe.

We illustrate herewith a lathe, manufactured by the Lodge & Davis Tool Company, Cincinnati, Ohio, in which the design includes an electrical motor, taking the place of the



MOTOR DRIVEN LATHE.

usual cone pulley. The lathe is reversed and the speed regulated by the movement of rod *d*. With the back gears arranged as usual, not only is a much wider range of speeds obtained than by a cone pulley, but a much more finely graduated speed. In fact, the speed may be anything from the highest to the lowest desired.

The armature is wound on a phosphor bronze spider with

a carrier disc, which revolves freely on a spindle, the same as a cone pulley. It is surrounded by pole pieces inclosed in housing, the lower half of which is cast in one piece, with the head stock proper, to which it is substantially fitted and secured by means of four bolts. This construction forms an ironclad motor, entirely free from external magnetism. This is necessary in order to keep small particles of steel and iron from adhering to the lathe, making it impossible to keep the same clean.

Amongst the advantages secured by such an application of electricity are that tools may be placed independently of fixed conditions overhead, such as shafting, cranes, etc., and with regard to the arrangement best suited to handle the product most conveniently, and the operator has best control of his machine, especially when a variable speed is necessary. The motors, which are furnished by the Card Electric Motor and Dynamo Company, of Cincinnati, are simple, substantial and of sufficient capacity for the maximum load, free from complication and requiring very little attention in use.

Rigidity.

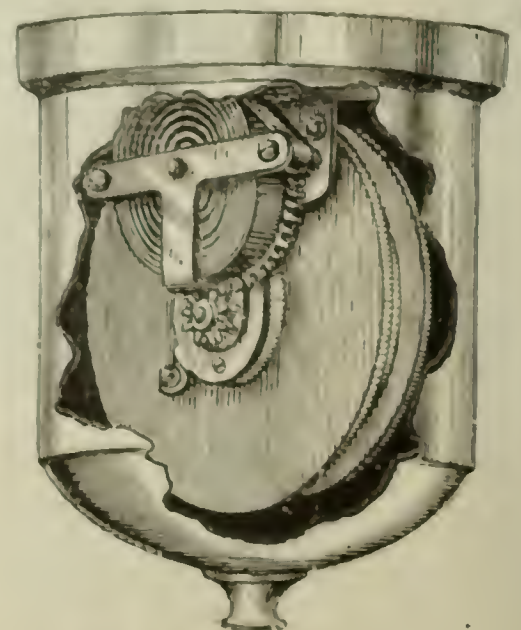
This is the oracular manner in which a semi-scientific American contemporary announces the fact that no known substance is perfectly rigid: "The form of no solid matter or metal can be said to be fixed, under the possibilities of pressure equal to the flow of its atoms toward a readjustment of an equilibrium necessary to maintain a permanent form, by equalizing or transferring pressures from a single direction to the multiple directions required for stability."—*Lond. "Electrician."*

Measuring Minute Temperatures.

Prof. Langley, of the Smithsonian Institution, has constructed a bolometer which is so delicate that a change of temperature of one-millionth of a degree is easily detected and measured.

Incandescent Lamp Adjuster.

The Blair lamp adjuster which we illustrate, manufactured by the Blair Lamp Adjuster Company, 509 McCague Building, Omaha, Neb., has been on the market for a little



LAMP ADJUSTER.

over a year, during which time it has met with much success. The adjuster is self-balanced, thus doing away with the annoyances incident to the use of window shade roller mechanisms, sometimes used for the same purpose. The construction is simple, there being no delicate parts to get out of order, and combines a double-pole fuse rosette. The adjuster is fastened to ceiling and presents a neat appearance.

New Books.

ON THE DEFINITIONS OF THE TRIGONOMETRIC FUNCTIONS. By Alexander Macfarlane, M. A., D. Sc., LL. D. Boston: J. S. Cushing & Co. 59 pages, 15 illustrations. Paper. Price, 50 cents.

This pamphlet is a reprint of a paper read before the Mathematical Congress at Chicago, Aug. 22, 1893. In it the author advocates the claims of a system of notation invented by himself, which applies to vector analysis. In a former paper, entitled "The Principles of the Algebra of Physics," the author introduced this notation, which is founded on the assumption that the trigonometrical functions, sine and cosine, are more simple in their nature than vectors. In the London "Electrician" of Dec. 9, 1892, Mr. Oliver Heaviside takes exception to this view, on the ground that vector algebra is far more simple and fundamental than trigonometry. In the present paper Prof. Macfarlane defends his position in replying fully to Mr. Heaviside and developing a set of definitions of the circular and hyperbolic functions which are logically consistent, and which bring together all these different quantities under a single theory. While many will doubtless think that Prof. Macfarlane has the best of the argument, those who do not will at least admit that he has made a valuable contribution to the theory of circular and hyperbolic functions.

REFERENCE BOOK OF TABLES AND FORMULAS FOR ELECTRIC STREET RAILWAY ENGINEERS. By E. A. Merrill, author of "Electric Lighting Specifications for the Use of Engineers and Architects." New York: The W. J. Johnston Company, 41 Park Row. Flexible morocco. Price, \$1.00.

To a busy man the value of a reference book depends largely on the facility with which he can get from it the information he desires. In the larger works the labor involved in seeking out information, which perhaps is scattered through several sections and encumbered with examples and explanations already familiar to the engineer, is often exceedingly annoying, especially when many times repeated. It is the object of this text book, the author states in his preface, to avoid such annoyances, and meet a practical need by collecting and arranging in a concise, logical order those tables and formulas which are in constant use by the electric street railway engineer in making estimates, ordering material on construction work, etc. An examination of the work shows that this design has been consistently carried out. Superfluous examples and explanations have been excluded, as well as unnecessary extensions of formulas into tables when such extensions consist only in the simplest mathematical processes; as a consequence of this treatment, every element stands out in an unusually clean cut, terse form. Reference without the use of the index is facilitated by the arrangement of the matter, which follows a logical order, beginning with the details of the steam plant, and then taking up successively cars and their equipment, overhead work, track work and miscellaneous tables and formulas in constant use but only indirectly related to the main divisions.

Not only has considerable care been evidently taken in selecting and checking material compiled directly, but a number of original tables and formulas appear, especially in the sections on track and overhead work, which will save many calculations; further, many tables and formulas have been extended and modified to meet the conditions imposed in street railway work.

The practical arrangement of the book, its condensed style and convenient form will commend it to every street railway engineer. Every heading is in bold-faced type, which easily catches the eye as one glances over the page, thus materially aiding quick reference; as a further aid a complete cross index is added. The book is durably bound with flexible covers to lie open flat on the desk, and is of convenient size to carry in the pocket.

A POCKET-BOOK OF ELECTRICAL ENGINEERING FORMULAE. By W. Gelpel and M. Kilgour. London: "The Electrician Publishing and Printing Company." 774 pages, illustrated. Price, \$3.

Whether the title of this book is a misnomer or not depends in one respect upon the definition of electrical engineering. If we accept the definition sometimes offered, that electrical engineering comprises nine-tenths mechanical engineering and one-tenth electrical knowledge, the title would, with an exception to which we shall refer, be fairly correct provided it were supplemented with a substitute indicating that the book also contains references of greater or less length to about everything else in the constructive, physical and mathematical sciences. The exception above noted is in regard to the use of the word "formulae" as descriptive of a book that contains abbreviated treatises on hyperbolic functions, the calculus, differential equations, the slide rule (6 pages) on boilers, engines and their accessories (210 pages) etc. Engines, by the way, are classed as internal and external furnace engines, which upon examination we find to refer to gas and oil engines under the first head, and steam engines under the second; about seventy pages are devoted to this subject, consisting of matter appropriate enough in a text book on heat engines but rather out of place in a book of electrical engineering formulae. The same may be said of the lengthy section on boilers, with its instructions on design, testing, incrustation, riveting, management, etc.

In short, the book contains a miscellaneous collection of information which, though it be all intrinsically useful, is in great part out of place in a pocket book. A person does not refer to such a work for a monograph on hyperbolic functions, nor to study the theory of heat engines, nor to learn how to use a slide rule; he can get all of this information in a necessarily more satisfactory form elsewhere, and space is merely wasted in attempting to give, for example, the theory of differential equations in six small pages, or teach the management of boilers in the same space.

About 250 of the 774 pages of the book are devoted to electricity. In the first part of the volume are seventeen pages on units; then, sandwiched between "melting points" and "light," are thirteen pages on thermo-electricity, specific inductive capacities and resistance, after which are almost 500 pages on about everything but electricity. The electrical section proper consists of 210 pages, and is principally descriptive or explanatory, with occasional formulas and tables. The article by Dr. Sumpner on alternate current transformers is an excellent resume. The section on the economy of conductors (8 pages), which should be one of the most important in the book, is rather an essay on the subject with little or no direct practical bearing. In the section on the heating of conductors there are no tables of heating limits for different gauges of wire, but instead a table of values of d^2 and in the section on drop there are no wiring tables such as are universally used in the United States. Almost half of the space devoted to the incandescent lamp is given up to the consideration of the "smashing point," notwithstanding that the conditions which can render the "smashing point" of importance are rarely if ever present in practice.

While the book is therefore far from being what its title purports and lacking in many respects from an electrical standpoint, yet the great collection of data which it contains will render it useful to practising engineers. The mechanical execution is excellent in typography, presswork and binding.

Electric Traction in Switzerland.

The Bernese Oberland Railway Company is contemplating the substitution of electric traction for steam. The scheme is a very important one, comprising 200-h. p. locomotives, with ten trains on the line simultaneously.

Financial Intelligence.

The Electrical Stock Market.

New York, April 23, 1894.

GENERAL ELECTRIC—Very little trading has been done in this stock the past week so far as the Stock Exchange record of sales shows. There has been a disposition to bull the stock on the general belief, as expressed in these columns last week, that everything bad concerning the corporation is now an open secret, and that the future must witness an early return to the accumulation of profits for distribution among stockholders, but the conditions prevailing in Wall Street have been contrary to the existence of a well sustained advance, and fluctuations have not been of material significance. In the meantime the General Electric people are getting more confident than ever in the future of the company. In the first place the management has inaugurated a reign of economy without affecting the efficiency of the real working force, that will result in an annual saving of thousands of dollars. In the Chicago office alone about 20 clerks have been dropped from the rolls in the past two weeks, and discharges of useless employees, who were kept on throughout the dull times for sentimental reasons, are being made in other centres. Moreover, a summary stop has been put to the practice of getting business at prices that do not admit of a profit. It is stated that the company is still slashing rates in the Western region, but no orders are any longer accepted that do not allow of a fair margin of profit. The policy of the company now is to do away with construction work, and rather sell standard machinery, on which the most money is to be made. The most gratifying piece of news that General Electric stockholders have heard in a long time is the announcement of President Coffin that "It is the intention of the company to issue, after a while, monthly or quarterly statements regularly." Nothing has yet been done towards making good the impairment in capital by reducing the capital stock. The board of directors has not even met yet to elect the two additional directors authorized at the annual meeting in Schenectady last week, and it is reported that nothing will be done for a week or two. There has been private discussion of the capital impairment matter by the directors and their counsel, but no tangible conclusion has as yet been reached. As soon as a feasible plan is branched, stockholders will be called together in special meeting to ratify the directors' programme. It will require practically unanimous consent on the part of the stockholders to make any plan a success.

WESTINGHOUSE ELECTRIC stocks continue to be freely bought in Boston, both for local and New York account. The chief buying is understood to come from the people who are close to the insiders and who know how steadily the company's business for the past three months has been gaining on all previous good records. In fact the present amount of business is said to be the best in the history of the Westinghouse company.

INTERIOR CONDUIT AND INSULATION stock woke up this week after a long rest, and sold at 40 and 41½. The friends of this concern say that it is an important factor in electric lighting of buildings on account of the safety of its methods. It is also, they add, to be a leading factor in equipping electric railways, and its business is now on a sound basis and making money. They confidently assert that, if anybody will buy a little of this stock and put it in his strong box, he is quite likely to see it selling at par before the end of this year.

EDISON ELECTRIC ILLUMINATING, of Brooklyn, has advanced to bid on the outcome of the stockholders' meeting on Thursday, when it was determined, in accordance with the recommendation of the board of directors, to issue \$500,000 new stock to present stockholders at par. This makes the total capital stock \$3,500,000. The proceeds of the new stock issue are to be used to carry out the contract recently made in the city of Brooklyn for street lighting, and also to strengthen and extend the company's rapidly increasing business. Secretary Peabody says that substantial progress is being made in getting ready the plant to light the principal streets of Brooklyn under the recently granted franchise. In 30 days the company will begin to set up ornamental poles similar to those on Fifth Avenue this city, as illustrated in a recent issue of The Electrical World, and the placing of all the wires underground will remove some 1,500 unsightly and disfiguring poles. By June 1 the current will be turned on the new lines. The company has placed the orders for additional machinery and apparatus to take care of this new street lighting. In view of these extensions and improvements the increase of capital stock is perfectly justifiable.

THE EDISON ELECTRIC ILLUMINATING, of New York, stocks and bonds continue in good favor as a result of the good showing for March, when nearly ¼ of 1 per cent. was earned on the stock, after allowing for the month's proportion of the annual fixed charges.

THE EDISON ELECTRIC ILLUMINATING COMPANY, of Boston, has declared a dividend of 1½ per cent. payable May 1, to stockholders of record April 18.

TRIP TELEPHONE stock continues strong in Boston on buying that is known only for inside account. The present earnings are reported as being excellent, and the general financial condition is officially stated to be better than ever before in the experience of the company.

WESTERN UNION TELEGRAPH stock has advanced slightly. There is seemingly little interest in the stock just now. No inside support is manifested, the Gould boys being apparently more absorbed in making and breaking engagements and buying cup defenders.

ELECTRICAL STOCKS.

	Par.	Hid.	Asked.
Brush Ill., New York.....	50	10	30
Detroit Electrical Works.....	10	7	3
Cleveland General Electric Co.....	—	85	90
East River Electric Light.....	100	—	65
Electric Con. & Supply Co., pref.....	15	15	16
Electric Con. & Supply Co., com.....	15	15	17½
Edison Electric Ill., New York.....	100	100	103
Edison Electric Ill., 1st.....	—	107½	107½
Edison Electric Ill., Brooklyn.....	100	104	105
Edison Electric Ill., Boston.....	100	115	120
Edison Electric Ill., Chicago.....	100	130	135
Edison Electric Ill., Philadelphia.....	100	130	135
Edison Electric Light of Europe.....	—	—	3
Bonds.....	—	80	85
Ore Milling.....	—	10	11
Fort Wayne Electric.....	—	4½	6½
General Electric Company.....	100	39½	40
Interior Conduit and Ins. Co., deb. 5's.....	—	85	86
Interior Conduit and Ins. Co., 100.....	100	35	50
Mount Morris Electric.....	—	—	65
Westinghouse Consolidated.....	50	35	37½
Westinghouse Consolidated, pref.....	50	51½	52½
Western Union Telegraph.....	—	84½	84½
American Bell Telephone.....	—	168½	169

*Ex. dividend.

New Incorporations.

THE ST. LOUIS ELECTRIC BRAKE COMPANY, capital stock \$5,000, has been incorporated by J. L. Black and others.

THE L. GUTHMANN COMPANY, of Chicago, Ill., capital stock \$1,000,000, has been formed to manufacture telephones, torpedoes, etc.

THE ELECTRIC LIGHT COMPANY OF TIPTON, IOWA, capital stock \$12,000, has been formed to operate an electric light plant. W. H. Treichler, J. H. Coatts, G. A. Garrett, P. R. Pine and J. T. Moffitt, all of Tipton, are interested.

THE HILLSBORO INVESTMENT AND ELECTRIC COMPANY, Hillsboro, Tex., capital stock \$50,000, has been organized to generate electricity for various purposes, manufacture gas, etc. A. T. Rose, H. T. Ivy and E. G. S. Shields are the incorporators.

THE NORTHERN TELEPHONE AND TELEGRAPH COMPANY, Chicago, Ill., capital stock \$10,000, has been formed to construct and sell telephone and telegraph systems and electrical apparatus. E. C. Preble, J. R. Keogh and T. H. Fitzgerald are the incorporators.

THE ELECTRIC TELEGRAPH COMPANY OF WESTCHESTER, N. Y., capital stock \$10,000, has been formed for the purpose indicated in its title. E. I. Leonard, 158 East 97th street; J. J. Baker, Mt. Vernon; William Waldr, 273 South First street, Brooklyn, N. Y., are the promoters.

WALES CENTRE, N. Y.—The Buffalo Valley Telephone Company has been incorporated to build and maintain a telephone line in this vicinity. H. W. Richardson, of East Aurora; Dr. J. D. Wooster and Harry S. Gail, of Wales Centre, and W. R. Hoy, and William Richardson, of Strykersville, are interested.

THE WASHINGTON GAS AND ELECTRIC COMPANY, Washington C. H., Ohio, capital stock \$100,000, has been formed to manufacture and furnish electricity and gas for light, heat and power. J. Penn, G. H. Clapp, M. Sharp, O. S. Hopkins, A. F. Hopkins and E. J. Light are interested.

THE BUTTE LIGHTING COMPANY, Butte, Mont., capital stock \$1,000,000, has been formed to manufacture and deal in electric and gas lighting, etc. H. M. Byllesby, H. C. Levis, W. P. Johnson, St. Paul, Minn.; H. W. Turner, Missoula; J. W. Forbis, F. E. Corbett and J. R. Wharton, Butte, Mont., are interested.

THE DALLAS AND OAK CLIFF ELECTRIC RAILWAY COMPANY, of Dallas, Tex., has been incorporated with a capital stock of \$200,000, to construct and operate street railways in these towns, to be operated by electric and other power. D. E. Green, J. N. Simpson, C. F. Carter, Dallas, Tex., and F. H. West, St. Louis, Mo., are interested.

HAZEL PARK, MINN.—The Hazel Park Electric Light and Power Company, capital stock \$25,000, has been formed to supply light, heat and power by electricity. W. J. McWinney, Joseph Lafonze and H. A. Jansen are the promoters. Mr. J. Nismo King, formerly chief electrician for the Oshkosh (Wis.) Electric Light Company, has been engaged as electrician and general superintendent.

TRENTON, N. J.—The Central Jersey Traction Company has been incorporated by J. H. Baldwin, of Orange; John H. Tingley, of Rahway, and George G. Crosby, of New York, and they propose to connect New York and Philadelphia by a trolley line, to touch Elizabeth, New Brunswick, Newark and other points. Frank A. Magowan, of Trenton, is president, and J. H. Baldwin, of Newark, N. J., is secretary.

TRENTON, N. J.—A large Pittsburgh concern has incorporated in Trenton, and is represented by Frank S. Katzenbach, Jr., of Trenton, N. J. Among those interested are Charles C. Burton and Curtis Grubb Hussey, of Pittsburgh; Louis Edward Holden, of Beloit, Wis., and George McMurtry Ludlow, of Chicago, Ill. They will engage extensively in the manufacture of electric appliances in Pittsburgh, Pa.

THE INTERNATIONAL ELECTRICAL SUPPLY COMPANY, of Detroit, Mich., has been incorporated with a capital stock of \$500,000.

THE CHIHUAHUA ELECTRICAL AND POWER COMPANY has been incorporated by J. B. Hood and others. The capital stock is \$100,000.

THE WISCONSIN ELECTRIC DYNAMO COMPANY, Milwaukee, Wis., capital stock \$50,000, has been formed to manufacture dynamos, erect electric plants, etc. The promoters are G. Podall, J. M. Brandmueller and J. B. Zann.

THE WATERLOO LIGHT AND POWER COMPANY, Waterloo, N. Y., capital stock \$50,000, has been created to supply electricity for various purposes. F. Bacon, P. M. Kendig and A. G. Mercer, of that place, are the promoters.

THE LOCK HAVEN ELECTRIC RAILWAY COMPANY, Lock Haven, Pa., capital stock \$100,000, has been formed to build and operate a railway. The organizers are S. Christ, T. H. Harmon and J. H. Fredericks, Lock Haven, Pa.

THE PASADENA AND LOS ANGELES ELECTRIC RAILWAY COMPANY, Los Angeles, Cal., capital stock \$500,000, has been formed to construct and operate railways by electricity or otherwise from the one place to the other. The incorporators are P. M. Green, H. W. Magee, E. C. Webster, L. P. Hanson, F. E. Beach, Pasadena; William Lacey, E. P. Clark, Los Angeles.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, New York, April 23 1894.

QUEEN & CO., of Philadelphia, have established a branch at 116 Fulton street.

THE STORAGE BATTERY SUPPLY COMPANY has removed its offices to 239 East 27th street, New York.

H. B. COHO & CO., 203 Broadway, New York, contractors for the Mather Electric Company's apparatus, sold last week two 120-kw. and one 10-kw. Mather generators.

THE LAW BATTERY COMPANY, 85 John street, New York, still keep apace with the electrical fraternity. Favorably known for so many years, their product has constantly kept in the front rank.

MESSRS. DOUBLEDAY, MITCHELL & CO., 136 Liberty street, New York, are handling the Metropolitan electric fan motor, manufactured by the New Haven Insulated Wire Company, of New Haven, Conn.

THE ELECTRICAL AND MECHANICAL ENGINEERING AND TRADING COMPANY has moved its office from the Edison Building, 44 Broad street, New York, to the Monroe Taylor Building, 39 Cortlandt street.

MR. HARRY W. COLBY, New York manager for the Holtzer-Cabot Electric Company, of Boston, Mass., has moved his office from 143 to 114 Liberty street. Mr. Colby reports quite a number of sales of fans manufactured by his company.

MR. CHARLES BLIZARD, representing the Electric Storage Battery Company, of Philadelphia, Pa., has returned from an extended Western trip in the interest of his company. Mr. Blizard reports business in the West as being prosperous.

MESSRS. McLEOD, WARD & CO., 91 Liberty street, New York, manufacturers of the Kinsman desk and portable lamp, have appointed agents in all of the principal cities in the United States, from whom large orders are daily being received.

J. JONES & SON, recently removed to 67 Cortlandt street, New York City, are still selling the stock of the A, B, C Company. Messrs. Jones & Son will keep in stock the Columbia lamps, and will continue to supply the demands for their well known anti-thunderbolt insulating paper.

MR. D. P. FITZGERALD, JR., formerly with the E. S. Greeley & Co., is now manager of the Enterprise Electric Equipment Company, 298 Broadway, New York. Mr. Fitzgerald's company, while doing a general line of electrical construction work, also deals extensively in telephones.

MR. DAVID CHALMERS, formerly connected with the A, B, C Company, and recently manager for the receiver of the above named company, has accepted the position of manager of the New York office of the Holtzer-Cabot Company, of Boston, Mass. This company will occupy the ground floor of 114 Liberty street, and will carry a full line of specialties manufactured by it.

THE BROOKLYN ALDERMANIC COMMITTEE ON LAMPS AND GAS has received a petition for a franchise from the Kings County Electric Light and Power Company, represented by Lawyer Mirabeau L. Towns, T. S. Quinn and James T. Lewis, with a capital of \$250,000. The matter was considered in executive session, and will be reported upon later.

MR. LOUIS J. AUERBACHER, formerly connected with the E. S. Greeley & Co., has accepted the position of secretary and general manager of the Automatic Electrical Specialty Company, 136 Liberty street, New York. While the company will act as

general electrical contractors, and also deal in electrical supplies, its specialty consists of the Hoggson automatic electrical time stamp.

THE JOSEPH DIXON CRUCIBLE COMPANY held its annual meeting of stockholders at its offices in Jersey City on April 16. The vote of the shareholders was the largest ever cast, and was a decided compliment to the board of managers. In the organization of the board Mr. E. F. C. Young was elected president, John A. Walker vice president and treasurer, and George E. Long secretary. The Dixon company was founded by Joseph Dixon as early as 1821, and was organized as a stock company in 1868.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., April 19 1894.

BOSTON PAYS \$25,840.07 for rental and tolls for 767 telephones.

THE BOSTON INCANDESCENT LAMP COMPANY has been notified of an injunction granted against it by the United States Circuit Court, Judge Colt, on motion of the Edison Electric Light Company.

MR. J. J. GATES, of the Royal Arc Electric Light Company, favored this office with a call this week. He was, as always, in the best of spirits and full of business. Who ever saw him otherwise? He is the prince of good fellows, and none can boast of greater popularity.

THE AMERICAN BELL TELEPHONE COMPANY has not yet received authority to increase its capital from \$20,000,000 to \$50,000,000. The bill for the same in the Massachusetts House of Representatives has been tabled to await a coming revision of the State corporation laws.

MR. T. H. BIBBER has accepted the New England agency for Charles E. Chapin, of New York, with headquarters at 620 Atlantic avenue, Boston. Mr. Bibber has a large circle of friends and acquaintances in this territory, and will undoubtedly do a good business. We wish and predict for him success.

EAST WEYMOUTH, MASS.—The citizens of this town held a meeting to discuss an extension of the Quincy and Boston Electric Railway from North Weymouth. The railway company stated that a road would be built if sufficient financial support could be obtained from the citizens, and a canvassing committee of citizens was appointed to obtain subscriptions for the stock.

MR. P. M. REYNOLDS, treasurer of the Brown Electric Company, of Boston, is a great grandson of Paul Revere, who figured so prominently in the historic battles of Lexington and Concord, Mass. Mr. Reynolds' connection with this honored patriot is known to but few of his electrical friends, as he is a modest man, but he undoubtedly felt considerable pride over it upon the occurrence of the 119 anniversary of these battles on the 19th inst., and which was observed for the first time as a legal holiday in Massachusetts, and celebrated in a most magnificent and appropriate manner.

MR. WILLIAM LEE CHURCH, of Westinghouse, Church, Kerr & Co., is at present sojourning in the Bahamas for the purpose of recruiting his health, which became impaired considerably because of a recent attack of the grip and close application during the past winter to the conduct of his business. Mr. Henry J. Conant will look after the interests of the company during Mr. Church's absence.

THE USE OF THE TELEPHONE in connection with the fire alarm service, as an adjunct to the boxes, which was introduced by the Boston fire commissioners last fall, was availed of last week for the first time, and Chief Webber states that it worked admirably, and placed him in direct communication with the fire alarm office in the city hall dome. Heretofore he has had to send his orders by the Morse telegraph, each box having an operating key. This is a combination which admits of any one opening the alarm box and pulling the hook, but the telephone box is separated from the alarm box.

"THE ELECTRIC POTENTIAL."—The efforts to form an electric organization in Boston proved successful at the dinner held at Young's Hotel last Friday evening, the 20th inst. It will be known as "The Electric Potential," will be governed by the most simple of by-laws, and the expense of membership will be but \$2 as an entrance fee and \$1 per annum as dues. Mr. C. W. Holtzer, who started the movement, was elected president of the organization. The other officers elected are: Vice presidents, Col. E. H. Hewins and Frank Ridlon; secretary, A. C. Shaw; treasurer I. H. Farnham. Over 20 names were enrolled as members at the dinner. Mr. W. J. Denver acted as chairman of the meeting.

THE MATHER ELECTRIC COMPANY, Manchester, Conn., reports the following sales of apparatus outside of its railway business for the last ten days: Massachusetts Hospital for the Insane, Northampton, Mass., one 350-light and one 600-light dynamo; Eastern Yacht Club, Boston, Mass., one 250-light dynamo; Wayne county house, Wayne, Mich., two 20-kw. direct connected dynamos; S. N. Blake, Elmira, N. Y., one 350-light dynamo; Sherman & Kopf, Detroit, Mich., one 250-light dynamo; George Whitney Woolen Company, South Royalston, Mass., one 100-light dynamo; Syracuse "Herald," Syracuse, N. Y., one 250-light dynamo; Union Central Life Insurance Building, Buffalo, N. Y., one 450-light dynamo and one 250-light dynamo;

Patent Cereal Company, Geneva, N. Y., one 150-light dynamo; Crane Bros., Westfield, Mass., one 50-light dynamo; Henry Reinhardt, New York City, one 150-light dynamo; Boston Ferrule Company, East Boston, Mass., one 50-h. p. slow speed motor; Phelps Publishing Company, Springfield, Mass., one 50-h. p. slow speed motor, also in Springfield two 15-h. p. and one 1-h. p. motors; sixteen other motors from 1 to 15 h. p. in various places.

Pittsburg Notes.

Pittsburg, April 21, 1904.

THE SECOND AVENUE TRACTION COMPANY is now reconstructing its entire line from Pittsburgh to Glenwood, a distance of four miles.

THE PITTSBURGH, ALLEGHENY AND MANCHESTER TRACTION COMPANY contemplates putting on the lines of its system a large number of open cars for the summer traffic.

THE WESTMORELAND ELECTRIC COMPANY, of Greensburg, Pa., will double the capacity of its plant, which will necessitate expenses aggregating \$12,000. The company also intends to introduce the system of selling the electric current by meter.

A CHARTER was granted to a number of well known capitalists of this city for what may be termed the first long distance electric railway in Western Pennsylvania. The company is called the Allegheny and Butler Railway Company, and it is proposed to construct a railway 50 miles long. The capitalization is \$300,000, and the directors are F. Gwinner, Jr., E. W. Gwinner, W. B. Rhodes, Charles K. Hill and W. I. Muatin.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD
726 Monadnock Building Chicago April 14, 1894.

MILWAUKEE, WIS.—Superintendent Kleinsteiber, of the Police Alarm Telegraph system, states that the underground system will be extended this summer.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, has decided to again supply the old reliable Packard lamp, and to carry a more extensive stock than has ever been carried before in Chicago. The stock will be well assorted and complete, running in sizes from 5 to 500 c. p.

THE METROPOLITAN ELECTRIC COMPANY, 186 Fifth avenue, reports that N. I. R. wire is being put into the Leland Hotel, the famous old hotel at the corner of Adams street and Michigan avenue, Chicago, and that the Stock Exchange Building of the same city is the latest to adopt "Xntric" switches throughout. The Old Colony Building has these switches also, and they are found to be entirely satisfactory.

THE GENERAL ELECTRIC COMPANY has removed its offices from the old Edison General headquarters, at 173 Adams street, to the Monadnock Building, on account of more room being required for the large stock of goods that this company carries, and the better facilities needed for making shipments. The new storehouse is located on the line of the Wisconsin Central, Chicago & Great Western and Baltimore & Ohio railways, and is splendidly situated for shipping purposes; the company is therefore in shape to make even prompter shipments than heretofore. The removal of the stock to this new storehouse left the Adams street building partially vacant, and other quarters for office purposes were sought, arrangements finally being made for a portion of the tenth floor of the Monadnock Building. The rooms occupied, 1912 to 1916 inclusive, take up the whole of the south end, and are fitted up handsomely so that they now have one of the finest suites in the building, which means one of the finest in Chicago.

English Notes.

(from our own Correspondent.)

London, England, April 16, 1904.

AN ALTERNATING CURRENT TRAMWAY.—The well known Grand Depot will show an electric tramway on the alternate current system at the forthcoming exhibition at Lyons.

ELECTRIC RAILWAY ENTERPRISE IN LONDON.—A bill now before Parliament, for running an electric railway from the City to Epping Forest, has the honor of being the best opposed bill in the session.

THE CITY LIGHTING.—The gas lamps in the main streets of the city have now all been removed. The City company announces that it has now laid its mains in 496 "streets, courts, lanes, etc.," within the city boundaries, and expects to have mains everywhere by the end of May.

ELECTRIC RAILWAY IN SWITZERLAND.—The Bernese Oberland Railway Company is, it is stated, contemplating the substitution of electricity for steam. As this line employs locomotives of 20 h. p., and there are, at a place, some 10 trains simultaneously on the track, the job will be a fairly big one.

PROPOSED ELECTRIC TUBULAR RAILWAY IN PARIS.—The French Government, at the suggestion of the Minister of Public Works, has placed a bill before the Chamber of Deputies empowering the Paris Municipal Council to construct a tubular

electric railway connecting the Bois de Boulogne with the Bois de Vincennes.

News of the Week. Telegraph and Telephone.

CORDELE, GA.—F. J. Moore is about to establish a telephone exchange.

LEXINGTON, KY.—Percival Moore and others are to start a telephone exchange.

MT. STERLING, KY.—A telephone exchange is to be established by Adam Baum.

ORANGEBURG, S. C.—L. H. Wannamaker and others are to establish a telephone exchange.

TEMPLE, TEX.—The Taylor Telephone Exchange has been formed by J. D. Seiders and others.

AUGUSTA, GA.—D. J. Murphy will be the manager of the new telephone company now forming.

SALEM, VA.—A. F. Wolfenden has been granted an exclusive franchise for a telephone exchange, and will begin work at once.

RENNVILLE, MINN.—The Renville Telephone Company will extend its lines this spring. McGregor Brothers & Co. will also build a line from Hector.

STAUNTON, VA.—The Monterey and Staunton Telephone Company has been organized by J. C. Matheny and others to construct a telephone line.

THE TAMPA AND MANATEE TELEPHONE AND TELEGRAPH COMPANY, Tampa, Fla., has been organized with F. A. Salomonson as president, J. H. Knight, vice president, and S. A. Padgett as secretary and treasurer.

Electric Light and Power.

PALATKA, FLA., is considering the question of electric lighting.

RIPON, WIS.—The Council is investigating the matter of municipal lighting.

WAVERLY, OHIO.—An electric light plant, costing \$15,000, will be constructed.

MT. STERLING, KY.—An electric light plant is to be erected by the local government.

DELANO, MINN.—Citizens have voted to issue \$10,000 in bonds for waterworks and electric lights.

LEXINGTON, KY.—The Queen and Crescent Railroad Company will put an electric plant in its yards.

HENDERSON, MINN.—Taxpayers of Henderson have voted to issue bonds to purchase an electric light plant.

EATONTON, GA.—The Eatonton Electric Light Company is being organized to establish an electric light plant.

SANDERSVILLE, GA., wishes estimates for an electric light plant, which may be addressed to the mayor of that city.

PAW PAW, MICH.—A Mr. Farley is getting plans for an electric light plant for Paw Paw.

DETROIT, MICH.—The lighting commissioners estimate that \$174,000 will be needed during the coming year.

FREELAND, PA.—The Freeland Light and Power Company will at once erect a plant near the waterworks.

COLLIERSVILLE, TENN.—E. K. Leake desires estimates for a dynamo of 200 to 300 incandescent lights capacity, with all necessary fixtures.

MOUNT STERLING, KY.—Bids will be received by the Council for the construction of an electric light plant. Adam Baum is mayor.

LONDON, ONT.—Tenders will be received to May 15 for electric lighting for the streets of London. A. Ormsby Graydon is city engineer.

EASTON, PA.—The secretary and superintendent of the water and light department have been instructed to call for bids for another dynamo.

FLORILLA, GA.—Capt. W. F. Smith is contemplating installing an electric lighting plant, operated by water power, to light Florilla and Indian Springs.

TENVILLE, GA., is desirous of having estimates on the erection of an electric light plant. Communications should be addressed to the mayor.

LE ROY, N. Y.—The village Board of Trustees has voted to lay on the table the petition of Charles F. Prentice for a franchise for incandescent electric lighting.

WASHINGTON, D. C.—The War Department has not yet reported to the district commissioners in the matter of the proposed electric light plant at Great Falls.

THE HOLLY SPRINGS ELECTRIC LIGHT AND ICE MANUFACTURING COMPANY, Holly Springs, Miss., is being organized by J. G. Leach and others.

LANCASTER, MASS.—Mr. H. T. Gibbs can be addressed concerning the electric light station and the electric railway power station, which is to be built there.

WILLIAMSPORT, PA.—Sealed proposals will be received to noon, April 30, for lighting the streets of Williamsport for five years with gas or electricity or otherwise. William I. Dreisbach is city clerk.

SAVANNAH, GA.—The Brush Electric Light Company has bought land adjoining its present plant, and will spend \$50,000 for improvements, to include new engines and boilers.

JAMESTOWN, N. Y.—It has been decided to use the town plant for commercial and street lighting, the Board of Public Works having been instructed to prepare plans and specifications.

EVART, MICH., has voted for the establishment of an electric light plant, and will want a 75½ or 100-h. p. engine, arc and incandescent dynamo, which have not yet been contracted for.

WILMINGTON, DEL.—The electric lighting contract with the Wilmington City Electric Company expires Jan. 1, 1895, and there will then be a competitor in the field—the Wilmington Light, Heat and Power Company.

LEXINGTON, N. C.—The Lexington Electric Light and Power Company has been organized with J. D. Neal as president, C. M. Thompson, vice president, and J. M. Riley, secretary, and a complete plant for both arc and incandescent lighting will be erected.

ALTOONA, PA.—The Edison Electric Light Company has bought the property in the Fifth Ward, located between the Pennsylvania Railroad, the branch railroad, Union avenue and Fred. Ramey's coal yard, and will erect there a large electric lighting plant.

COLUMBIA, S. C.—The Columbia Cotton Mill is to be operated by some 17 65-h. p. induction motors, taking their power from two 650-h. p. 500-volt three-phase generators, operated by water power some 300 yards distant from the mill. This plant is now being installed by the General Electric Company.

The Electric Railway.

OVID, MICH.—Taxpayers of Ovid have voted to issue bonds for electric lights.

ANDOVER, MASS.—The South Side Street Railway has been granted location on certain conditions.

EAST ORANGE, N. J.—The matter of awarding a contract for street lighting has been laid over to April 30.

CINCINNATI, OHIO.—The Mount Adams Street Railway line will build to the village of Oakley this summer.

WATERLOO, N. Y.—An electric road is to be constructed by the Seneca and Waterloo Electric Railway Company.

NEW BRITAIN, CONN.—Four miles of new electric road will be built by the Central Electric Light and Railroad Company.

MILWAUKEE, WIS.—The Milwaukee Street Railway Company will extend the Farrell avenue and Flotson place line to the Park.

ANDOVER, MASS.—The Lowell, Lawrence and Haverhill Street Railway has applied for right to lay tracks and operate a street railway.

HOLYOKE, MASS.—The People's Street Railway Company is to build a 9½ mile electric railway. Contracts have not yet been awarded.

BRISTOL, ME.—Negotiations are under way for the construction of an electric road from Pemaquid to Damariscotta, a distance of 13 miles.

FRIEDENSVILLE, PA.—James A. Endy, of Friedensville, is petitioning the Rapid Transit Company to extend its lines to Salisbury and Saucon.

GALESBURG, ILL.—A franchise is being asked by the Galesburg Motor Company for right to control and maintain an electric railway. W. Secord is president.

PLAINFIELD, N. J.—Messrs. Runyon & Moffett are contemplating the extension of the street railway to Netherwood, and are getting consents of property owners.

NORRISTOWN, PA.—The Norristown and Chestnut Hill Railway Company has been granted permission to build a line to be extended to Philadelphia within 14 months.

AUBURN, ME.—The special committee of the City Council has reported in favor of granting a franchise to the Lewiston and Auburn Railway Company upon certain conditions.

KANSAS CITY, MO.—The Kansas City Cable Railway and the Kansas and Independence Rapid Transit Company have consolidated. L. C. Kurthoff and Webster Withers are interested.

MONTGOMERY, ALA.—The street railway company has ordered 15 motors and car equipments of the General Electric Company, and is at work equipping all its lines for electric cars.

LOWELL, MASS.—The House of Representatives has passed to be engrossed the bill allowing the Lowell and Suburban Street Railway Company to extend its tracks and to use electricity.

DUNKIRK, N. Y.—The bill authorizing the Dunkirk and Fredonia Street Railway Company to furnish incandescent light and power to business houses and residences has passed the Senate.

WATERBURY, VT.—The Mt. Mansfield Electric Railroad is to be built, but it is not yet contracted for, and equipments will be wanted. Mr. M. H. McIntosh is the person to address for particulars.

MIDDLETOWN, CONN.—Mayor Vinal has vetoed the ordi-

nance granting to the Middletown Horse Railway Company the right to equip with electricity. It will come up again in modified form.

WEST SENECA, N. Y.—The petition of the Crosstown Railway Company, of Buffalo, for right to build and operate a street railway in West Seneca will be heard at the town meeting, May 1, at 2 P. M.

OPELIKA, ALA., is to have an electric railway seven miles long, extending to Auburn. Two motor cars and a generator will be used, and power will be furnished by the Opelika Electric Light and Power Company.

PHILADELPHIA, PA.—It is stated on good authority that the Penn Traction Company, of which ex-Senator John J. Patterson, of Lancaster, is the prime mover, will go ahead with its proposed trolley line from Harrisburg to Philadelphia.

LOCK HAVEN, PA.—The Lock Haven Railway, capital stock \$100,000, has been chartered, and arrangements will be made to build the line at once. J. H. Fredericks, T. H. Harmon and L. M. Patterson are the committee to make contracts.

BRADFORD, PA.—The Council has received a petition for right to build and operate an electric street railway from L. Emery, Jr., C. P. Collins, L. E. Hamsher, W. R. Weaver and C. C. Melvin, and the petition was referred to the joint street committee.

CLEVELAND, OHIO.—It is proposed to build an electric road at a cost of \$300,000, to be called the Cleveland and Akron Electric Railway. Hon. Martin Dodge, of Cleveland; Charles D. Everett, of Cleveland, and F. N. Wilcox, of Akron, are the promoters.

HARRISBURG, PA.—The Carbon Limestone Railroad Company, capital stock \$20,000, has been chartered to build a two-mile road in Lawrence County. The directors are James H. Reed, of Pittsburgh; James H. Bailey, of Allegheny, and John G. Robinson and Rawdon Evans, of Pittsburgh.

ST. PAUL, MINN.—In the matter of placing an electric light plant in the court house, five plans were submitted, but it was decided to reject all bids and call for new plans and specifications, and contracts will then be let.

EAST WEYMOUTH, MASS.—President John R. Graham, of the Quincy and Boston Railway, is anxious to extend the road to East Weymouth, and offers to do so if residents will take \$20,000 in stock, being one-half the estimated cost.

WAKEFIELD, MASS.—There was so much opposition to the petition of the Wakefield and Stoneham Street Railway Company for a franchise for a road on the Lake Drive that it is likely the matter will be submitted to a town vote.

SOUTH MOUNT VERNON, N. Y.—The Board of Trustees of South Mount Vernon has granted a franchise to the Union Railroad Company, of New York, to lay tracks on Third street, which will make 18 miles of road from West Farms.

NEW HAVEN, CONN.—A special to the New York "Evening Post" states that a syndicate has bought King's Island, and will dam the Connecticut River some 12 miles above Hartford, to supply towns and cities in the lower Connecticut valley.

ALBION, N. Y.—The Rochester "Times" is authority for the statement that right of way has been secured for the proposed one-rail electric line from Waterport to Lakeside, and that the company will erect a power house at Waterport on land already purchased.

FREEMPORT, ILL.—R. S. Brown, of Easton, Pa., has bought the street railway on behalf of a syndicate composed of himself, Congressman Haines, of New York, and Congressmen Mutchler Shibley, of Pennsylvania, and they will convert the road into an electric line.

ENFIELD, CONN.—A special to the New York "Recorder" states that Terry's Island, opposite Enfield, Conn., has been sold to a syndicate, which will build a dam there to develop power for supplying towns with electricity. C. Douglas, of Windsor Locks, Conn., will give details.

ORANGE, N. J.—Thomas Nevins & Sons, of Orange, N. J., have signed a contract for the purchase of the entire street railway system, 80 miles, of which 30 miles are trolley in the city of Detroit, Mich., and they will organize a \$10,000,000 company to develop the system and equip entirely with trolleys.

MANCHESTER, N. H.—It looks as if the proposed electric road for Manchester would soon become an actuality. General Williams, of Manchester, and Engineer William McQuestion, of New York, have been going over the proposed route, but they decline at present to give detailed information.

ATLANTA, GA.—The Atlanta Traction Company has been reorganized with Dayton Hall, president; W. C. Hall, vice president, and W. L. Sedden, secretary. The reorganized company will build additional lines, and has closed contracts with the General Electric Company for 10 motors and car equipments.

NEW ORLEANS, LA.—The Traction Company is pushing forward the work of equipping its lines with all possible speed. Sufficient money has been secured to pay off all indebtedness. James H. Maury, of New York, is president, and H. M. Littell, general manager. Within 90 days it is anticipated that four of the lines will be in operation.

NASHVILLE, TENN.—The electric railway has been placed in a receiver's hands. To satisfy an indebtedness of \$9,000 the road will have to be sold. The United Electric Railway was sold at auction April 18 to Nathaniel Baxter, Jr., representing the bond-

holders, for \$12,500. The road is 43 miles long, and the purchasers assume the bonded indebtedness of \$1,716,000.

Personal Notes.



MR. D. A. ANDREWS, JR., the vice president and treasurer of the Pettingell-Andrews Company, was born in Boston and has always resided in that city. After completing his studies he connected himself with the well known importing and commission firm of Stoddard, Lovering & Co., of Boston, where he received the very best business training. The business principles instilled by this firm he has always carefully observed and practiced, and they have contributed largely towards the success he has achieved for himself in the electrical business. His father, whose full name he bears, who laid the foundation for the present success of this company through his excellent financial management, was one of the most thorough of business men, so that it may be said that Mr. Andrews inherits his business ability. As is generally known, the Pettingell-Andrews Company succeeded the firm of F. E. Pettingell & Co., by which it was known when Mr. Andrews connected himself with it. He commenced at the "bottom round of the ladder," thoroughly informing himself of every detail of the business, and rapidly earned promotion, being admitted finally as a partner in the firm. In June, 1890, the business was incorporated as the Pettingell-Andrews Company, and Mr. Andrews was elected to the responsible position of vice president and purchasing agent. Upon the death of his father, about a year ago, he was elected to his present position, and has shown himself to be possessed of excellent financial ability and business judgment.

MR. C. B. PRICE, was born in Salem, Mass., where he still lives. After leaving high school he entered the drug business, in which he acquired valuable business knowledge and experience. He left this business to accept a position with the then F. E. Pettingell & Co., about the same time as Mr. Andrews. He was ambitious from the start, and was willing and eager to do anything that would familiarize himself with the business, finally securing an important clerkship in the firm, advancing himself to the position of principal salesman, and gaining admittance into the firm at the same time as Mr. Andrews, March 1, 1890. Upon the incorporation of the business into the Pettingell-Andrews Company, Mr. Price was made secretary, and upon the reorganization of the company after the death of Mr. Andrews, Sr., he was elected to his present position, for which he possesses unusual abilities.



MR. FRANK N. CICOTTI, manager of the railway department, was born in Detroit, Mich., attended private school there, and went to San Francisco, Cal., in 1867, via Panama, before the completion of the transcontinental railroad. He graduated at the Pacific College in 1869. He traveled extensively in Mexico, Central America and China in 1871, and made two trips to Japan in 1872. He entered commercial life in San Francisco in the latter part of 1872, and in 1874 he was appointed chief clerk of the mint of the United States at San Francisco, by President Grant. During his administration as clerk, from 1874 to July, 1881, \$27,000,000 was coined, being mostly the product from the Bonanza Mines, at Virginia City, Nev. Retiring from political life, Mr. Cicotti resumed commercial pursuits, acting from 1881 to 1887 as resident agent on the Pacific coast for Holmes, Booth & Hardens, electrical supplies, and also for various railway material etc. Leaving the Pacific coast he located in Chicago to accept the management of the railway department of the Electric Merchandise Company, of that city. In 1891 he started a tramway and railway paper in London, England, called the "Railway World," and still continues as a shareholder and director on the board of the English publishing company. In January of this year he accepted his present position of secretary and general manager with the Pettingell-Andrews Company.

MR. J. E. WILSON, the traveling salesman of the company, was born in Salem, Mass., received a good common school education, and commenced his business career with the Telegraph Dispatch Company of Boston, which was finally merged into the New England Telephone and Telegraph Company. He was with this company for eight years, gradually working himself up to the position of inspector and central office electrician. Leaving this company, he connected himself with the Financial Telegram Company, of Boston, now known as the United Telegram Company. He held the position of superintendent of this company for about three years. He then went to Chicago as representative of J. A. Grant & Co., of Boston, selling the well known McIntosh & Seymour engines, in which he was very successful, installing several plants, among which was one of 600 h. p. in the Wisconsin Central depot. Returning to Boston in 1891, Mr. Wilson became identified with the Eastern Electric Supply Company, of that city, and when this company was merged into the Pettingell-Andrews Company he went with it, and has retained his connection ever since. It will thus be seen that Mr. Wilson is an "old timer" in the electrical business.



Miscellaneous Notes.

THE CORRESPONDENCE SCHOOL OF TECHNOLOGY, Cleveland, Ohio, is preparing a new catalogue, which will announce a mathematical course commencing with algebra and going through the calculus, and also comprising advanced studies connected with various specialties.

COST OF INCANDESCENT LIGHTS.—The Edison Illuminating Company, of Milwaukee, has adopted the following schedule of rates: One cent per hour for each 16-candle power lamp, subject to a discount of 25 per cent. on monthly bills of \$25, and a discount of 50 per cent. on monthly bills of over \$50. The minimum charge to any consumer will be \$1 per month. The discount allowed heretofore was 5 per cent. on all bills up to \$50, and 10 per cent. on bills of more than that amount.

THE ASSOCIATION FOR THE PROMOTION OF PROFIT SHARING, of which Carroll D. Wright, United States labor commissioner, is president, General F. A. Walker one of the vice presidents, and the ubiquitous R. R. Bowker one of the directors, has issued a circular letter to employers and employees inviting their attention to the subject of profit sharing. Applications are invited for full information concerning the history and the results of the system, as it is now in operation in many establishments, small and large, in Europe and the United States. The secretary is Nicholas P. Gilman, 25 Beacon street, Boston.

THE OTTUMWA ELECTRIC RAILWAY, of Ottumwa, Iowa, has adopted a plan originated by its president and general manager, Mr. W. R. Daum, by which frequent patrons of the road can be given reduced rates that would not be available for the occasional rider. The company issues coupon books containing 100 tickets each, offering one book for \$4.50, three for \$12.90, five for \$20.25, ten for \$38. In addition to this the company agrees that the cover of each book, if presented at the office, will be accepted toward the purchase of another book at the following values: 25 cents if presented within 90 days, 50 cents if presented within 60 days, 75 cents if presented in 30 days from the date of issue. By this means those people who ride most frequently obtain the lowest rates. The company has limited this offer until May 15, and as an additional inducement further agrees that if 1,000 books are sold before that date the time will be extended 30 days for the acceptance on the covers at the values marked on all books sold by that date. The system is said to be working very successfully.

THE COMMERCIAL CABLE COMPANY'S THIRD CABLE—The steamer Faraday left London on April 1 with about 500 miles of the Commercial Cable Company's new cable, the destination being Waterville, Ireland, from which she will lay about 100 miles of shore cable and bury it, and then proceed to Fox Bay, Cango, N. S., and will lay about 400 miles more of shore cable there; then she will return to London, where she will take on board the balance of the cable, the laying of which will probably be completed by July 1. The conductor consists of 500 pounds of pure copper per knot and 228 pounds of gutta-percha dielectric per knot. It has the largest core of any cable ever yet laid. The material consumed consists of 1,100,000 pounds of copper, 800,000 pounds gutta-percha, 9,500,000 pounds steel wire, 1,200,000 pounds jute yarn and 1,000,000 pounds compound. A large portion of the cable has been supplied by John A. Roebling's Sons. The guaranteed speed of the cable is 75% greater than the present Commercial cables. The length is 2,250 nautical miles. Specially heavy types will be laid in the vicinity of the fishing grounds off Nova Scotia and Newfoundland. The contractors were Messrs. Siemens & Bros., of London, England.

POWER AT NIAGARA.—In a letter to a daily contemporary, a writer states that there is now in course of development about the great falls of Niagara, the enormous amount of 520,000 h. p. On the American side the old canal which for thirty years has carried water to the bluffs below the cataract is being enlarged until its capacity this spring will be over 40,000 h. p., and, when completed two years hence, will yield 100,000 h. p. Another, and a distinct, company has completed a tunnel under the city which has a capacity to convey sufficient water to generate 100,000 h. p. At present one mill is using the tunnel, taking 3,000 h. p. by gears direct from the wheel shafts, and will eventually put in wheels for 3,000 h. p. more. By June 1, 1894, the tunnel company will have in operation three dynamos, which, collectively, will generate 15,000 electrical horse power. When the proper demand arises, this will be increased to the capacity of the tunnel. The same company own the franchise upon the Canadian side of the river, and are just commencing work upon a tunnel there, which will, when fully completed, have a capacity of 250,000 h. p. And still a third company, this time composed of Canadian capitalists, have just received permission to develop 70,000 h. p. near the Horse Shoe rapids. Remembering that the United States census gives the entire horse power of the great city of New York, including steam heating plants, elevators, etc., at 236,000, the immensity of this Niagara development is seen, and it must be conceded that the day is far distant when this power can all be used at the point where it is manufactured. Referring to the subject of distribution, the writer says that at Niagara, where the severity of the climate makes ice and sleet the foe of overhead wires, and electrical disturbances in the atmosphere are of frequent occurrence, the engineers have decided that reliability can only be obtained by placing the wires under ground in a subway so large that men can pass through it to give attention to the cables. Twenty-five hundred feet of such a subway has been built as an experiment upon the lands of the company at Niagara. It is 5½ feet high by 3 feet 10 inches wide; is made of Portland cement and gravel, but it cost over \$20 a running foot to build. This cost is too great for long distance transmission, and the company now purpose erecting a pole line from the falls to Buffalo, on which experiments will be made. As to the transmission of power to Buffalo, it is stated that the electric lighting company in that place, after having carefully considered the question of Niagara power, has announced the conclusion that electricity could be generated by coal in Buffalo for less than it would cost to bring it from the Falls, and that it would at once erect a new power house in Buffalo. The street railway of the same city, after much consideration, is building two new power houses there, entirely ignoring Niagara. The conclusions of the writer are that the claim that electricity can be supplied from Niagara to all parts of the State of New York is extremely doubtful from a commercial standpoint, though feasible from an electrical one, and intimates that it can only be commercially applied at Niagara alone, and that the popular belief in long distance transmission has been fostered for ulterior purposes in the recent Erie Canal scheme.

Trade and Industrial Notes

THE GENERAL ELECTRIC COMPANY has sold 12 G. E. 800 motors, with six double controller equipments, to the Macon (Ga.) and Indian Spring Railway, and four motor equipments, one 85-h. p. generator and 2½ miles of track material to D. I. McIntyre, of Thomasville, Ga.

J. C. GRANGER & CO., electrical and mechanical engineers, 67 Remsen street, Cohoes, N. Y., make a specialty of complete lighting installations. Mr. Granger, the senior member of the firm, has had a particularly extended experience in mill lighting work, and is well known throughout the northern New York mill district.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., has received a contract from Dr. Drysdale, of Philadelphia, for an iron roof over the new power house for the hospital for the insane, at Norristown, Pa., to be covered with anti-condensation corrugated iron covering; also a contract for two cleaning sheds from the McNeal Pipe and Foundry Company, Burlington, N. J.

MESSRS. CHARLES A. SCHIEREN & CO., 47 Ferry street, New York, the well known manufacturers of perforated electric leather belting, have received quite a large order for this belting, consisting of two 32-inch double, four 10-inch double and one 13-inch double belts to be used in the power house of the Richmond Light, Heat and Power Company, Richmond, Ind.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 32 Cortlandt street, New York, of which Mr. H. L. Johnson is president, is actively engaged in the manufacture of telephones, magneto bells and other electrical specialties, at its factory in Jersey City. Not only has the sale of telephones increased this company's business to a very great degree, but, combined with the continued success of the Mesco dry battery, has taxed its factory capacity to its fullest extent.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, of St. Louis, Mo., has given agencies for the Wagner transformer to the following firms: Eastern agent, John Mustard, Betz Building, Philadelphia, Pa.; Northwestern and Canadian agent, Wells Goodhue, 1564 Monadnock Block, Chicago, Ill.; Southwestern agents, Western Electrical Supply Company, St. Louis, Mo.

ROSSITER, MACGOVERN & CO., 39 Cortlandt street, New York, announce their removal on May 1 to 141 Liberty street, Central Building, where they will continue their business as electrical contractors and Eastern agents of the Jenney Electric Motor Company. It is their purpose during the summer months to give particular attention to the sale of electric fan motors and installation of ventilating apparatus.

THE BINGHAMTON GENERAL ELECTRIC COMPANY'S VOLUNTARY DISSOLUTION.—Justice C. E. Martin, of the Supreme Court of Broome County, N. Y., on the first day of March on the reading and filing of a petition of a majority of the directors of the Binghamton General Electric Company, ordered that all persons interested in said corporation show cause before Henry C. Olmsted, appointed a referee for that purpose, on the 12th day of June, 1894, why said corporation should not be dissolved.

THE SOUTHERN ELECTRICAL MANUFACTURING AND SUPPLY COMPANY, 110 Baronne street, New Orleans, has issued a catalogue, giving a list of plants installed by it, and a number of very complimentary letters from its patrons. The extent of the business of this company may be judged from a list of its installations, which comprises plants for 33 sugar plantations, 27 oil, saw and cotton mills and sugar refineries, 3 central stations and 19 plants in steamers, breweries, ice manufactories, public buildings, etc. The aggregate of lights installed is 18,236. The repair shop of this company is the largest and best equipped in the South.

THE HARRISON NATIONAL TELEPHONE COMPANY, 44 Wall street, New York, is becoming widely known in the telephone field, attention being attracted by the large number of eminent and wealthy men in its board of directors, and also by the merits of its apparatus. The Harrison international telephone is an electric (not a magneto) telephone, and the patents for exchange system, magnetic bells, lightning arresters, switchboards (which are both automatic and manual), generators and all other devices are the sole property of this company, and consequently free from royalty or tax of any kind which go to make the cost to subscriber excessive. The transmission of vocal sound is clear and distinct, whether long or short distance, and the system embraces both automatic and manual switchboards of the most efficient kind. The patents are claimed to be all valid, and tested in the highest courts. Prominent patent attorneys have stated as their opinion that these patents are original and sound, and in no way infringe on any existing patents.

THE METROPOLITAN ELECTRIC COMPANY, 186 Fifth avenue, Chicago, has just issued a new catalogue, which presents a novelty in the way of its binding. Contrary to the usual custom in catalogues of its size, the Metropolitan catalogue has a cover of soft paper, with strong cloth end binding. The effect of this is that the book will remain open in almost any position, which readers will understand is a great advantage where a catalogue is certain to be opened and referred to frequently. The first 35 pages of the catalogue are devoted to figures and data of "N. I. R." wires and cables, and then follow chapters on switches, binding posts, connectors, fuse wire, etc. The "Metropolitan" incandescent lamp is described and listed, together with all sizes of miniature incandescent lamps. The next 55 pages describe supplies of different kinds, and then comes a chapter on "P. & B." specialties, for which the Metropolitan company is general Western agent. Fletcher's specialties occupy considerable space, as also the well known Garton lightning arrester and the "Blair lamp adjuster." Fixtures, shades, lamp sockets, construction tools, for both telephone and electric light work, are carefully catalogued, and special attention is given to fan motors, for both alternating and constant current. The house goods department of this catalogue is very complete. The book contains 452 pages, is neatly printed on good paper, and with its Chinese red cover presents an agreeable appearance.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

POWERFUL PRIMARY BATTERY, for Motors, Cautery or Electric Lamps. All summer Fan Battery and outfit. Boat Motors, \$35. Taylor's Booklet of Recipes and Advice, \$2.00. Catalogue No. 3 is ready. Taylor Battery Company, 51 Dey street, New York.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. **THE HAYDEN-BOOKER MFG. CO.**, 2140 DeKalb St., St. Louis, Mo.

THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT, Berlin, Germany, announce herewith that, owing to the general appreciation which their exhibition has met at the World's Fair, it is their intention to appoint selling agents in New York, Chicago, Cincinnati, Atlanta, San Francisco, Boston, Philadelphia, St. Paul, Washington, Denver, etc., for the sale of their manufacture. Trustworthy electrical firms inclined to handle their goods are requested to forward offers to head offices, 22 Schiffbauerdamm, N. W. Berlin.

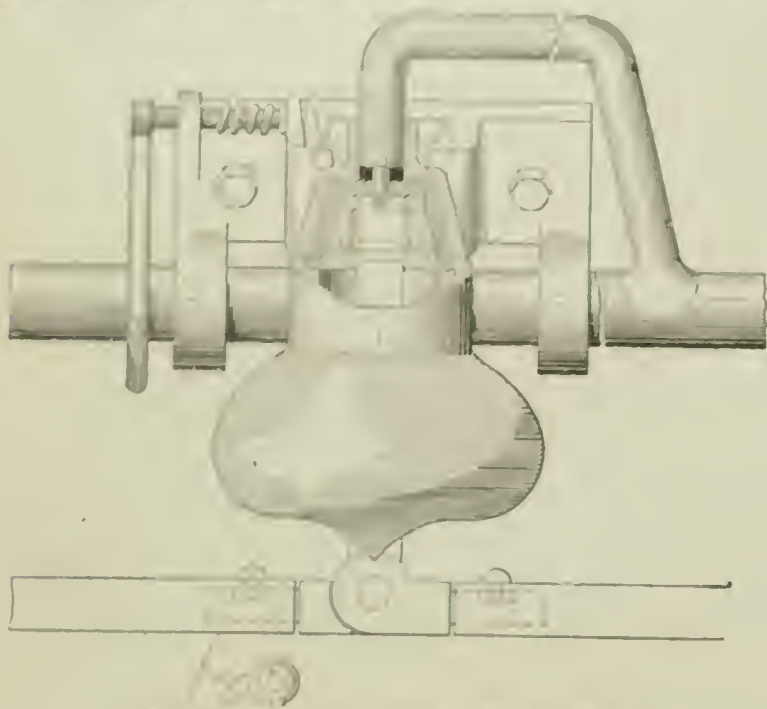
Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED APRIL 10, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

517,851. **ELECTRIC POWER APPLIANCE**; E. J. Arnold, Chicago, Ill. Application filed Aug. 31, 1892. A speed indicator for a dynamo electric machine, consisting of opposed gear rings, associated one with the driving shaft, the other with a moving part of the machine, and indicators proper actuated one from each ring.

517,858. **ELECTRIC MOTOR**; E. T. Greenfield, New York, N. Y. Application filed Oct. 1, 1891. The combination with an annular core made up of magnetic sections and non-magnetic sections of solenoids, brushes, of centering rollers and a centering and friction roller. (See illustration.)



NO. 517,858.—ELECTRIC RAILWAY.

517,862. **ELECTRICAL FOOT BATH**; I. A. Isaacs, New York, N. Y. Application filed Jan. 10, 1894. This consists of a vessel, a ring and voltaic couple thereon, a hot water inlet beneath the pipes, and an outside hot water pipe.

517,866. **GOVERNOR FOR ELECTRIC AND OTHER MOTORS**. N. S. Keith, San Francisco, Cal. Application filed July 5, 1893. This consists of a dynamo having its field magnet mounted to be rotatable in one direction by the torque of its armature on its field magnet, and rotatable in the other direction by a spring or weight, and means to control the supply of electricity to the dynamo.

517,884. **RAIL CUSHION**; T. C. Paulsen, Chicago, Ill. Application filed Dec. 29, 1893. The combination of a rail connector of two caps closed at one end, with a wire having one end inserted into the opening of each cap, the caps having the metal partially cut away on one side.

517,886. **ELECTRIC RAILWAY**; H. S. Pruyn, Hoosick Falls, N. Y. Application filed Nov. 1, 1893. In an electric railway system, a sectional conductor having rigid insulated joints and flexible insulated joints. (See illustration.)

517,910. **ELECTRIC RAILWAY SYSTEM**; C. D. Tidale, Boston, Mass. Application filed Jan. 17, 1894. The combination with a railway rail, of a sectional conducting rail provided with contact pins, an elastic support for the conducting rail, a main conductor, contact plate, and support for the same.

517,918. **METHOD OF, AND MEANS FOR, SPEED REGULATION OF ELECTRIC LOCOMOTIVES**, C. E. Emery, Brooklyn, N. Y. Application filed Oct. 14, 1892. This consists in connecting a generator, at will, with motors which severally develop different counter electromotive forces at like speeds of the car, thereby operating the car at different speeds for the same available voltage.

517,967. **ELECTRIC SWITCH**; A. T. McCoy, Boston, Mass. Application filed April 13, 1892. The combination of two levers, a pivot for the same, and a spring to maintain the levers one upon the other on the pivot, one of the levers being provided with prongs projecting at right angles to the same to meet the other lever and move the latter.

517,997. **MODE OF CONNECTING DYNAMOS TO CAR AXLES**; W. Biddle and P. Kennedy, Brooklyn, N. Y. Application filed July 4, 1893. This consists of divided rings clamped upon the axle of a car wheel, an armature surrounding the axle and armature rings in halves at the ends of the armature, screws for clamping same, field magnets at opposite sides of the armature, supporting frames for the same and half circle bearings surrounding the sleeve upon the axle and bolts for connecting the half circle bearings.

517,998. **ELECTRIC CAR LIGHTING SYSTEM**; W. Biddle and P. Kennedy, Brooklyn, N. Y. Application filed April 24, 1893. The combination of a car axle and a dynamo, a divided sleeve bolted upon the axle, a divided ring around the sleeve and bolts for connecting the same to the dynamo frame, and a link between the dynamo frame and the truck frame for suspending the dynamo.

518,006. **ELECTRIC LOCOMOTIVE**; W. Lawrence, New York,

N. Y. Application filed Jan. 21, 1893. The combination with a commutator having contacts, with brushes, a rocking shaft for moving the brushes into engagement with the contacts and with brushes.

518,015. **ICE-CUTTING TROLLEY**; R. W. Thompson, Cleveland, Ohio. Application filed Nov. 4, 1893. In a combined trolley and wire stripper, the combination of a centrally perforated hub provided with a grooved disc and concentric peripheral rings completing the sides of the groove.

518,033. **ELECTRIC MOTOR**; J. C. Henry, New York, N. Y. Application filed Aug. 19, 1890. The combination in a brush holder of a divided arm supporting the brushes, having tapered screw above and handle screwed thereon.

518,037. **ELECTRICAL ANNUNCIATOR**; R. L. Hunter, St. Paul, Minn. Application filed Feb. 13, 1893. This comprises a disc supplied with a series of notations, a stationary face plate having a separate opening for each series, and a cut-off plate arranged to cover and uncover the openings so that only one is open at a time.

518,062. **SPEED AND POWER REGULATOR FOR MOTORS**; H. B. Gale, San Francisco, Cal. Application filed June 21, 1893. The combination of a motor, an auxiliary generator and secondary battery for regulating the power thereof, and electrically operated valves controlling the supply of working fluid to the motor.

518,071. **TROLLEY WIRE INSULATOR**; L. McCarthy, Boston, Mass. Application filed June 8, 1893. This comprises an outer case, having arms to secure the same to the span wire, an insulated portion fitting within the case and a screw connecting piece for securing the insulator to the clip on the trolley wire, the case having a downwardly projecting skirt extending below the lower portion of the insulator proper.

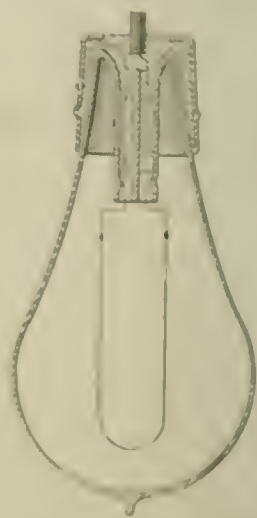
518,092. **PERMANENT MAGNET**; A. T. Collier, St. Albans, England. Application filed Jan. 8, 1894. This consists of a bar or bars formed as a loop or coil, having the ends crossing each other and both extending inward toward the interior of the loop or coil to constitute two poles.

518,133. **ELECTRICAL CONTACT MECHANISM**; J. F. Blake, New Haven, Conn. Application filed Jan. 25, 1894. This comprises a lever provided with terminals and with an insulating portion, a rolling contact adapted to travel between the terminals and the insulating portion, and a hollow spring connected to the lever to receive pressure for actuating the same.

518,142. **TELEPHONE TRANSMITTER**; J. and H. M. Goodman, Louisville, Ky. Application filed Aug. 19, 1893. This comprises two magnets and a mass of metal susceptible of magnetic induction, and in a state of comminution, between the extremities of the magnets, in combination with a vibrating diaphragm mechanically connected at or near its centre with an extremity of one of the magnets, and an electrical condenser.



NO. 517,858.—ELECTRIC MOTOR.



NO. 518,173.—INCANDESCENT LAMP.

518,179. **ELECTRIC INCANDESCENT LAMP**; J. E. Criggal, Springfield, Mass. Application filed Dec. 8, 1893. A lamp bulb having supported within its neck two tubes of glass, which are open from end to end, the leading-in wires passed longitudinally through the tubes, a cement or plastic material filling and closing the inner ends of the tubes, a quantity of mercury in the tubes above the inner end-filling, and a filament connected to the inner ends of the leading-in wires. (See illustration.)

518,188. **CIRCUIT SWITCH**; E. E. Hersh, B. F. Woodward and J. W. Pettee, Denver, Col. Application filed Oct. 25, 1893. This comprises a casing, a T-shaped rotatable switch block, two contact brushes adapted to engage the block, an apertured face plate, and a single push button for actuating the switch block.

518,198. **ADJUSTABLE ELECTROLIER**; C. M. McCamey and S. H. Root, Izemont, Col. Application filed Dec. 5, 1893. The combination of depending stationary metallic tubes insulated from each other and connected with the feed wires, metallic rods telescoping within the tubes and provided with adjustable spring contact brushes, the outer tubes insulated from the inner tubes, an insulating base connecting the rods, and lamp wires respectively connected with the rods.

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Established 20 years ago THE ELECTRICAL WORLD is the Pioneer Electrical Journal of America, and has well maintained its lead. It has the Largest Circulation of any electrical periodical in the world, and is the Best Advertising Medium.

In the growth of the paper in circulation, size and general improvement, the value of its columns for reaching those engaged in electrical pursuits has not failed to be appreciated by advertisers. The following table shows its steady onward march in this department of business. The first issue of

1880 contained 25 different adv'ts.	1887 contained 154 different adv'ts.
1881 " 28 " "	1888 " 175 " "
1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 289 " "
1884 " 82 " "	1891 " 325 " "
1885 " 100 " "	1892 " 316 " "
1886 " 138 " "	1893 " 317 " "

The first issue of 1894 contained 320 different Advertisements.

No announcements of the Publisher are included in this list.

"WANT" AND "FOR SALE" ADVERTISEMENTS

are a special feature of THE ELECTRICAL WORLD. Position Wanted small advertisements cost but \$1 an insertion; Help Wanted and For Sale small advertisements cost but \$1.50 an insertion. Remit in advance for the number of insertions desired.

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THE ELECTRICAL WORLD,

253 Broadway, New York.

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STREET RAILWAY TRACTION PRIZE.

A bill introduced by Senator Coggeshall was passed at the last session of the New York State Legislature offering a prize of \$50,000 for the invention of an economical street railway system of traction. We have thus far been unable to secure details, but it is probable that the bill incorporates the terms of the recent sham competition of the Metropolitan Traction Company.

A NEW SYSTEM OF POLYPHASED DISTRIBUTION.

Elsewhere Lieutenant Patten describes a new system of polyphased distribution which is interesting not only intrinsically but as showing the flexibility of alternating currents. As explained, the system is one in which two alternating currents differing in phase by 120 degrees are transformed at the generating station into triphased currents for line transmission by means of transformers, and at the point of consumption are again converted as required by the same means, step-up and step-down transformers being respectively used for the two operations. The salient feature claimed for the system, and the one in which it differs from that of Mr. C. F. Scott, which we recently described, is that either biphased or triphased currents may be transformed to a single alternating current that will tax the two biphased or three triphased lines equally, and thus secure an equal distribution of a single-phased load among the different circuits of a biphased or triphased system. As will be seen, the biphased currents are not generated in quadrature relation to each other, as in Mr. Scott's system, but with a phase difference of 120 degrees. Either ring type or simple transformers are used, according to the requirements, and thus a number of transformations rendered possible.

ELECTRICITY VS. COMPRESSED AIR.

In another column is printed an abstract from the annual report of the city engineer of Omaha, giving estimates for transmitting a large amount of power a distance of seven miles, and based upon both electricity and compressed air as the agents. While such a short distance is favorable to the use of compressed air, we doubt if it would actually have the advantage shown. The estimate for electricity is based upon prices which, owing to the already large experience in this country in building large units, and the simplicity of the estimates for the line, are probably very nearly correct. Those for compressed air, on the other hand, can only be approximate for lack of such experience, and, unless this one instance should prove an exception to similar doubtful estimates, would probably be far below the actual cost. The comparison between the advantages of electricity and compressed air is also hardly fair. The objection to electricity on the ground of less safety we are rather surprised to meet at this day, for it has become generally recognized that with the ordinary precautions now taken this has ceased to be an element to be considered. We are still more surprised to find that electricity as a mode of transmission for general power purposes is objectionable on the ground of relatively less ease of application, and that it affords less constancy of operation and freedom from jerks than power from compressed air. As the points named are the only ones urged in favor of compressed air and the points in which electricity is acknowledged to be superior are real ones and of great weight, the comparison is, in fact, entirely favorable to the latter.

RAPID TRANSIT.

While the force of public opinion caused the New York Legislature to finally pass a rapid transit bill for New York, the politicians and the interests adversely affected by it were sufficient to badly cripple the measure. If signed by the Governor the referendum clause requires that the matter be submitted to a vote, which also introduces a question of constitutionality, so that if the gauntlet is finally passed, work cannot be begun for a year or more. With the commission named in the bill, however, there is little danger of the Manhattan monopoly obtaining control as it did of the present commission, and there seems also to be no doubt as to the people approving the measure by their votes. Unsatisfactory as the position of New York is, it is yet better off than Boston, where there seems to be irreconcilable differences of opinion as to the proper rapid transit plan to adopt. While Mayor Mathews favors a subway plan, the rapid transit committee of the Legislature opposes it and favors elevated railways, and, as was the case in New York, the underground tunnel plan does not seem to have enough "in it" to gather much of a following. Chicago also appears to be committed to elevated railways, whose popularity everywhere may probably be explained on the ground that their construction involves many political berths and jobs through the condemnation of property and otherwise—for no rational grounds seem to exist for the preference.

PRACTICAL ASPECTS OF RESONANCE.

The subject of electrical resonance, though only recently brought forward in a definite shape by Drs. Pupin and Duncan, seems likely to play an important part in practical electrical engineering. In another column we publish the first part of an important paper by Mr. F. W. Dunbar, which shows that the principle of electrical resonance may possibly create a revolution in the electrical transmission of power. While the mathematical sections may appear difficult to some of our readers, they can nevertheless easily follow the article, as these sections are merely proofs of the statements made and do not therefore interfere with an understanding of the principles treated. As stated by the author, the object of the articles is to bring forward the practical importance of capacity and self-induction in long lines and demonstrate that, instead of being detrimental, they may, in a properly designed circuit, become of great practical utility and allow a great reduction of copper to be made over that of a direct current at the same voltage. It will also be shown that if the transmission line is in resonance the impedance of the receiving apparatus will not affect it, provided the line is over a certain length, which, fortunately, falls within practical limits. One point of great practical importance, however, is left open, and that is how the necessary self-induction may be obtained. The use of properly designed bimetallic conductors suggests itself, but then the question of losses through hysteresis comes in, as does the question of resistance if open coils are employed. These, however, are points that can be taken up in turn, and the principle of practically tuning long-distance electrical lines once established, a satisfactory solution for them will doubtless be found.

MODERN ELECTRICITY.

The development of alternating currents has, it may truly be said, revolutionized the science of electricity, and introduced an order of ideas much more complex and difficult to grasp than those connected with continuous currents. The latter require no particular preparatory education of the mind to understand, the ideas being of a simple kind that merely require an exercise of the ordinary faculties to comprehend. With alternating currents, however, the more abstruse notion of rates is introduced, which is one that everyday operations do not usually involve, and therefore has

to be cultivated. The phenomena, therefore, due to the principle of rates cannot be thoroughly grasped until that principle is comprehended. As a consequence, whoever wishes to obtain a thorough understanding of alternating current phenomena must not depend too much upon his knowledge of continuous currents, but should rather commence again at the beginning and learn the fundamental principles, without which he cannot go very far. Ordinarily, our ideas are bound up in the absolute magnitudes of a phenomenon and with no reference to the influence of the rate of change of these magnitudes, but in alternating currents it is the rate of change which is the prime principle to be borne in mind, the nature of the phenomena, and, to a more or less extent, their effect, depending upon this alone. An extensive mathematical knowledge, however, is not necessary to understand the subject; in fact, the difficulty of treating it mathematically, except with the aid of assumptions that all depart more or less from the truth, are such as to be apt to render that method the last one to be chosen. On the other hand, some of the graphical methods proposed are even worse, as they introduce a complexity of lines, which, divorced as they are from any physical meaning, only further involves the subject. There are methods, fortunately, by means of which the path may be made clear for the student. That followed by Mr. Scott in his paper, recently reprinted in our columns, is one of these, as are those employed by Lieutenant Patten in his series of "Laboratory Notes." Neither of these uses any mathematics, the graphical representations are simple, yet the purpose sought is nevertheless attained. The use of analogies is another fruitful method. Dr. Pupin, in his explanation of the phenomena of resonance, has shown how beautifully this method may be employed, and it is the one used by Mr. Dunbar in another column with much success.

Students' Course at Schenectady.

An article in a recent issue of *The Electrical World* on the education of electrical engineers referred to the students' course in practical electrical engineering at the Schenectady works of the General Electric Company, but incorrectly stated that a fee of \$100 is required for admission to the course. For a while, we learn, such a fee was charged, but it was soon found that it barred out many young men who had made their own way through college and were just the kind of men wanted, but who could not very well afford to pay an entrance fee; it was therefore abandoned and the money refunded to those who had paid. We are also informed that it is not the custom to put students at work sweeping floors and doing general dirty work, but, on the contrary, they are placed where they may learn the details of the various apparatus in the most systematic and thorough manner, the object being to supplement the collegiate education of the young men by a practical course that will render them thoroughly competent electricians.

The course is intended for a limited number of young men possessing the degree of civil, mechanical or electrical engineer, or who have had three years' experience in electrical or machine shop work. At present, we learn, the complement is full, and there will be no vacancies during the present year. The object is to furnish the student with a thorough practical knowledge of the various processes through which a piece of electrical apparatus is carried from its inception to completion, as well as of the various mechanical and electrical principles involved. To accomplish this the student is placed for a limited time in each of the various departments of the factories, where, under the supervision of the foreman, he takes part in the actual work done, and is given such instructions as may be necessary to enable

him to accomplish the work in an intelligent and satisfactory manner.

The usual time occupied in covering this ground is about two years, and the student is paid at the rate of 8 cents, 10 cents, 12 cents, and 17 1-2 cents per hour for each period of six months. All students are required to observe the same rules, regulations and hours of work as the regular workmen. The General Electric Company does not guarantee to retain in its employ any student after the completion of the prescribed course, and unsatisfactory work or a serious violation of the rules and regulations is considered sufficient cause for discharge.

The following is a schedule of the course, with the time devoted to each branch:

Kind of work.	Months.
1. Erecting Department:	
Assembling motors and dynamos.....	2
Winding field magnets	1
2. Tube Department:	
Galvanometer work, junction boxes, etc.....	2
3. Armature Department:	
Winding and connecting armatures, Gramme ring.....	1
Winding and connecting armatures, drum.....	1
Testing armatures	1
4. Motor Department:	
Testing small motors and generators.....	2
5. Testing Department:	
Testing large motors and generators	2
Use of instruments and general testing.....	1
6. F. and A. Department:	
General machine work.....	2
Commutator work	1
Shop wiring and power station.....	2
7. Cable Department:	
Finishing cables, testing insulation, etc.....	2
8. Engineering and special work.....	4
	24

American Institute of Electrical Engineers.

The Philadelphia local committee is making elaborate arrangements for the entertainment of members of the Institute who attend the coming annual and general meetings in that city. The social features are being especially arranged with regard to the attendance of ladies, and it is hoped that the fair sex will be well represented. This being the tenth anniversary of the Institute, the rule of strict attention to business will necessarily be relaxed somewhat in order that members and guests may avail themselves of the proverbial hospitality of the City of Brotherly Love. In addition to the list of papers published last week, Dr. Louis Bell will present one upon "Some Facts about Polyphase Motors."

A brief outline of the preparations in progress, prepared by Chairman Willyoung, of the local committee, embraces the following functions:

On Tuesday, May 15, address of welcome by Mayor Stuart, to be followed by the annual business meeting and reading of papers. Mr. Wurts' paper on "Lighting Arresters," will be accompanied by experimental demonstrations at the station of the Philadelphia Traction Company. In the evening will occur the annual dinner of the Institute and a theatre party for the ladies.

Wednesday afternoon, a tally-ho excursion will be provided for the ladies, and the Engineers' Club will tender a reception in the evening.

Thursday afternoon will be occupied by a visit to Cramps' shipyard, followed by a steamer trip down the river to Gloucester, where a shad dinner will be served.

Fuller details of the arrangements will be given in the official programme. Visiting members will be welcome to the office facilities of Messrs. Houston and Kennelly, rooms 1105-1106 Betz Building, near the Pennsylvania R.R. station, where letters may be addressed.

The secretary of the Institute would deem it a favor if those who propose attending the meeting will write him to that effect at 12 West 31st street, New York City.

THE CHICAGO MEETING.

The April meeting of the Chicago section of the Institute was held on the evening of April 25, and was a very successful one. A considerable number of electrical and street railway men not members of the Institute were present, the total attendance being over sixty. Mr. Rodman was chosen chairman of the meeting, and after the reading of Mr. Farnham's paper by Mr. Abbott and the exhibition of the lantern slides, the discussion was carried on by Messrs. Arnold, Abbott, Stine, Welles, Armstrong, Alderman Mann and others.

After the discussion was closed, it was moved and carried "that it is the opinion of the Western members of the American Institute of Electrical Engineers that the expenses incurred in connection with the local meetings held in Chicago should be paid out of the general fund of the Institute, and that a committee of three, of which Mr. Hibbard shall be chairman, be appointed to bring this matter to the attention of the Institute at the annual meeting in Philadelphia next month for the purpose of securing, if possible, such legislation as will make the general funds available for this purpose."

Power Transmission for Omaha.

In his annual report for 1893 Mr. Andrew Rosewater, city engineer of Omaha, discusses the problem of making Omaha a manufacturing centre by means of water power generated seven miles distant from the city and transmitted thereto by electricity or compressed air.

Two plans for the development of the water power have been studied, one based upon a continuous delivery for 24 hours, and the other on a delivery for 10 hours and a storage of 750 cubic feet per second for 10 hours and a storage of the flow during the remaining 14 hours. The former would develop 18,567 h. p. throughout 24 hours at the wheel shaft at a cost of \$2,000,000 for development, and the latter 22,279 h. p. for 10 hours at a cost of \$1,500,000 for development, or, assuming 6,500 h. p. used in the first case during the night, at a cost for development of \$80 and \$67.33 per horse power, respectively. The cost of a net water power per annum at the wheel shaft will in the first case be \$9.60 and in the second \$8.08, calculated on the basis of 5 per cent. for interest, 4 per cent. for depreciation and repairs, 2 per cent. for operation and 1 per cent. for taxes.

Electrical Transmission.—An electrical installation capable of transmitting the requisite power a distance of seven miles with an efficiency of 70 per cent., based upon the prices given by electrical manufacturers, will cost about \$73 per horse power of net delivery seven miles from the plant, and the yearly cost of transmission per horse power of a 20,000-h. p. plant is estimated as follows:

Interest, 5 per cent.; depreciation and repairs, 8 per cent.; attendance and operation, 2 per cent.; taxes and insurance, 1½ per cent.; total. 16½ per cent.; 16½ per cent. of \$73.00 equals.....	\$12.05
Estimated cost of canal power, } 100	
\$9.60, which to deliver one elec- } of \$9.60, equals.....	13.71
trical horse power net must be } 70	
Total cost per net horse power, plan No. 1.....	\$25.76
With canal at \$8.08 } 100	
per horse power } \$8.08 multiplied by — equals	\$11.54
at wheel shaft; } 70	
Electric transmission per horse power.....	12.05

Total cost per net horse power, plan No. 2..... \$23.59

Compressed Air.—The cost per net horse power of compressors, receivers and seven miles of mains for a 20,000-h. p. installation, based on 70 per cent. efficiency, per net horse power, delivered, is estimated at \$52.70. The annual cost of transmission is approximated as follows: Interest, 5 per cent.; depreciation and repairs, 6 per cent.; attendance and operation, 2 per cent.; taxes and insurance, 1 1-2 per cent.; total, 14 1-2 per cent., which gives \$7.64 as the annual cost of transmission per net horse power.

Cost of canal power required to develop one net power delivered (plan No. 1)	\$13.71
Cost of transmission	7.64
Cost of coal for reheating	.80
Total	\$22.15
Canal horse power per (plan No. 2)	\$11.54
Cost of transmission	7.64
Cost of coal for reheating	.80

Total

The above includes the cost of coal for reheating at point of consumption to compensate for loss in transmission.

Mr. Rosewater is of the opinion that there are advantages in compressed air transmission over electrical transmission, due to the mechanism being much simpler, the absence of danger in connection with its use, its direct applicability to old engines and more extended application. In addition, he states that the lost power of transmission can be regained with the application of very little heat where the power is used, it being claimed that over 70 per cent. of the heating power of coal can be derived in heating compressed air, while less than 15 per cent. is obtained in its application to the steam engine.

Mr. Rosewater gives the following estimated cost of 1 h. p. generated by steam in the vicinity of Omaha, January, 1894:

Description of Plant	Net Horse Power	Loss of steam lbs. per hour	Cost of steam per h. p. per year of 308 days, 10 hours each, at \$5 per ton.	Approx. cost of engineer, fireman, and supplies per h. p. per year of 308 days.	Approx. cost of interest, tax and depreciation per h. p. per annum.	Approximate total cost per h. p. per annum.
Omaha Street Railway	1500	5.71	\$19.34	\$6.00	\$6.33	\$31.67
* Florence Station Omaha						
Water Works	701	1.583	8.83	6.00	6.33	21.16
Izard St. Sta. Omaha W. Wks.	566	0.90	17.40	7.85	7.77	33.02
Elway St. Co. Bldg.	215	0.3	19.62	8.92	8.01	36.55
Walton Hill Sta. Omaha	122	0.33	13.72	15.15	8.77	37.64
Woodman's Lint'd Oil Wks.	100	0.5	25.41	15.15	8.77	49.33
Co. Bufile Bridge & Motor Co.	100	0.55	23.12	15.15	8.77	47.04
24th and Popple St. Omaha						
Water Works	66	0.429	31.49	25.87	10.39	67.75
River St. Co. Bldg. W. Wks.	63	0.5	48.40	25.87	10.39	84.66
Lincoln Street Railway	425	....	22.71	9.55	7.10	39.51
Flourish Laundry, Omaha	40	....	....	....	....	....

The cost of coal was deduced from approximate data obtained at the various installations mentioned. The remaining expenses were approximately deduced from state reports and tables of steam engineering experts.

* Triple expansion engine.

For comparison with the above we give below a carefully prepared schedule by Dr. Emery, which Mr. Rosewater finds closely approximates to data he gathered from various sources, the cost being expressed per year of 308 days of ten hours each:

5 horse power engine	\$175.00	per horse power
10	108.75	"
15	88.80	"
20	72.10	"
25	66.00	"
50	51.00	"
200	27.50	"
300	25.80	"
400	25.01	"
500	24.70	"

The following is a resume, showing the comparative total investment in steam and water power plants as per plans 1 and 2, and the cost of operation per annum, the latter including interest, maintenance, etc.:

	Direct Transmission	Power Plant	Power Plant	Net horse power
	Cost of plant	Annual revenue	Cost of plant	Annual revenue
* Steam	\$1,000,000	\$100,000	\$1,000,000	\$100,000
* Canal	\$1,000,000	\$100,000	\$1,000,000	\$100,000

The following resume shows the relative cost per net horse power delivered in the city by steam and water transmitted electrically and by compressed air on schemes 1 and 2:

* Scheme 1, steam power electrically per net horse power per year of 308 days of ten hours each	\$44.32
* Scheme 1, steam by compressed air per net horse power per year of 308 days of ten hours each	49.71
Canal power, 24 hours continuous delivery, electrically as above, scheme 1	25.76
Canal power, 24 hours continuous delivery, by compressed air as above, scheme 1	22.15

Canal power, 24 hours continuous delivery, electrically as above, scheme 2	23.59
Canal power, 24 hours continuous delivery, by compressed air as above, scheme 2	19.98

*Twenty-five per cent. to be added to make up for 6,500 h. p. night service on water plant.

The conclusions reached by Mr. Rosewater are as follows: First—There is over 50 per cent. loss sustained in the operation of power plants as generally used.

Second—This power can be more economically secured through large central power installations.

Third—That with the existing conditions at Omaha, water power is cheaper than steam power.

Fourth—As between electricity and compressed air as a mode of transmission, for lighting and electric railway purposes, an electrical installation of sufficient capacity directly connected with the waterwheel will be preferable. For general power purposes, on the grounds of greater safety and ease of application, constancy of operation and freedom from jerks, which are complained of even where large flywheels in electric transmission are used, compressed air would be more desirable and economical.

Thirteenth Annual Meeting of the American Street Railway Association.

The thirteenth annual meeting of the American Street Railway Association will be held at Atlanta, Ga., on Oct. 17, 18 and 19, 1894. The following papers and addresses will be presented:

"Can the T Rail be Satisfactorily Used in Paved Streets?" Joel Hurt, president of the Atlanta Consolidated Street Railway Company, Atlanta, Ga.; S. Hendrie, manager of the Wyandotte and Detroit River Railway Company, Detroit, Mich., and H. J. Crowley, engineer of the Atlanta Consolidated Street Railway Company, Atlanta, Ga.

"City and Suburban Electric Railways": Elwin C. Foster, superintendent of the Lynn and Boston Railroad, Boston, Mass.

"Mall, Express and Freight Service on Street Railway Cars": Richard McCulloch, electrical engineer of the Citizens' Railway Company, St. Louis, Mo.

"The Best Method of Treating Accidents and Complaints": John B. Parsons, general manager of the West Chicago Street Railroad, Chicago, Ill.

"Street Car Wheels and Axles": D. S. Cook, electrical engineer of the Trenton Passenger Railway Company, Trenton, N. J.

"Transfers and Commutation": Rodney Curtis, president of the Denver Tramway Company, Denver, Col.

"The T Rail Construction of the Terre Haute Street Railway Company": M. F. Burke, superintendent of the Terre Haute Street Railway.

"A Standard Form for Accounts for Street Railways": H. I. Bettis, constructing engineer of the Atlanta Consolidated Street Railway Company, Atlanta, Ga.

Testing Iron.

In the Lond. "Elec.," April 13, Mr. Parsons gives some further information regarding the matter mentioned in the Digest April 14, and under "Hysteresis Testing," April 7; he ascertains that the induction is equal in both cores by observing whether the voltage across the terminals of each coil is the same; in iron cores of medium permeability, practically the whole magnetic resistance lies in the air gap, hence with similar cores of iron the induction is necessarily equal; since the total number of lines, if the coil has a small resistance, is proportional to the voltage of the coil, by varying the cross-section of the core, the induction can be varied; that this is correct, he claims, is shown by the rate of increase of temperature varying with the cross-section of the core.

Direct Currents "Not Quite Obsolete."

In a recent discussion in a London electrical society, Mr. Mordey, in referring to a certain instrument, remarked that it "was only suitable for direct currents which were not quite obsolete."

ELECTRICAL FEATURES OF THE MIDWINTER FAIR

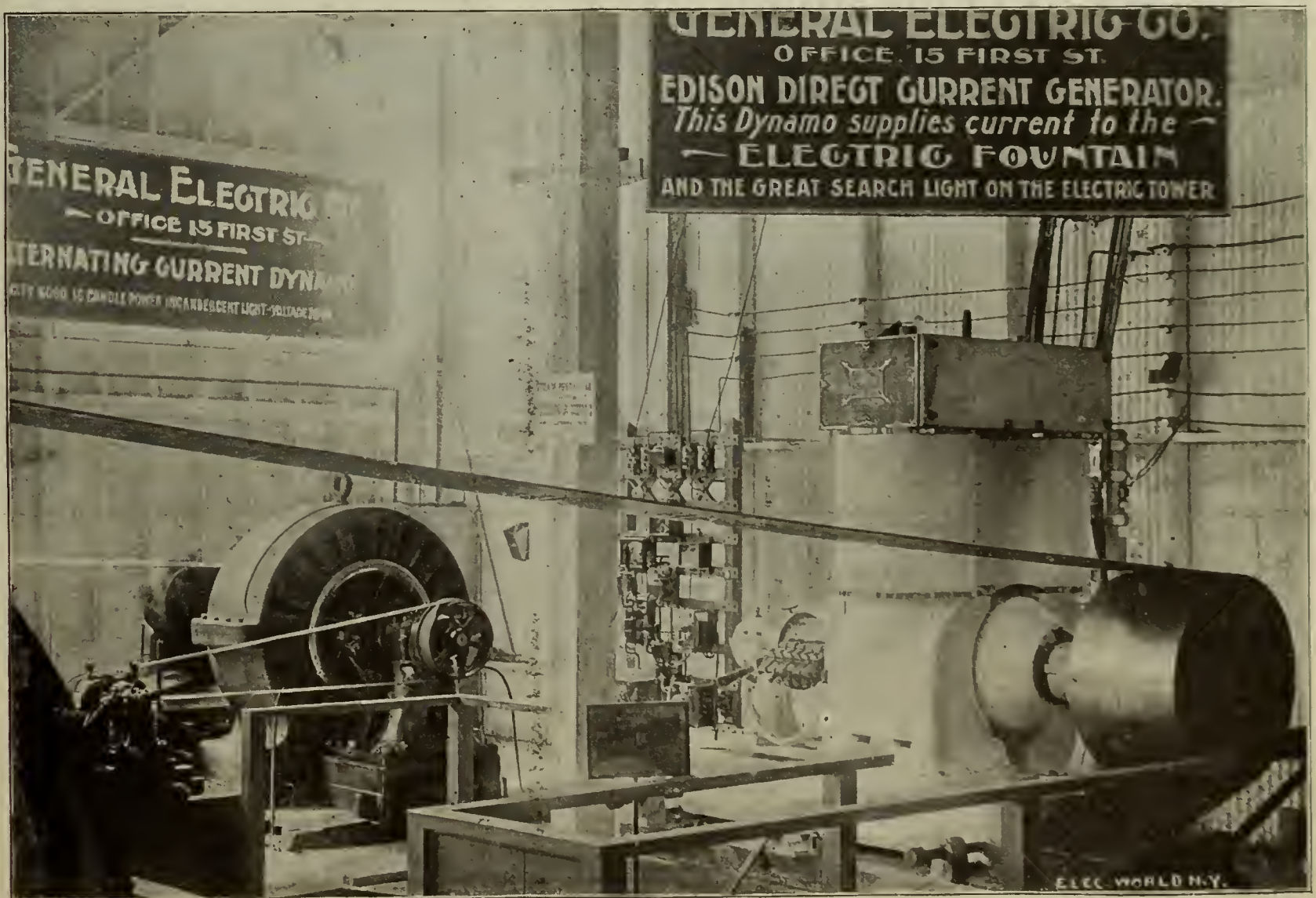
No industrial exhibition in these days would be considered successful in which a considerable portion of the space allotted to machinery was not taken up with electrical machines and apparatus. The Midwinter Fair, though far from the industrial centres, has a fine electrical exhibit, almost entirely from beyond the Mississippi, and the fact that the Eastern manufacturers are willing to incur the expense incident to an extensive display shows the important position the extreme West is taking as a user of electrical machinery.

The Pacific coast early took a position in the electric railway field, and now has many fine roads in operation and many more projected or building, while recent schemes for long distance transmission of power on a large scale make the coast well worthy of study.

As was the case at the World's Fair at Chicago, the largest

with a love for machinery, will be likely to find the exhibit of incandescent apparatus. It is not by any means insignificant, but is placed in the annex, outside the regular beat of visitors. Nevertheless it is prominently placed in the annex, and the machines are of sufficient capacity to attract attention. The view given shows that it consists of machines of both the direct and alternating current type. The alternating system is represented by one 6,000-light Thomson-Houston alternator of 24 poles and giving 1,440 volts at 680 revolutions. It is belted through a counter shaft to a Corliss engine, hastily put together for the purpose. A standard skeleton switchboard carries the regular station instruments. This dynamo is used for lighting concessions.

The direct current is generated by a 150-kw. bipolar dynamo of the Edison type, shown on the right. It is run at



DISPLAY OF THE GENERAL ELECTRIC INCANDESCENT SYSTEM.

exhibitor is the General Electric Company, about half the available space being taken up by it. Its exhibit covers very well every variety of commercial apparatus made at its factories, a very prominent place in the centre of the hall being given to the multiphase and mining display. Incandescent lighting is so well known and needs so little advertising, that only visitors with a capacity for nosing about, or

110 volts, and supplies current for the electric fountain, for the great searchlight on the Bonet tower, and a smaller one on Machinery Hall.

The series arc exhibit consists of eight Thomson-Houston arc dynamos of 50 lights each, together with the necessary lamps, etc. They are used for lighting roads and concessions and are run at full capacity. These dynamos are ar-

ranged in two groups of four machines each, one group being run by a Buckeye engine, and the other by a Russell. In each case a counter shaft is used to give the requisite speed, and two dynamos are driven from each pulley on the counter shaft.

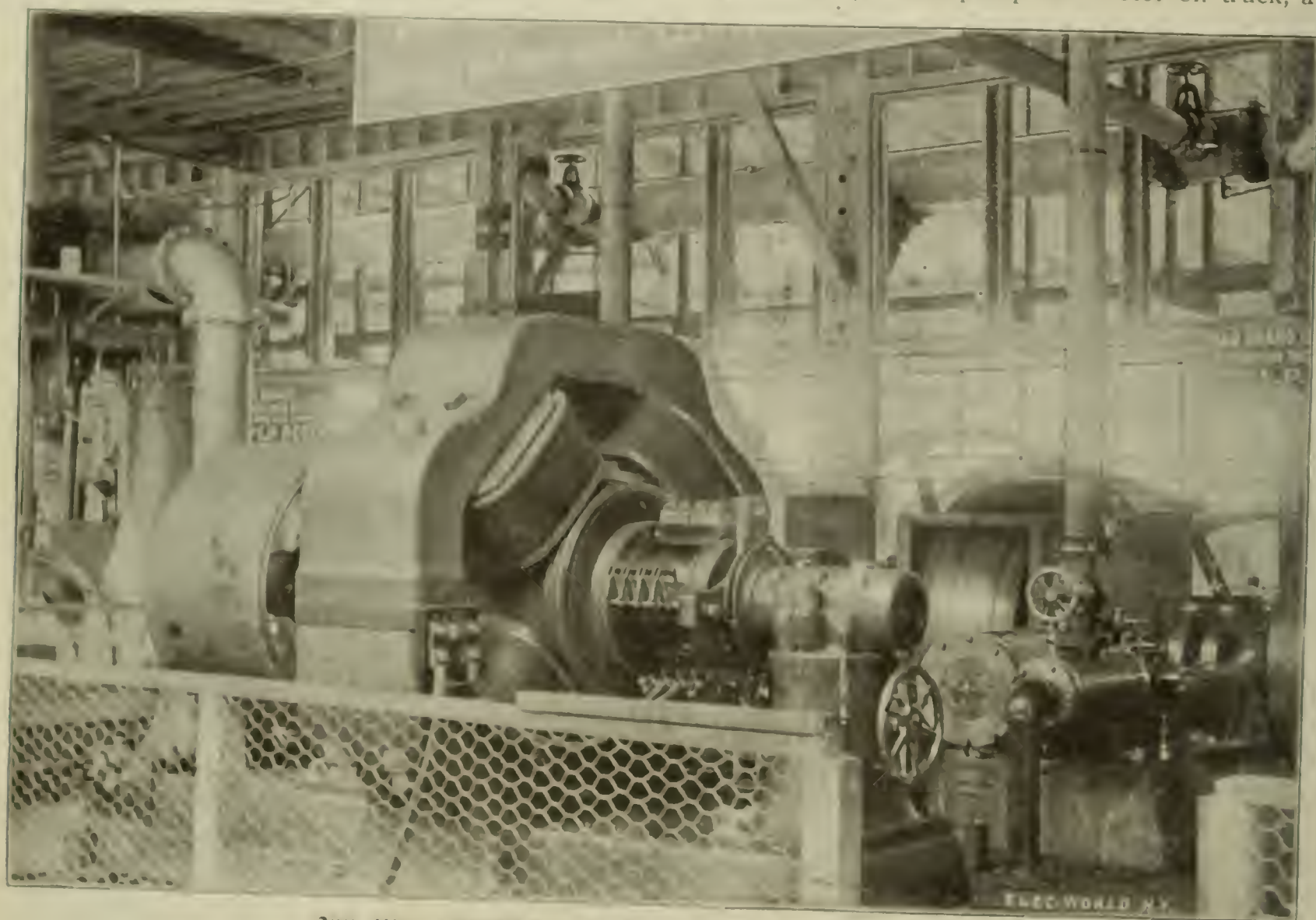
Railway station equipment are represented by one 200-kw. four pole generator, a view of which is given. It is used for lighting the cornice lamps on the main buildings, furnishing current for the elevator motor in the tower, running a 60-kw. motor for the Western Electric Company, and several small motors in the Manufacturers' Building and other parts of the grounds. The cornice lights are arranged in groups of ten in parallel, with five groups in series, single series of five lamps being used where necessary to fill in a space. There is also a panel with necessary power house instruments.

The railway exhibit is limited to a truck fitted with two G. E. 80c motors, with S. P. controllers. The motors turn slowly with a 110-volt current, the truck being raised to allow the wheels to revolve.

Two views are given of the multiphase and mining ex-

hibit is also supplied to run a 10-h. p. triphased induction motor, which is belted to a drill generator of the Thomson-Houston type, with revolving brushes. A 7 1-2-h. p. drill, of the Marvin type, is set up, and at times picks holes in a block of granite for the edification of a crowd, who wonder what it is for and what's the use of doing it. The granite block was placed on the main floor by the side of a booth in which is an oil display, and when the drill was at work it shook the floor so much as to knock over the oil exhibit. To avoid this it was necessary to make a special foundation for the block, thus insulating it from the floor. The drill is a somewhat modified form of the Marvin formerly made by the Edison company, and the report is that this type is to be used to the exclusion of the old Thomson-Houston form. A 5-h. p. triphased induction motor and a rotary transformer complete the multiphased exhibit.

There is a considerable display of mining machinery, the exhibit comprising a 10-h. p. sinking pump for deep mine work, 3-h. p. centrifugal pump outfit, a 3-h. p. motor running a triplex pump, made by the Risdon Iron Works, of San Francisco; a portable pump and motor on truck, a 2-h. p.



200 KW. GENERAL ELECTRIC RAILWAY GENERATOR.

hibit, which occupies a prominent place in the centre of the hall, just in front of the main entrance. The company has been at considerable pains to make this exhibit as attractive as its prominent position warrants, and it certainly is not the least interesting display, even to those who look and wonder what it is all about.

The generating station of the multiphased system consists of a 15-kw., 500-volt bipolar motor, of the Edison type, which runs a 35 kw. triphased generator, giving a current at 300 volts. A skeleton switchboard, with all necessary instruments, passes the currents to step up transformers, where the pressure is raised to 6,000 volts. A line about 40 feet long carries this current to a receiving and distributing station, where the pressure is reduced to 110 volts. On each of the three circuits are placed 20 lamps, and on two of them are incandescent arcs, each with its regulating rheostat. Cur-

diamond prospecting core drill, capable of drilling 600 feet and taking out a 1 3-8-inch core; a hoist and the reciprocating drill previously mentioned. There is also a 20-h. p. mining locomotive of 24-inch gauge.

One of the views shows a neat display of switches, cut-outs, station instruments, etc., and several clusters of lamps on pole tops make a very effective incandescent display. Several Lundell fan motors, with gay streamer attachments, show at once the power of wind, and attract the attention of the girl with an eye to color effects in ribbons.

The great searchlight on the tower, the most powerful in the world, and emitting a light, the intensity of which is guessed to be hundreds of millions of candle power (the guess is 350,000,000 c. p.), is the exhibit which produces the most far-reaching effect. Under proper conditions as to atmosphere and elevation, this light can be seen 120 miles, and

when turned towards the city it spreads out in a broad, silvery cone, the effect of which is especially fine when seen from the hills on the north side of the city. As seen from this point, the light just grazes the crest of a hill, and the outline of the beam is very sharp against the dark background. The lamp takes 200 amperes at 90 volts; the lens is 60 inches in diameter, and the carbons two inches.

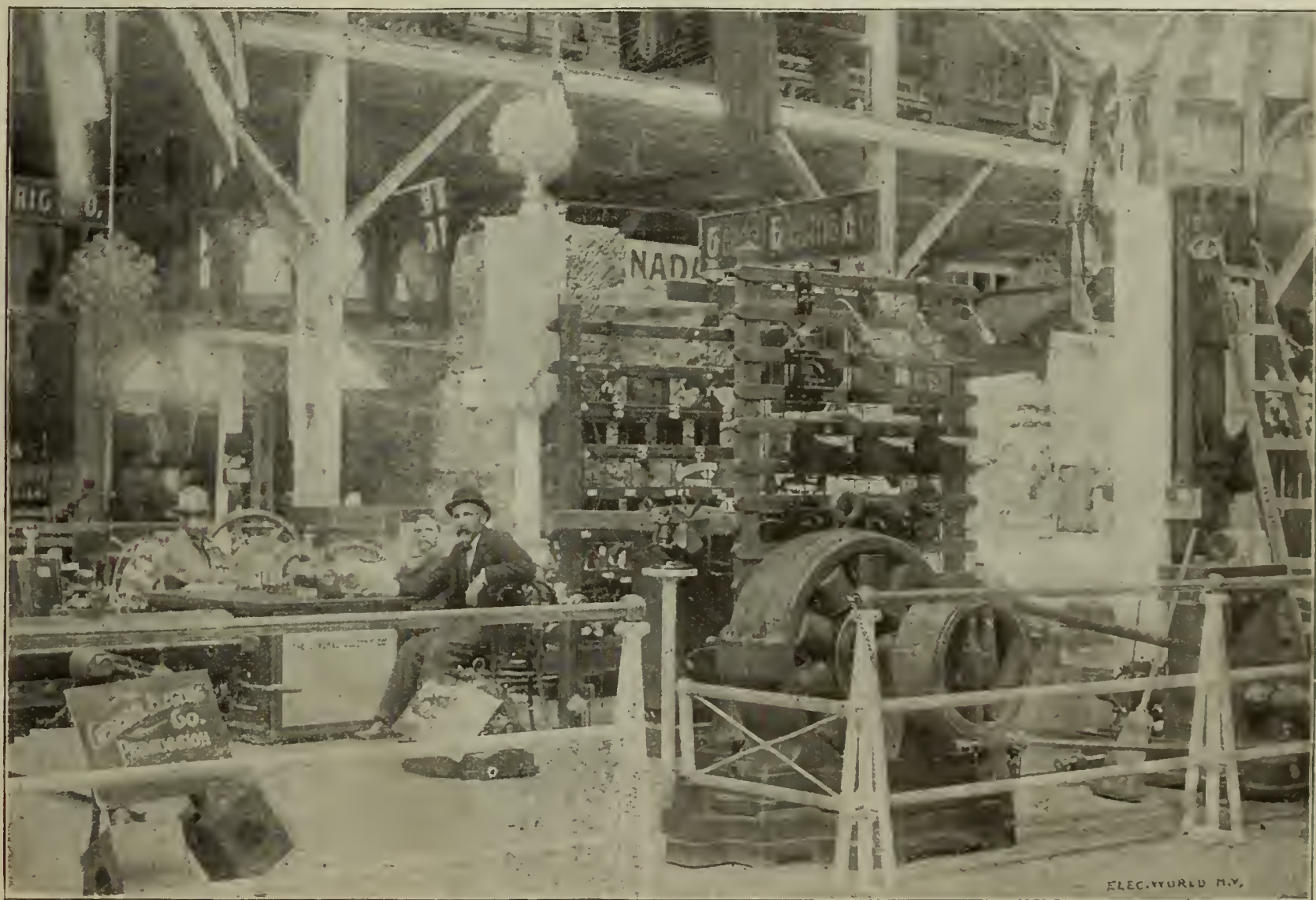
Mr. W. F. C. Hasson, the chief electrician of the fair, has made a novel proposition for determining the candle power of this lamp. He proposes to use a smaller lamp, the power of which can be measured, but which is sufficiently powerful to be seen in the instruments at Mount Hamilton observatory. Observations of the two beams would enable the relative intensities at the observatory to be determined, and consequently the candle power of the great lamp. The work would be placed in the hands of experienced comet finders.

The first proposition of the General Electric Company was to furnish five railway generators, from which buildings, concessions, etc., could be lighted by lamps in series of five. These machines were tendered because they were such as

ing, and the honor of making the fair an electrical success lies largely with these two companies.

The Western Electric Company's exhibit occupies a prominent place on the main aisle of Machinery Hall, and is well calculated to catch the eye. The largest machines shown are two 220-volt, 6-pole, 150-kw. generators, used for furnishing current for the town stationary lights, which are wired two in series. They are driven by a vertical compound engine, built by the Union Iron Works, of San Francisco, it being one of six intended for the Mission street electric road, which is now building. A view of the machines is given.

The portion of the exhibit which attracts most attention is a motor-generator combination, which runs all day. This consists of a 60-kw., 500-volt generator, which is connected up to run as a motor, taking current from the General Electric Company's 500-volt circuit. This machine was intended to be run as a generator and supply current to the elevator motor, and a power circuit in Manufacturers' Building and other places, but the engine available was too small, and as the General Electric Company had its large railway



A CORNER IN THE MINING AND MULTIPHASED EXHIBIT.

could be sold on the coast, and would not require retransportation to the East. Large incandescent machines could not be sold here, and, as it was not at first considered that the fair would be of any real importance, the electrical companies would not consent to incur any expense for which they could not expect some return. When, however, one of the electric fountains in use at Chicago was finally purchased by the exposition, the General Electric Company became very liberal in its tender of machines, and made the installations, without which much would be lacking to make the electrical exhibit, and even the Midwinter Fair itself, a success.

The exhibit of the Western Electric Company is only less extensive, and not less attractive, than that of the General Electric Company. Indeed, its lighting of the Bonet tower is by far the most important and attractive display, except during the brief intervals when the electric fountain is play-

generator, arrangements were made by which it was to supply the power circuit and run the Western Electric Company's generator as a motor. The motor thus supplied runs two 30-kw. machines, on one bed, which were originally intended for a motor-generator combination, the motor taking current at 220 volts, and the generator giving 110 volts, but as now connected up both machines run as generators, the 220-volt converted motor supplying current to a power circuit that runs through the various buildings, and the 110-volt machine furnishing current for a scenic theatre, run by the Western Electric Company. This combination machine was on exhibition at Chicago, and was run as originally intended, i. e., as a 220-volt motor, driving a 110-volt generator. In addition to these machines, the company has several motors ranging from 1-2 to 20 h. p.

The switchboard is the only one in the fair in which anything elaborate has been attempted. It is the same that was

used at Chicago. The portion shown on the right of the view consists of seven panels, five of which are for arc lamps, the capacity being for 700 lamps; the sixth panel is fitted as a testing board, with ground alarm, etc., and the seventh is for a 220-volt direct current, the capacity being 1,200 amperes. Four 50-lamp arc machines are connected to this board, and are used for running 150 arc lamps of 2,000 c. p. in the Manufacturers' and Liberal Arts Building. They are of the regular Western Electric type, the armatures being wound in 12 sections with a 12-part commutator.

The distributing board shown on the left is made in six sections, five of which are for 110-volt circuits and the other for 220 volts. It carries on the back the field rheostats for the 30-kw., 110 and 220-volt generators, and the starting rheostat for the 500-volt motor. All the back connections are neatly made and exposed to view. All bus bars and connectors are calculated on the basis of 1,000 amperes per square inch of copper section, 600 amperes per square inch

this lamp replaced by a stiff, flat spring. The carbon rod is held by the clutch generally used in the Western Electric Company's arc lamps, this clutch being closed by the action of the stiff spring, which acts on the armature of the magnet in opposition to the shunt coil. When the lamp is not burning the main circuit is open, the carbon points being drawn apart by the action of the spring. When current is turned on its only path is through the shunt coil, which is consequently strongly energized, and its armature drawn down against the force of the spring, thus opening the clutch and releasing the rod, which drops and completes the circuit through the carbons. Instantly the shunt circuit loses its current, and the action of the spring opens the circuit and draws the arc. An auxiliary spiral spring is used for adjusting the balance between the main spring and the shunt magnet, so as to maintain the arc at the proper length. The feeding is by imperceptible degrees and the arc remains of almost constant length.



A VIEW OF THE MINING AND MULTIPHASED EXHIBIT.

of brass section and 300 amperes per square inch of surface for surface contacts.

Both these boards are dark marble, highly polished back and front, and present a very neat appearance.

A small exhibit just outside the rail, which attracts considerable attention, is a small electromagnet, the keeper of which comes off with a pull of about 400 pounds. It is fitted with a handle large enough to be grasped with one hand only, and is generally surrounded by three or four men, who tug away, one after the other, and finally give it up. Then there appears that unique product of the Midwinter Fair, a gum girl, who seizes the handle, gives it a quick jerk sideways, and off it comes, while the strong men look silly. They then all do as she did, and go away satisfied, thinking how easy it is when you know how.

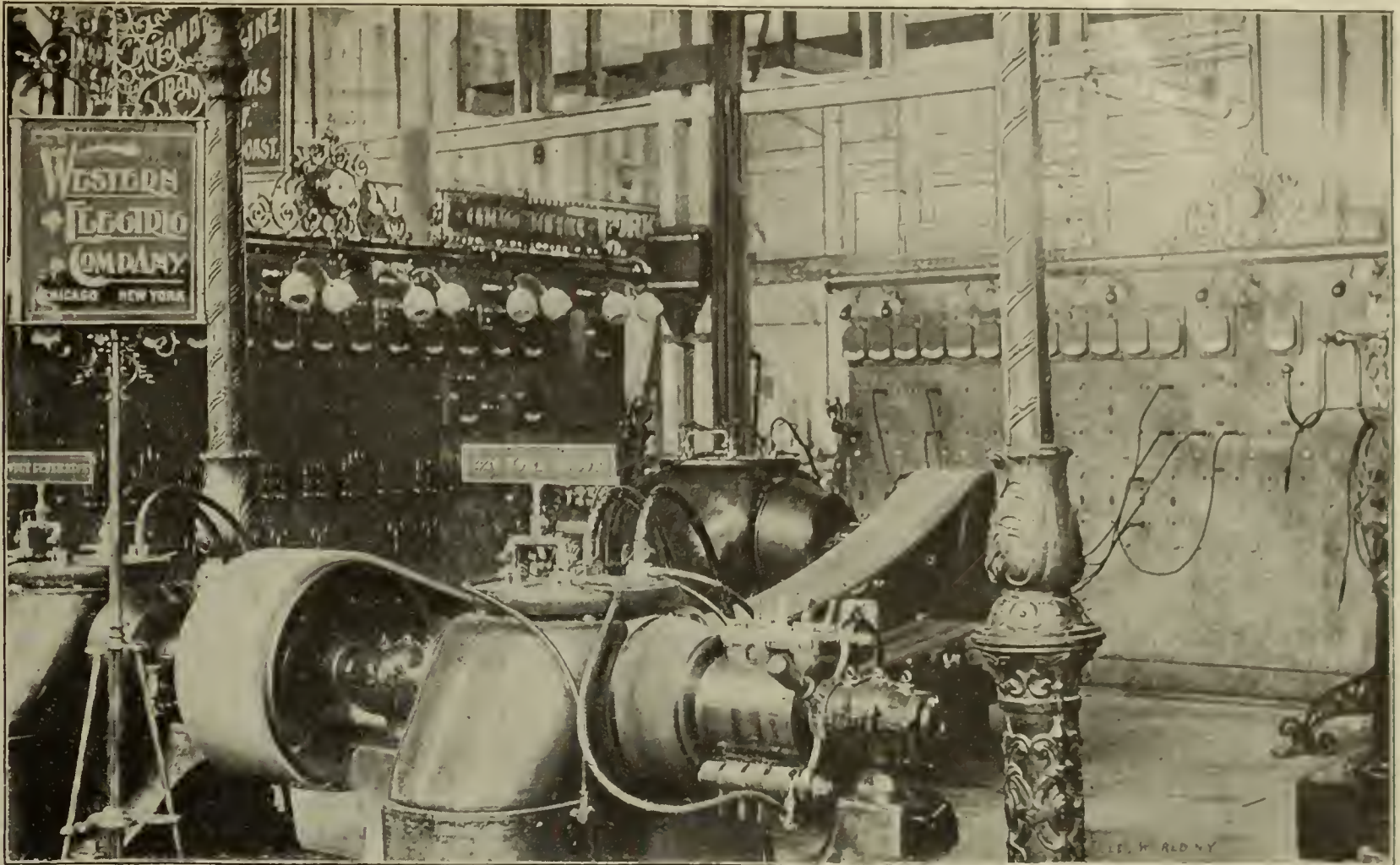
The company has on exhibition a pair of its new arc lamps for incandescent circuits. They are extremely simple and burn with a very steady light. There is only a shunt coil, the series coil usually employed to draw the arc being in

A singular accident happened to one of the company's employees. He had tinsel braid on his coat sleeve, and one day was leaning his arm on the handle of a 220-volt double pole switch, when it slipped off and wedged between the two parts of the switch so that the braid on his sleeve short-circuited the mains, with the result that there was a fine display of fireworks and a man with a burned eye. That the braid on his sleeve was metallic and might be a source of danger had never occurred to him, and it was two days before he was really certain what had happened.

Among the most important exhibits of the Western Electric Company is the automatic revolving switch controlling the disappearing figures on the tower. This consists of a cylinder 85 inches long and 12 inches in diameter, made up of a large number of thin cast-iron discs set with 5-8 inch space between them. Each of the discs is furnished with holes and slots along the edge, through which bolts can be passed for securing pieces of hard wood, which project 3-4 inch above the surface. These pieces are 1-2

inch wide, and are curved and set concentric with the cylinder. They are of various lengths, depending upon the time

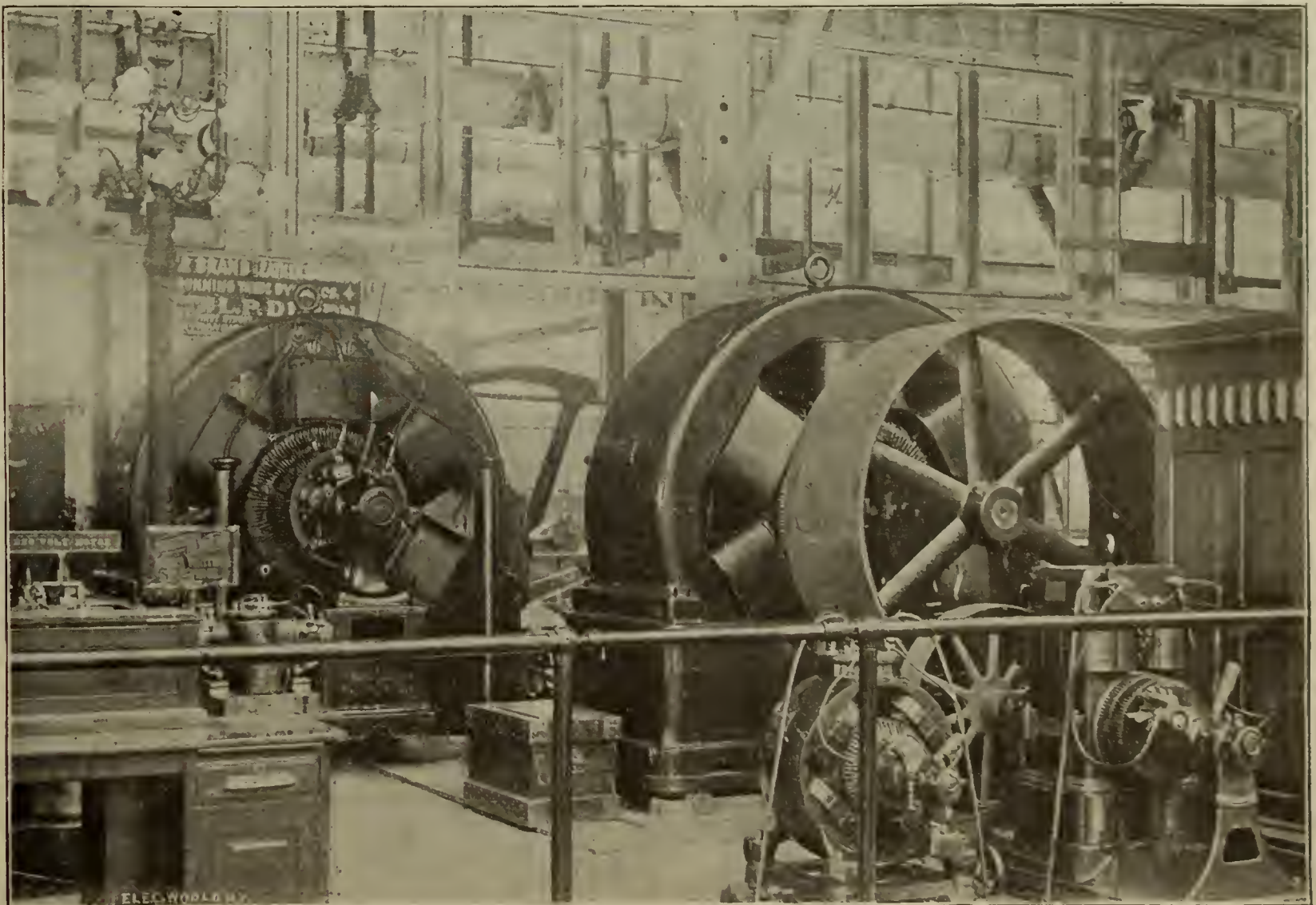
bent round and bolted to the ends of the arms, and in these holes are secured, by spring pressure, short pieces of arc



AN INTERESTING MOTOR-GENERATOR COMBINATION.

the circuit is to be closed. Two rods, the length of the cylinder, and placed one on each side, acts as centres, upon which swing 56 bell cranks of cast brass. One main from

light carbons, which can make contacts with corresponding pieces held in springs secured to circuit boards, one of which is placed on each side of the switch (the view shows one of



WESTERN ELECTRIC 150 KW. GENERATOR.

the dynamo is connected with these centres, thus making the bell cranks part of the electric circuit. The horizontal arms of these levers have holes formed by pieces of spring brass

them). The springs in which these second carbons are secured are quite stiff, so that the carbons can be pressed together with considerable force, and each spring is connected

with a binding post, by means of which it can be placed in a circuit leading to a group of lamps on the tower. Springs acting on the bell cranks keep the circuits broken at the carbon contacts, except at such times as they are pressed forward by the pieces on the revolving cylinder. The cylinder is turned steadily by a 1-2-h. p. motor, the speed of which is reduced by one spur and one worm gear. Usually the cylinder has a speed of about two revolutions per minute, but by means of a rheostat in the field of the motor, the speed can be varied from 2 to 13 revolutions.

The figures to be produced having been designed, the lamps composing it are wired in the groups as required, and circuits led to the circuit boards on the switch. The wooden pieces are secured to the cylinder so as to make the contacts in the order and for the time required. If the groups of a figure are to be lighted and extinguished one after the other at short intervals, a number of short pieces will be secured to the cylinder in a spiral fashion, so that one contact will be broken just as the other is closing. If it is desired to have the groups light one after the other and remain lighted until the figure is complete, the pieces on the cylinder will have a spiral beginning and all end on the same line, so that as the last group lights they will all break away and leave the figure with all lamps extinguished, ready for a new beginning, with contacts differently arranged, so as to produce several different figures with the same lamps. It will thus be seen that with a given number of lamps in a large group, but wired with several sub-groups, a number of



The Cost of Producing Electricity.

BY JAS. B. CAHOON.

At the last meeting of the National Electric Light Association one of the most interesting reports made was that of the committee on data giving in tabulated form the reports of the watt-hours, pounds of coal, kinds of coal, watt-hours per pound of coal and various other data from 65 stations situated presumably in the various parts of the country. An analysis of this tabulated statement seems to show on

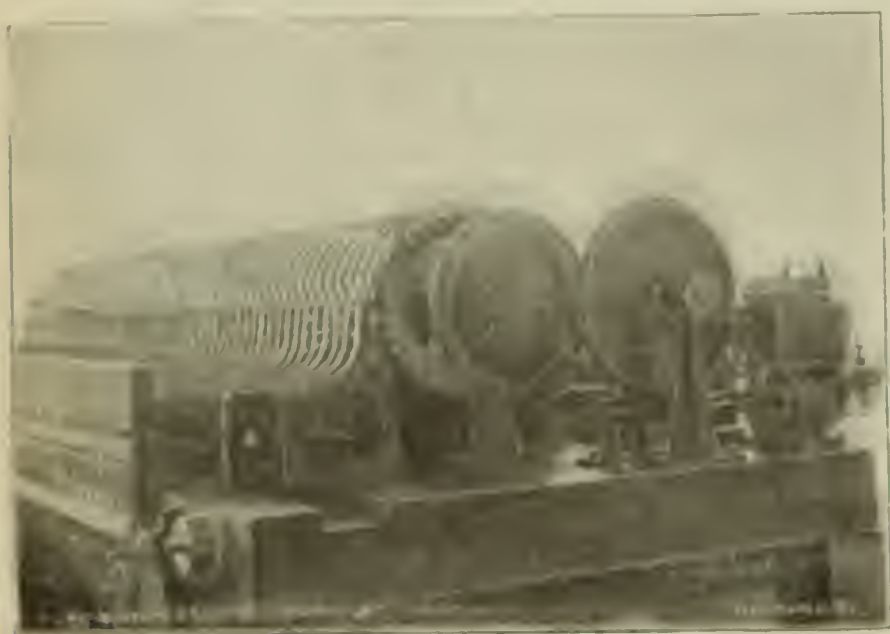
the face of it that the central stations as a whole throughout the country are not in the habit of keeping this particular kind of data, and in many instances where the watt-hours per pound of coal runs low, it would indicate fitfulness in operation, combined with remarkably poor firing in the boiler. It seems hard to conceive that any station at the present time should require 20 pounds of coal per hour for each indicated horse power, yet we find three stations reporting practically what amounts to this; and the number requiring between 10 and 20 pounds of coal per indicated horse power is quite numerous, while those requiring over five pounds of coal are in a great majority. I find on averaging up the different kinds of coal, and combining most of them under the four heads of slack, bituminous, small hard and screenings, that 16 users of slack furnish an average of watt-hours per pound of coal of 72.75; next come 10 users of bituminous coal, which gives an average of 75.6; then 12 users of small hard, with an average of 116.4, while lastly two users of screenings head the list with 183 and 208 watt-hours respectively per pound of coal, while Youghioghenny coal, which is supposed to be at the head of the list of steaming coals, makes the unfavorable showing of 83 and 104 watt-hours from the two places reporting this. I think we would be perfectly justified in saying that if manufacturing concerns can, with their large Corliss engines and first-class boiler plants with suitable attendants, produce horse power at the rate of 1 h. p. for every 1 1-2 pounds of coal used, then our large and well equipped central stations in the largest cities should do equally as well, while those in the smaller sized cities and towns, where the load is more unequal, should at least obtain 1 h. p. for each 2 1-2 pounds of coal, and the stations in country towns running only for seven or eight hours a day, with non-condensing engines, should be able to produce 1 h. p. on approximately five pounds of coal per hour. These figures are within the bounds of reason, and warranted if we are to strive for economical results and a proper dividend on our investment. We, of course, expect that the stations in different parts of the country will use that coal which is nearest to them, provided it be the most economical as well. An average theoretical value of coal is given by various authorities in pounds of water evaporated as follows, from which it will be seen that the value is not as variable as many people suppose:

TABLE 1—THEORETICAL VALUE OF COAL.

Kind	Lbs. of water evaporated
Youghioghenny	14.76
Pennsylvania anthracite, average	14.48
Colorado lignite, average	14.20
Texas lignite	13.41
Illinois, average	13.35
Cambridge	12.65

Of course the practical value of these coals is considerably less than that shown; either, however, does to illustrate the point that no one section of the country need say that they cannot compete with another section, because they are handicapped too heavily in the steaming quality of their coal.

In going over the table of data it seems to me that a con-



REVOLVING SWITCH CONTROLLING FIGURES ON THE TOWER.

different figures can be produced during a revolution of the cylinder.

This switch is arranged to control 12 figures on the tower, each of which consists of several sub-figures. As the cylinder revolves there comes a point where all the lamps of the figures are lighted, and a little further movement of the cylinder causes all contacts to break away, and the figures begin again. Fifty designs were made by Mr. Jenness, of the Western Electric Company, and of these 12 were chosen after a consultation between the company's representative and Chief Electrician W. F. C. Hason.

The carbon contacts open about 1-2 inch, and with 110 volts the arcs would hold. To avoid this, a blower, run by a motor, placed beneath the switch, discharges air into a 2 inch pipe running the length of the switch and close to the carbon contacts. Short, flat nozzles end close to the contacts, one for each, and a continual blast of air plays upon them and blows out the arcs when the circuits are broken.

A similar switch was used by this company at Chicago, but it was sold to Mr. Wanamaker, of Philadelphia, for controlling lights in his store, and this one was specially made for this exposition. The view given shows it very clearly.

(To be continued.)

venient way in which station men might find out the total watt-hours for their daily consumption of coal, as well as other points of interest, would be by the construction of a diagram similar to the one shown herewith; on this, the curve *A B C* is plotted from the number of pounds of coal per indicated horse power per hour as ordinates and watt-hours per pound of coal as abscissae, while the lines radiating from zero point are plotted with tons of coal as ordinates and total watt-hours as abscissae for each of the rates in watt-hours per pound of coal, running from 30 to 400.

The use of the diagram may be illustrated as follows: Suppose we are burning coal at the rate of two pounds per indicated horse power per hour and consuming 10 tons per day and we wish to find the total watt-hours. Start from the point 2 in the right-hand margin and go across horizontally until we meet the curve; thence proceeding vertically, we find on the upper margin the watt-hours per pound of coal to be 302.13, the nearest line to this is *O F* marked 300, following down the adjacent line corresponding to 302.13 until it intersects the horizontal line through 10 on the left-hand margin, we get vertically underneath the total watt hours as

by a single-pole porcelain knob switch. The feed wires are connected to each cabinet by a double-pole knife switch of the old Edison pattern and protected by fuses. The main switch connects with the balance wires, which join the ends of all feeders, each connection to balance wires being through a double-pole knife switch with fuse cut-out. Each cabinet is lighted by a lamp placed inside. Brass armored conduit was used throughout. The climatic conditions are very severe, and ordinary rubber insulation will not stand, so a special grade of insulation, made by the Okonite company, was used—over 175,000 feet of conduit (Interior Conduit and Insulation Company) and 110,000 feet of Okonite cable.

A special feature in the work is the absence of joints in the wire, all the wire being run in loops to connecting points. This allows the removal and replacing of any wire in the buildings without disturbing any others. In order to reach the lamps placed on the garden walls, it was necessary to run the wires underground. The soil eats away iron pipes in a short while, so special care had to be taken to protect the underground wires. A wooden trough was first placed in the ground and in this the wires in brass-armored con-

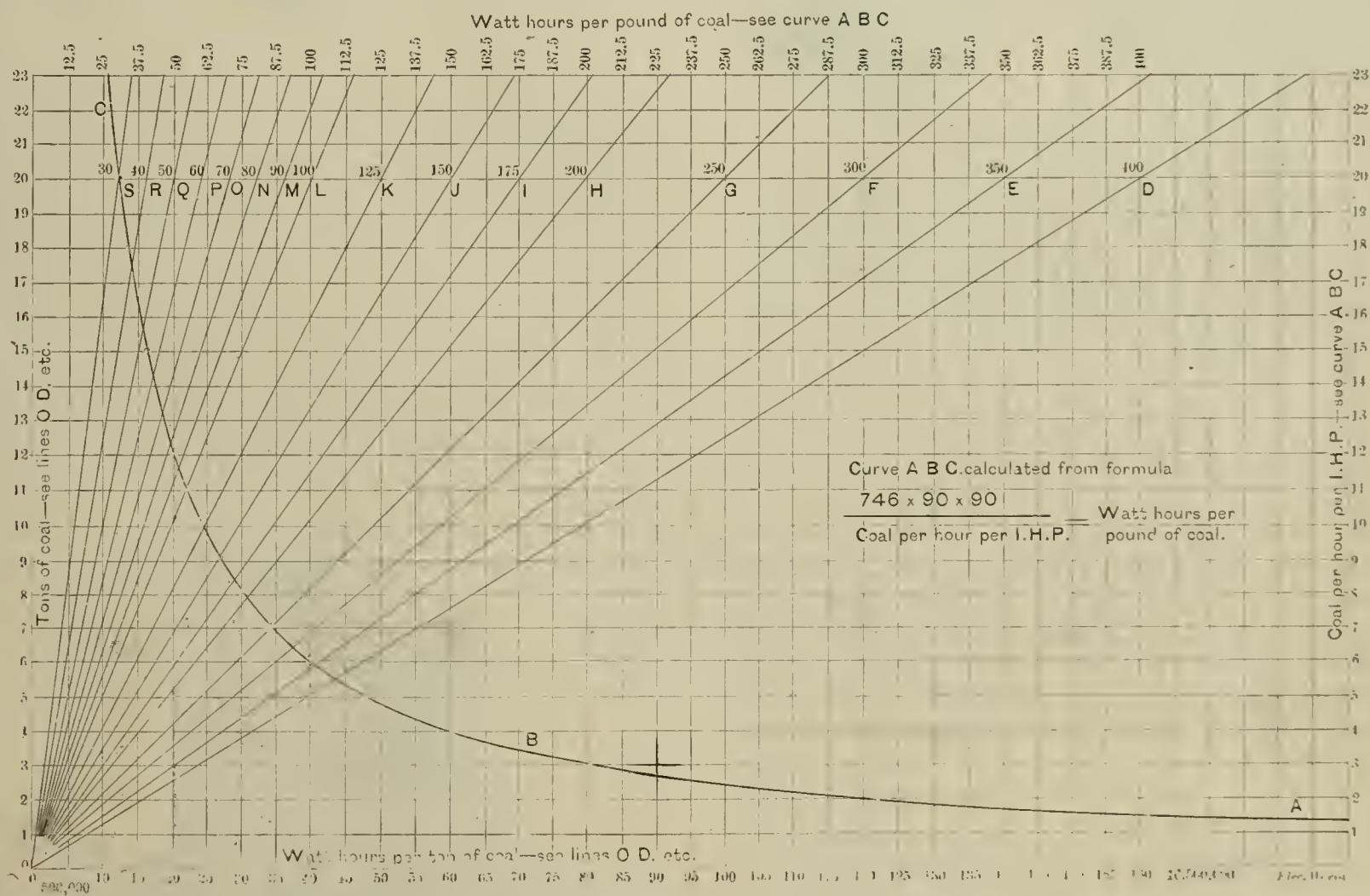


DIAGRAM OF COAL CONSUMPTION AND WATT-HOURS.

6,042,600. By starting with either of the other items indicated, any one of the others may be ascertained. This can easily be drawn out on quite a large scale, and will thus, I hope, prove of some assistance to station men.

(To be Continued.)

The New Wiring Installation of the St. Augustine (Fla.) Hotels.

The magnificent hotels, Ponce de Leon and Alcazar, at St. Augustine, Fla., have been recently rewired and refitted electrically in the most complete and approved manner. The original wiring was, at the time when installed, in accordance with current practice, but the underwriters condemned the work a year ago, and it has been entirely overhauled and a system installed by Mr. H. E. Best, the electrician of these hotels, which is not only up to all requirements, but ahead of them. The cabinet system of cut-outs is exclusively used, the cabinets being made entirely of polished marble. Each circuit (having five lights on the average) is controlled

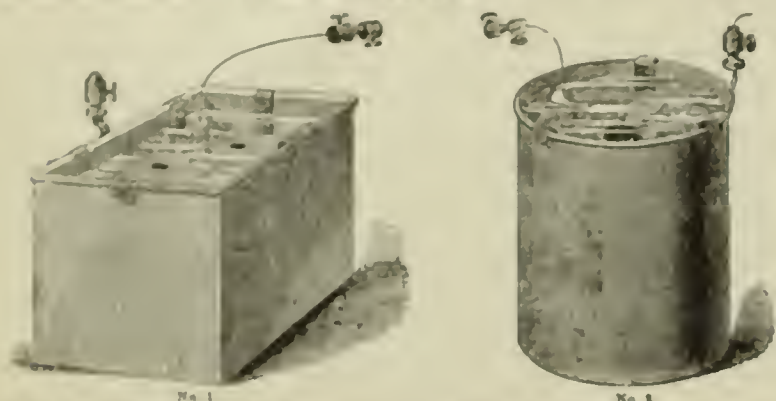
by a single-pole porcelain knob switch. The feed wires are connected to each cabinet by a double-pole knife switch of the old Edison pattern and protected by fuses. The main switch connects with the balance wires, which join the ends of all feeders, each connection to balance wires being through a double-pole knife switch with fuse cut-out. Each cabinet is lighted by a lamp placed inside. Brass armored conduit were laid and surrounded with pitch, which was kept from becoming brittle by mixing it with wax. In the dynamo room a handsome marble switchboard has been placed, and on it ammeters, voltmeters and a balance voltmeter of the standard Weston illuminated dial type. Pressure wires run to seven points of the system and give the pressure at these points by connection at the switchboard. The variation at no time exceeds 1 per cent. above or below the normal voltage. The electroliers are all fitted with the standard three-way switch of the General Electric Company, allowing the turning on or off of any number of lights. These switches have milled heads and are placed just under the bowl or central part of the electrolier, where they are unobtrusive and easily reached. The whole system has been installed in the most thorough and workmanlike manner, and reflects great credit on the electrician, Mr. H. E. Best, who designed the cabinets and planned and supervised the whole installation. There are over 6,000 lights in the two hotels.

Electrical Advertising Twenty Years Ago.

The removal of The Electrical World to its new quarters in the building adjoining the one in which twenty years ago its immediate predecessor, The Operator, occupied its first office, recalls the enormous growth of the electrical industries in that period, and in no way is this growth better illustrated than by a comparison between those early days and the present time in the number and character of the advertising announcements of those engaged in electrical pursuits.

We print with this reproductions of advertisements that appeared in the columns of The Operator two decades ago.

EAGLES' METALLIC BATTERY.



The Eagles Metallic Galvanic Battery,
PATRICK & CARTER, Sole Agents,

10 SOUTH FOURTH ST., PHILADELPHIA, AND 22 DEY ST., NEW YORK.

THE EAGLES METALLIC BATTERY, after two years of trial in every capacity, is now pronounced to be the best of all directions, as being without question the best and most powerful of all constant batteries, and as combining to a remarkable degree the powerful effects of the Callaud, Daniell or other batteries, with the constant and enduring capacity of the Callaud, Daniell or other batteries.

It is so constructed as requiring no skill to set up, nor the least trouble to manage, it does its work as long as it is in the jar as much as any sulphate of copper battery.

When set up properly, it will not foul or give out in from three to twelve months, according to the amount of work required from it, and always gives uniform strength of current.

For such reasons, where all other costly batteries are acknowledged failures, the Eagles Battery is found to be the only one that is a perfect success.

and which represent almost the entire advertising business of that day, for in going over the early numbers of that journal we find the space occupied with the announcements of other firms to be very small indeed. Yet the volume of this advertising, such as it is, was really representative of the electrical business of that day, and the contrasts afforded by a glance at the hundreds of business announcements in one of the current issues of The Electrical World is a striking object lesson to those who care to obtain an idea of the extent of the great movement which has given to the latter

EUGENE F. PHILLIPS,
PROVIDENCE, R. I.

MANUFACTURER OF

PATENT TWISTED INSULATED

Telegraph Wire.

PATENT ELECTRIC CORDAGE

Patent Rubber-covered Wire, Cables, etc.
We have made of the following sizes: 1/4, 1/2, 3/4, 1, 1 1/2, 2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60, 64, 68, 72, 76, 80, 84, 88, 92, 96, 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140, 144, 148, 152, 156, 160, 164, 168, 172, 176, 180, 184, 188, 192, 196, 200, 204, 208, 212, 216, 220, 224, 228, 232, 236, 240, 244, 248, 252, 256, 260, 264, 268, 272, 276, 280, 284, 288, 292, 296, 300, 304, 308, 312, 316, 320, 324, 328, 332, 336, 340, 344, 348, 352, 356, 360, 364, 368, 372, 376, 380, 384, 388, 392, 396, 400, 404, 408, 412, 416, 420, 424, 428, 432, 436, 440, 444, 448, 452, 456, 460, 464, 468, 472, 476, 480, 484, 488, 492, 496, 500, 504, 508, 512, 516, 520, 524, 528, 532, 536, 540, 544, 548, 552, 556, 560, 564, 568, 572, 576, 580, 584, 588, 592, 596, 600, 604, 608, 612, 616, 620, 624, 628, 632, 636, 640, 644, 648, 652, 656, 660, 664, 668, 672, 676, 680, 684, 688, 692, 696, 700, 704, 708, 712, 716, 720, 724, 728, 732, 736, 740, 744, 748, 752, 756, 760, 764, 768, 772, 776, 780, 784, 788, 792, 796, 800, 804, 808, 812, 816, 820, 824, 828, 832, 836, 840, 844, 848, 852, 856, 860, 864, 868, 872, 876, 880, 884, 888, 892, 896, 900, 904, 908, 912, 916, 920, 924, 928, 932, 936, 940, 944, 948, 952, 956, 960, 964, 968, 972, 976, 980, 984, 988, 992, 996, 1000.

SEND FOR CATALOG AND PRICE LIST

JOSEPH MOORE & SONS.

ESTABLISHED 1820.

222 & 227 CHINA ST.,

Philadelphia, Pa.

Philadelphia, Pa.

Insulated Wire Manufacturers

INSTRUMENT & OFFICE WIRES,

FLEXIBLE CORDS, CABLES,

HEAVY INSULATED LINE WIRE

RESISTANT WIRE

Wire of every variety of Insulation

a single issue since, The Electrical World, moreover, being the only electrical journal in which this firm carries an advertising announcement—is Partrick & Carter, established in 1867, and now doing business a few squares, as they say in the Quaker City, away from its original location on South Fourth street. Mr. Partrick himself died a decade or more ago, but Mr. Carter is still the superintendent of the factory, while two young men—Messrs. Charles M. and E. Ward Wilkins—who had grown up in the employ of Partrick & Carter, are the other members of the firm.

The business of L. G. Tillotson & Co., which, after the death of Mr. Tillotson, was incorporated under the title of The E. S. Greeley & Co., was founded by L. G. Tillotson and Gen. E. S. Greeley in 1865, though Mr. Tillotson had previously been engaged in the same business. The original

The "Snapper" Sounder.

PRICE 10 CENTS.  \$1.00 per doz
\$1.50 1-2 doz

Trade Mark. Patented May 12, 1876

Polished nickel-plated base, 4/16, or 6 for \$2

Polished, with Knob and Screw Fastenings, 75c.

PRICE 75 CENTS. 

Best post-paid on receipt of price

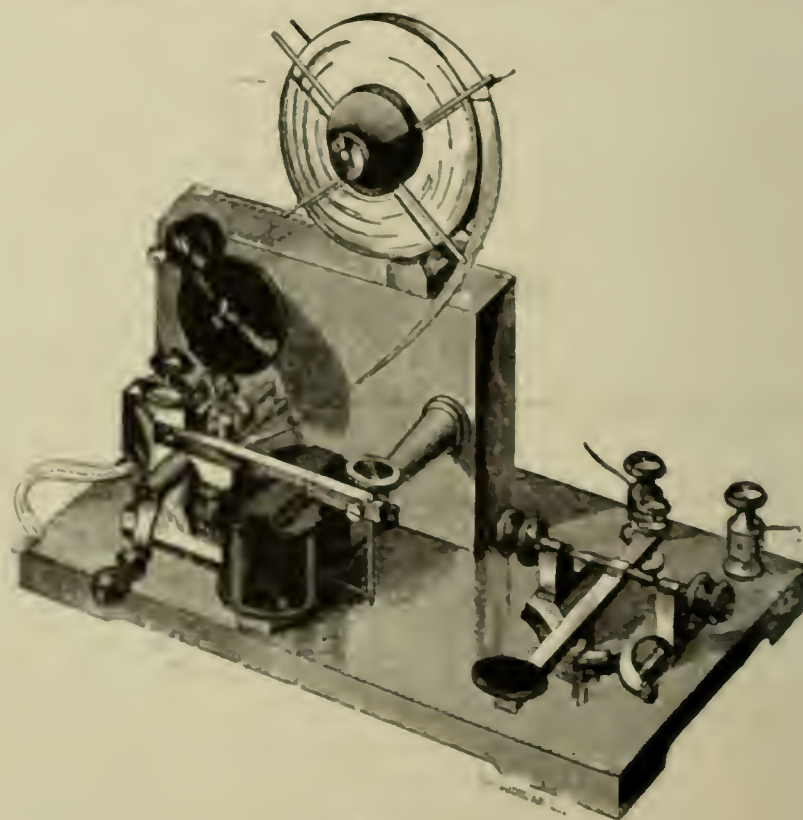
R. W. POPE, Box 5278, N. Y.

location of the firm was 8 Dey street, directly opposite its present place of business, to which it moved when the old quarters were vacated to make room for the Western Union Building. Thus, for almost thirty years, The E. S. Greeley & Co., or the firm which preceded it, has had its headquarters in the same street.

The name of Eugene F. Phillips, whose annual Rhode

EDISON'S INK RECORDER,

For Amateur Students and Private Lines.



(Patent applied for)

SEND FOR CIRCULAR.

EDISON & MURRAY,

10 and 12 WARD STREET,

NEWARK, N. J.

part of the nineteenth century the distinctive name of "The Electrical Age."

It is noteworthy that those who twenty years ago were most prominently in the electrical business still remain in the front rank, though some have transferred their attention to other departments of the great field they assisted in opening up.

The oldest firm represented is that of Joseph Moore & Sons, of Philadelphia, which was founded in 1820, and is now continued by Mr. Moore's son, Mr. Alfred F. Moore, with whom, however, is associated Mr. A. Bournonville and Mr. C. C. King.

Another pioneer Philadelphia firm whose advertisement appeared in The Operator two decades ago—and which, it may be added, has never been out of it or of its successor for

Island clambake has been the means for many years of introducing newcomers in the electrical business to the "Old Timers," and thus furnishing a connecting link between the past and the present, was relatively as familiar in the olden days as it is now, and almost as popular.

It is but natural that in an electrical journal of twenty

years ago we should meet with the name of Edison, though up to that time he had confined his inventive genius to the sphere of telegraphy. While he was well known at this early day, and had been one of the earliest contributors to the reading columns of *The Operator*, the great achievements which have immortalized his name had their birth in the half dozen years subsequent to 1874. Among those connected in business with Mr. Edison about this period was Mr. Franklin L. Pope and the late Mr. James N. Ashley. A

A CARD.

THE METALLIC GALVANIC BATTERY.

A Notice having been extensively published and circulated announcing the appointment by Edwin Eagles of another firm as sole agents for the manufacture and sale of the Metallic (or Lead) Galvanic Battery, known to the trade as the "Eagles Metallic Galvanic Battery," and enjoining all other parties from manufacturing or selling the battery, we take this method of informing the public of our position and rights in regard to said battery.

At the time the notice referred to was prepared and published it was well known to Eagles, as well as to us, that his application for a patent on the battery had been rejected more than a year previous, on the ground that the applicant was not the original inventor.

The original inventor of the battery now has an application pending in the Patent Office for a patent on his invention, which we have no doubt will be granted, and which, when issued, will be controlled by us.

In any case the notice is preposterous, as in no event can a valid patent possibly be issued to any other than the original inventor.

We continue and shall continue to manufacture and sell said Metallic Galvanic Battery, and parties purchasing of us will be fully protected in their right to sell and use the same.

Those who may purchase this battery manufactured by other parties not authorized by us, will be after the issue of the patent, legally liable to pay royalty to us on battery so purchased from or made by unauthorized parties.

The Metallic (Lead) Galvanic Battery may be had of us, or from Messrs. L. G. Tillotson & Co., who are our agents for its sale, at our prices, and who will guarantee against infringement in any battery that they sell.

F. L. POPE & CO.,

33 Vesey Street.

NEW YORK, Dec. 9, 1874.

IF YOU WANT EQUIPMENTS

FOR A

Telegraph Line.

ORDER OF

L. G. TILLOTSON & CO

They have the GREATEST VARIETY

They carry the LARGEST STOCK

Their PRICES are the LOWEST

and QUALITY THE BEST

THEY GUARANTEE

EVERYTHING TO BE AS REPRESENTED

They always RECTIFY MISTAKES at their OWN EXPENSE.

EVERY ARTICLE REQUIRED FOR THE

Construction and Operation of Lines

ALWAYS ON HAND

THEIR

EXCELSIOR

TELEGRAPH INSTRUMENT FOR STUDENTS

Comprising Sounder and Key, is the greatest success of the times.

We are offering 20 per cent. discount from list prices on all instruments of our manufacture.

L. G. TILLOTSON & CO.

Mr. Murray, however, a grocer, had furnished the money for the firm of Edison & Murray, one of whose advertisements is here reproduced.

Another familiar name is that of Mr. Ralph W. Pope, now the genial secretary of the American Institute of Electrical Engineers, who was the inventor of the, in its day, widely known "snapper" sounder mentioned in the advertisement. The idea of this popular instrument was conceived by Mr. Pope in a printing office one day while handling a printer's composing rule. The rule had been dented and when bent gave a note so near like that of a sounder, that he borrowed the rule and based on it the construction of the "snapper sounder."

Economy in Electrical Distribution.

BY ALBERT L. CLOUGH.

It is a well known fact that the utmost economy of distribution is attained in a system of electrical supply in which the sum of the interest on the investment plus the energy loss amounts annually to the smallest amount.

In many instances, however, this fundamental and unquestioned truth is disregarded and that system chosen which offers the possibility of starting the plant with the least expense, leaving the matter of future efficiency out of the question. In this way a great many stations have been equipped with the alternating system which would in the end have been better served by the three-wire method of distribution. Both of these systems have their advantages and defects and their conditions of greatest and least adaptability, which it may be well briefly to review.

In the alternating current system a constant loss, independent of the number of lamps operated, is experienced, which is due to the hysteresis and eddy currents in the transformers. This loss amounts to about 5 per cent. of the total capacity installed, and at low loads reduces the efficiency of the system to a ridiculously small amount. It may amount in extreme cases to many times the useful energy distributed.

The copper required for a given conductor loss in the alternating system is, as is well known, only about 1-32 that required in the three-wire system for the same amount of energy transmitted.

The three-wire system, on the other hand, reaches its maximum efficiency of distribution at its very lightest loads, and can only handle large loads commercially within comparatively small areas.

In the handling of large loads at a considerable distance the alternating system thus reaches its highest degree of usefulness, while the direct system can only overcome distances of any magnitude, with efficiency, when the call for current is small.

Now in most central stations there is a large demand for current only during six or seven hours in the evening. During the rest of the twenty-four hours the rate of supply falls to a very small fraction of the maximum, notably during the hours from midnight until morning and during the sunny hours of the day.

If a practicable combination of the two methods of supply could be devised, employing each during the period of its greatest adaptability, much improvement might result. The alternating current would be used—at its best—during the heavy load, while the use of the direct current during the rest of the time would do away with the uneconomical conditions brought about by the constant transformer losses.

Some effort must have been expended by inventors toward the solution of this problem, but not much seems to have been accomplished. The following diagram may possibly furnish a hint in the right direction. Referring to the figure, *D* represents a source of direct and of alternating current which may be, as here shown, a dynamo capable of furnishing both; its direct current output being used in connection with a storage battery, *B*, in order to make use of a three-wire circuit, or it may be the combination of an alternating current machine and two direct current machines, arranged in the usual way. The alternating current is supplied to the bus bars *MM* and the direct current to the three busses *NNN*. From *MM* extend the two feeders *M₁M₁* through the double pole switch *S₁* to the transformer primaries of the two representative consumers' stations *P₁* and *P₂*, and from *NNN* are run through the triple pole switch *S₂* the three feeders *N₁N₁N₁* connected to the lamps of the two consumers through their transformer secondaries. *HH* are automatic devices placed at certain points in the three-wire system to short circuit the mains while the alternating current is in use.

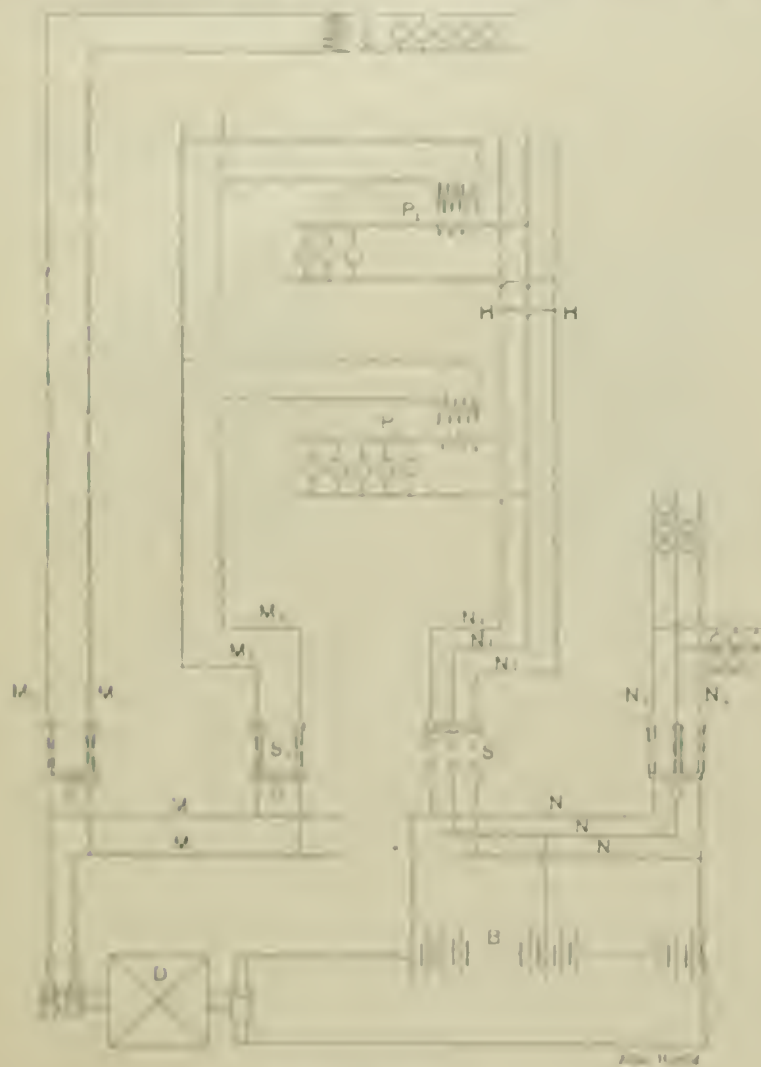
The operation of the arrangement is as follows: During the hours of large demand the switch *S₁* would be closed and switch *S₂* open and the lamps would be supplied on the alternating system in the usual way, with the exception that the devices *HH*, having acted, would form, by short circuiting *N₁N₁N₁*, a common return for the currents in the house circuits. The transformer secondaries would be distributed upon the three-wire mains so as not only to balance the two sides, but, furthermore, there would be the same number of transformers poled in the same direction on each side so as to reduce the current in the common conductor. The transformers are not in parallel, as might for the moment be thought to be the case.

During times when the call for current is light switch *S₂* would be closed and switch *S₁* would be open, and the lamps would be operated as from an ordinary three-wire system, the presence of the transformer secondaries producing only a very small drop.

The claim made for the arrangement is that the saving in constant transformer losses would far more than pay the interest upon the extra three-wire feeders (*N₁N₁*) at least within certain limits of distance and of load factor. The current required from the direct current conductors being

so small, owing to the period of the day during which they are used, calls for comparatively small wires, and the absolute amount of energy distributed is so inconsiderable that a larger percentage loss than usual may be allowed. The fact that the extra conductors would be run upon the same poles with the alternating wires is a point to be considered.

In the diagram M_1, M_2 are alternating current feeders supplying remote and scattered districts continuously by alternating current, and N_1, N_2, N_3 is a three-wire network serving continuously a region immediately about the station.



PROPOSED SYSTEM OF DISTRIBUTION.

It is believed that between these two classes of consumers and in certain conditions of the load factor a combined system would possess an advantage in economy.

An Unpatented Improvement in the Magneto Telephone.

BY ROBERT E. LOFF.

The idea mentioned by Mr. Gifford in *The Electrical World* of March 31, of superimposing a closed secondary coil upon the coil of a magneto telephone, has also been tried by the writer on a private experimental line.

The line was 750 feet long, with ground return. For 400 feet it ran parallel to two alternating incandescent circuits, an arc circuit and a street railway line. The instrument used had a 150-ohm coil, around which was laid a secondary coil of 100 turns, and outside of this was a thin metallic shell.

With the secondary open and the shell removed, the roar due to the induction from the alternator circuit was so loud as to make conversation difficult, and when an electric car was working up speed on that section of the road, all transmission of speech was out of the question.

The addition of the metallic shell did not appreciably reduce these objectionable effects. When the secondary circuit was closed, however, the roar was cut down about one half, the articulation becoming more distinct and giving a tone corresponding to the reversals in the alternator line. The loudness of the speech was also affected to a certain extent, and its distinctness increased, rendering conversation more satisfactory and without interruption.

The reason why these results in the matter of the metal

case do not agree with those of Mr. Gifford is probably on account of the very large amount of cross-induction, but may also be due to the large size of the principal coil.

Calculating Magnet Coils.

BY C. H. BEDELL.

The constant use of tables of copper wire, as published, has made us so familiar with them that it is possibly useless to suggest a change, even if that change is nothing more than an addition. To those, however, who make frequent use of the tables for calculations of field winding—and they are not few, but many—one more column is of great help, saving much time and rendering results more certain.

It is well known that a certain voltage at the terminals of a piece of wire of a given size will correspond to a definite number of ampere feet, whether the piece be long or short, if the temperature remains the same. For example, 1,000 feet of No. 10 B. & S. wire has a resistance of about 1 ohm; if a potential of one volt be maintained at the terminals of that 1,000 feet, about one ampere will flow, giving a total of 1,000 ampere feet. With 2,000 feet of the same wire, having one volt maintained at its terminals, only half the current will flow, as we have double the resistance, but we will again have a total of 1,000 ampere feet. In the same way every wire has a definite number of ampere feet per volt, and the ampere feet of any wire for any voltage can be obtained by multiplying the ampere feet per volt for that wire by the voltage used.

American gauge, B. & S. number.	Ampere feet per volt.	American gauge, B. & S. number.	Ampere feet per volt.
0000	20,383	19	120.6
000	16,166	20	98.40
00	12,819	21	78.03
0	10,172	22	61.91
1	8,062	23	49.07
2	6,394	24	38.92
3	5,070	25	30.86
4	4,021	26	24.47
5	3,189	27	19.41
6	2,529	28	15.39
7	2,005	29	12.21
8	1,590	30	9.681
9	1,261	31	7.857
10	1,000	32	6.088
11	793.2	33	4.829
12	629.0	34	3.828
13	498.8	35	3.036
14	386.0	36	2.408
15	321.0	37	1.909
16	248.8	38	1.514
17	197.4	39	1.201
18	156.5	40	.9528

In calculations of the field of a machine, find the ampere turns required, then the ampere feet, knowing the average length of a turn. If this number of ampere feet be divided by the voltage used, we obtain the ampere feet per volt that the right size of wire will give. By referring to the above table the nearest size of wire can immediately be obtained. The amount of that wire which must be used is, however, another consideration.

(The numbers in Mr. Bedell's table representing the ampere feet per volt are evidently the same as those representing the number of feet per ohm, the values of which are given in many tables.—Ed.)

Electric Cooking and Heating.

Mr. R. E. Crompton, in a recent interview in the "*Pall Mall Gazette*," gives some facts and figures in regard to electric cooking and heating. On a 100-volt circuit, he said, it took 25 amperes to heat up a small family oven, which would then cook for nearly an hour. A frying pan requires 21-2 amperes, and it costs one-third of a cent (with electricity at 8 cents per kilowatt) to heat an ordinary tea kettle. A flatiron takes from 21-2 to 3 amperes of current, and a soldering iron 11-2 amperes.

The Practical Importance of Resonance in the Transmission of Electrical Power.

BY F. W. DUNBAR.



THE rapid strides which have recently been made in the transmission of electrical power to great distances have increased the practical importance of so designing the circuit that a given current may be transmitted with a minimum cost of copper. It has become so customary in the designing of circuits for the transmission of steady or continuous currents in which the current follows Ohm's law to neglect the capacity and inductance of the circuit, that the effect of these two factors, which are all important in the transmission of power by alternating currents, are either entirely neglected or considered as correction factors, and as necessarily detrimental to the transmission of alternating currents.

The object of these articles is to bring forward the practical importance of these two factors, C and L , to point out the laws which govern their effect upon the current and to show that instead of being detrimental to a correctly designed circuit, they may become of great practical utility and will allow a far greater economy of copper in a circuit properly designed to respond to a given period of alternation than can be secured by means of the direct current *at the same voltage*.

In other words, while the current which can be produced by a direct E. M. F. in a given circuit is $\frac{E}{R}$, it can readily be shown that by suitably adjusting the electro-static capacity and electro-magnetic inductance upon this same circuit it may be made to deliver a current at the distant end for a definite rate of alternating E. M. F. far in excess of $\frac{E}{R}$.

It is, however, almost universally true that with the existing methods of circuit construction the values of C and L which occur are not at all suited for securing this economy of copper with the ordinary low rates of alternation, and that with few exceptions the current which is received at the distant end is less than would be secured with a steady E. M. F. of equal (average or maximum) value.

It may be readily shown that the physical dimensions of the electrical units C and L are respectively the reciprocal of an acceleration and a length. But the motion resulting from an impressed sinusoidal force is given by the law $t = \sqrt{\frac{4 \pi^2 \text{displacement}}{\text{acceleration}}}$, where t is the time.

Thus the motion of a simple pendulum is given by $t = 2 \pi \sqrt{\frac{l}{g}}$, where l = length and g = acceleration of gravity. We see at once, then, that the electrical circuit will assume under the impressed alternating E. M. F. $e = E \sin \omega t$, a harmonic vibration of the period $t = K \sqrt{\frac{L}{C}}$. K will be determined later

It at once follows that if every electrical circuit possesses a particular pitch or rate of its own, then it will respond perfectly only to that pitch or some of its overtones. Just as an organ pipe or piano string will respond perfectly only to its own natural rate of vibration or its overtones.

But if we take a long, light string, very loosely stretched, it is quite evident that it will possess no marked pitch of its own, and will be able to respond, to some extent, to any rate

of vibration impressed upon it. But if these vibrations be impressed at one end of the string, they rapidly die out during the period of traversing the string, and by the time the distant end is reached may have but a small fraction of their original value. The energy which would have been perfectly transmitted to the distant end had the string been tightly stretched and of heavier material, has in this case been largely absorbed by the light, inelastic string, and dissipated as heat. This is the case with the electrical circuits of to-day. They are constructed with little electrical inertia or weight, and so much electrical capacity (reverse of mechanical tension), that they possess no marked pitch of their own, and are consequently, like the light, loose string, capable of imperfectly responding to any period of vibration forced upon them, and of transmitting that vibration with a considerable loss to the distant end. If, now, the string be kept at the same tension, and the material be increased in size and weight, it is evident that the natural period of the string will become more and more prominent, and it will respond to and transmit that rate of alternation with little or no loss—and remain practically inert for all other rates—save the overtones of this fundamental.

Similarly, if the electrical inertia (inductance) of the current be increased, the natural period of vibration will assert itself, and if that vibration, or its overtones, be impressed upon it, little loss will occur during transmission, but the circuit will be practically incapable of responding to any other rates. Again, if the tension of the string be increased, or the capacity of the circuit be decreased, similar results will follow. It is obvious, however, that if the string be so light that the friction of the air, or other medium, seriously interferes with its vibration, then perfect resonance is impossible. Similarly it will be found that unless the inductance be made large in comparison with the electrical friction (resistance), then complete resonance will be impossible in the electrical circuit.

The method of the following articles will be to first determine those values of C and L which will bring an electrical current into resonance for a given period of vibration, and then to show graphically and analytically the advantages and economy of copper, secured by a resonant circuit.

Although the fundamental equations of E. M. F. and current have been derived by Mr. Heaviside for a circuit containing distributed resistance, inductance and capacity, they are here reproduced in the form most convenient for farther treatment.

The leakage factor has been omitted entirely, and for the following reasons: The leakage of a well constructed line is negligible, except during excessively wet or foggy weather, and during these exceptional times the effect of the leakage may be counterbalanced by a slight change in the rate of alternation.

Let the sinusoidal E. M. F., $e = E \sin \omega t$, act upon the closed metallic circuit of length l , where $\omega = 2 \pi N$, and N is the number of complete alternations per second.

Let R , C and L be respectively the resistance in ohms, the capacity in farads and the inductance in henrys, per mile of conductor.

Then at any point x , the drop of voltage through the differential length dx is:

$$de = i R dx + \frac{di}{dt} L dx, \quad (1)$$

or is equal to the current $\times$ resistance plus rate of change of current $\times$ inductance.

Again, as the capacity is uniformly distributed, the quantity of the "bound" charge at any distance x is

$$dq = C dx e = \int_0^x di dt; \text{ or } C \frac{de}{dt} = \frac{di}{dx} \quad (2)$$

These two equations determine the entire action, and are sufficient to determine the solution, which is known to be

of the form $e = k e^{pt+qx} \sin(\beta t + ax)$, where $e =$ Napierian base 2.718+.

This, when $x = 0$, reduces to $e = k e^{pt} \sin \beta t$.

But by assumption the E. M. F. at the origin, on either wire, is $e = E \sin \omega t$; hence $k = E$, $q = 0$, and $\beta = \omega$, and

$$e = E e^{pt} \sin(\omega t + ax). \quad (3)$$

The constants p and a remain to be determined. From (2) we get

$$C \frac{de}{dt} = C E e^{pt} \omega \cos(\omega t + ax) = \frac{di}{dx}.$$

Integrating we have

$$i = \frac{C E \omega}{p^2 + a^2} e^{pt} \left\{ p \cos(\omega t + ax) + a \sin(\omega t + ax) \right\}$$

Rendering this equation identical with (1) and equating the coefficients we have

$$\frac{de}{dx} = p e^{pt} \sin(\omega t + ax) + a e^{pt} \cos(\omega t + ax).$$

$$\left. \begin{aligned} R i &= \frac{R C \omega a}{p^2 + a^2} e^{pt} \sin(\omega t + ax) - \frac{R C \omega p}{p^2 + a^2} e^{pt} \cos(\omega t + ax), \\ L \frac{di}{dt} &= \frac{L C \omega^2 p}{p^2 + a^2} e^{pt} \sin(\omega t + ax) - \frac{L C \omega^2 a}{p^2 + a^2} e^{pt} \cos(\omega t + ax). \end{aligned} \right\} E$$

or

$$p = \frac{R C \omega a}{p^2 + a^2} + \frac{L C \omega^2 p}{p^2 + a^2} = 0,$$

and

$$a = \frac{R C \omega p}{p^2 + a^2} - \frac{L C \omega^2 a}{p^2 + a^2} = 0.$$

Solving we have

$$\left. \begin{aligned} p &= \pm \sqrt{\frac{C \omega}{2} \sqrt{(R^2 + L^2 \omega^2)^2 - L \omega}}, \\ a &= \pm \sqrt{\frac{C \omega}{2} \sqrt{(R^2 + L^2 \omega^2)^2 + L \omega}}. \end{aligned} \right\} \quad (4)$$

The double sign indicates that on both conductors of the circuit waves of equal magnitude and opposite phase are sent out and at any distance, x , the potential of one conductor is

$$E e^{-pt} \sin(\omega t - ax),$$

and of the other

$$-E e^{-pt} \sin(\omega t + a(-x)).$$

Now, it is evident that each of these impulses decreases in magnitude with an increase in the distance from the origin, and finally vanishes only when $x = \infty$, that is, each of these two impulses, starting simultaneously at the origin, and always of equal magnitude and opposite phase, traverses the circuit of finite length, l , in opposite directions, an infinite number of times with continually decreasing amplitude; just as the waves formed by plucking, at a certain point, a wire rope, suitably supported and stretched into a complete loop, would continue to traverse the circuit of the rope until their amplitude became zero.

Considering the point, x , on one conductor of the circuit, the value of the positive wave after traversing the circuit n times would be

$$e_n = E e^{-p(l+x+n l)} \sin \left\{ \omega t - a(x + n l) \right\}$$

and the combined effect of the waves summed to infinity is

$$e_x = E e^{-p(l+x)} \sum_{n=0}^{\infty} e^{-p n l} \sin \left\{ \omega t - a(x + n l) \right\}$$

Similarly the combined effect of the negative waves is

$$e_{-x} = -E e^{-p(l-x)} \sum_{n=0}^{\infty} e^{-p n l} \sin \left\{ \omega t - a(l - x + n l) \right\}$$

Combining the waves and separating the summation terms we have

$$e = E \left\{ \sum_{n=0}^{\infty} e^{-p l n} \cos a l n \left\{ e^{-p x} \sin(\omega t - ax) - e^{-p(l-x)} \sin(\omega t - al + ax) \right\} - \sum_{n=0}^{\infty} e^{-p l n} \sin a l n \left\{ e^{-p x} \cos(\omega t - ax) - e^{-p(l-x)} \cos(\omega t - al + ax) \right\} \right\}$$

$$\text{But } \sum_{n=0}^{\infty} e^{-p l n} \cos a l n = \frac{e^{p l} - \cos a l}{e^{p l} + e^{-p l} - 2 \cos a l}$$

and

$$\sum_{n=0}^{\infty} e^{-p l n} \sin a l n = \frac{\sin a l}{e^{p l} + e^{-p l} - 2 \cos a l}$$

Substituting and replacing $\frac{e^{p l} + e^{-p l}}{2}$ by $\cosh p l$, we have

$$e = \frac{E}{2 (\cosh p l - \cos a l)} \left[(e^{p l} - \cos a l) (e^{-p x} \sin(\omega t - ax) - e^{-p(l-x)} \sin(\omega t - al + ax)) - (e^{p l} \cos(\omega t - ax) - e^{-p(l-x)} \cos(\omega t - al + ax)) \right] \quad (5)$$

Combining the terms with respect to ωt we get

$$e = E \left\{ \frac{\cosh(p l - 2 p x) - \cos(a l - 2 a x)}{\cosh p l - \cos a l} \sin(\omega t - \tan^{-1} l) \right\} \quad (6)$$

Where $l = \frac{\sinh(p l - p x) \sin a x - \sinh p x \sin(a l - a x)}{\cosh(p l - p x) \cos a x - \cosh p x \cos(a l - a x)}$.

This equation expresses the magnitude and phase of the E. M. F. at any point and at any time and for all values of R , C and L except the value $C = 0$. For this value of C the equation is indeterminate, but in two operations reduces to the form

$$e = E \left(1 - \frac{2 x}{l} \right) \sin \omega t \quad (7)$$

showing a uniform drop in voltage throughout the circuit and no displacement of phase.

When $x = 0$ (6) reduces to $e = E \sin \omega t$, as per assumption. When $x = \frac{l}{2}$ the equation reduces to $e = 0$.

That is, as we have assumed equal position and negative

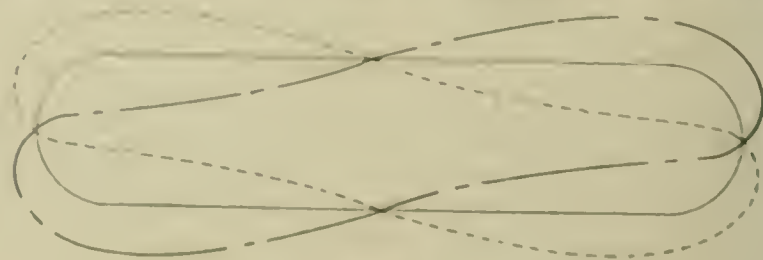


FIG. 1.

values of the E. M. F. at the origin at every instant, the potential of the middle point of the circuit is always halfway



FIG. 2.

between the potential of the two sides at the origin. The phase of the E. M. F. at this point is $\sin(\omega t - \tan^{-1} 0) = \sin(\omega t - n \pi)$ where n has all positive integral values including 0. That is, the phase of the E. M. F. may coincide with, or be displaced one-half a wave length from, the E. M. F. at the

origin, according as the circuit divides itself into an even or an odd number of wave lengths. Thus, in Fig. 1, the circuit is divided into an even number of wave lengths (two), and the phase at the distant end coincides with the phase at the origin; that is, it differs by an even multiple of π from the origin. But in Fig. 2 the circuit divides into an odd number of wave lengths, and consequently the phase differs from the origin by 180 degrees or some odd multiple of 180 degrees.

The equations for the current are similarly derived, thus introducing in equation (5) the relation,

$$C \frac{de}{dt} = \frac{di}{dx}, \text{ we have}$$

$$C \frac{de}{dt} = \frac{di}{dx} = \frac{CE\omega}{2(\cosh pl - \cos al)} \left[(\varepsilon^{pl} - \cos al)(\varepsilon^{-px} \cos(\omega t - ax) - \varepsilon^{-p(l-x)} \cos(\omega t - al + ax)) + \sin al(\varepsilon^{-px} \sin(\omega t - ax) - \varepsilon^{-p(l-x)} \sin(\omega t - al + ax)) \right]$$

Integrating and combining the terms with respect to ωt we get

$$i = - \frac{E}{\sqrt{(R^2 + L^2 \omega^2)^{1/2}}} \sqrt{\frac{\cosh(pl - 2px) + \cos(al - 2ax)}{\cosh pl - \cos al}} \sin(\omega t + \tan^{-1} y - \mu), \quad (8)$$

$$\text{where } y = \frac{\cos ax \sinh(pl - px) + \cos(al - ax) \sinh px}{\sin ax \cosh(pl - px) + \sin(al - ax) \cosh px} \text{ and } \mu = \tan^{-1} \frac{a}{p}.$$

This equation expresses the value of the current at any distance, x , from the origin at any time, t , and with all values of R , C and L save $C=0$. For this value of C it is indeterminate, but reduces in two operations to

$$i = - \frac{2E}{l \sqrt{R^2 + L^2 \omega^2}} \sin\left(\omega t - \tan^{-1} \frac{L\omega}{R}\right), \quad (9)$$

which is the well-known form for the current in a circuit devoid of capacity.

(It must always be borne in mind that the maximum value of the impressed E. M. F. is $2E$.)

The negative sign indicates simply that the direction of the "flow" of the current is opposite to an increase in potential and will hereafter be omitted.

The current at the origin is given when the condition that $x=0$ is imposed upon equation (8), thus

$$i_0 = \frac{E}{\left(\sqrt{R^2 + L^2 \omega^2}\right)^{1/2}} \sqrt{\frac{\cosh pl + \cos al}{\cosh pl - \cos al}} \sin\left\{\omega t - \mu + \tan^{-1} \frac{\sinh pl}{\sin al}\right\} \quad (10)$$

The current at the distant end is given when the condition that $x = \frac{l}{2}$ is imposed upon equation (8) thus

$$i_{\frac{l}{2}} = \frac{E}{\left(\sqrt{R^2 + L^2 \omega^2}\right)^{1/2}} \frac{\sqrt{2}}{\sqrt{\cosh pl - \cos al}} \sin\left\{\omega t - \mu + \tan^{-1} \frac{\tanh \frac{pl}{2}}{\tan \frac{al}{2}}\right\} \quad (11)$$

The factor $\left(\frac{\sqrt{R^2 + L^2 \omega^2}}{C\omega}\right)^{1/2}$ is the impedance or "apparent resistance" of the circuit per mile.

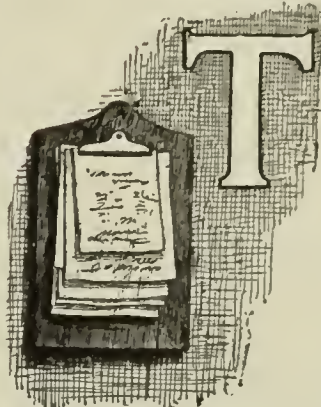
The factors $\sqrt{\frac{\cosh pl + \cos al}{\cosh pl - \cos al}}$ and $\sqrt{\frac{2}{\cosh pl - \cos al}}$ express the "apparent length" of the circuit at the origin and distant end respectively.

Equations 10 and 11, expressing the values of the current at the transmitting and at the receiving end respectively, are the important fundamental equations for a circuit containing distributed resistance, capacity and inductance.

Laboratory Notes—XVIII.

BY LIEUT. F. JARVIS PATTEN.

A NEW SYSTEM OF POLYPHASE DISTRIBUTION.



THE entire feasibility and evident advantage of combining biphas and triphase working in the same system of distribution, using each where it could work to the best advantage and economy, was indicated, probably for the first time, in a paper read before the recent Washington convention by Mr. Scott. The method shown of combining the two systems is strikingly novel and simple, and its importance seems evident from the attention it has drawn from all quarters. Mr. Scott's description of his double system as well as Mr. Steinmetz's later article on the transformation of alternating currents, which is chiefly directed to the same end, will make

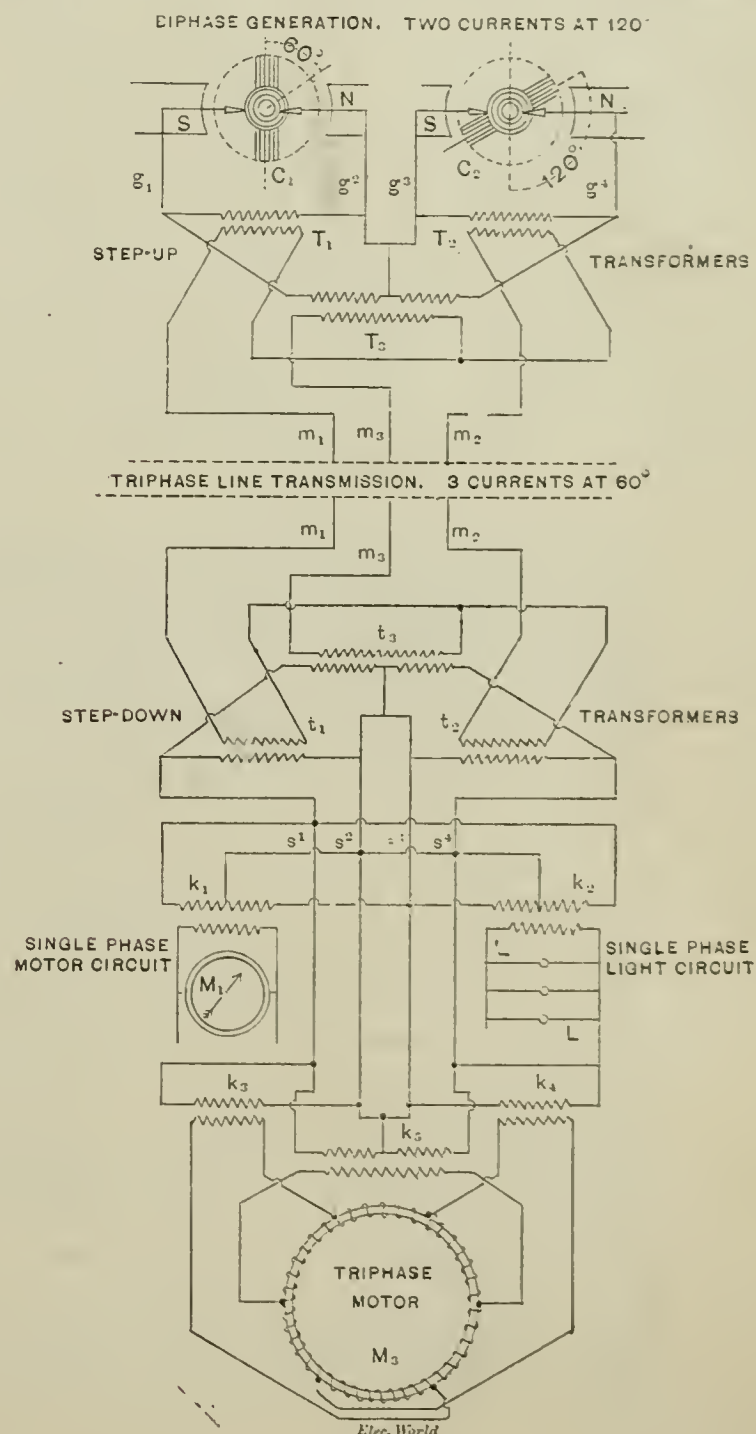


FIG. 52.

the following description of an entirely different way of obtaining similar results timely at this moment.

The advantage arising from a combination of biphas and triphase working in the same system rests apparently on the superior economy of the latter for line transmission, and the

better adaptability of the former to distribution under varying loads of different sorts.

The plan in general terms is one in which biphasic currents at the generating station are there transmitted to triphase currents for line transmission (presumably in the step-up transformers); three line wires take

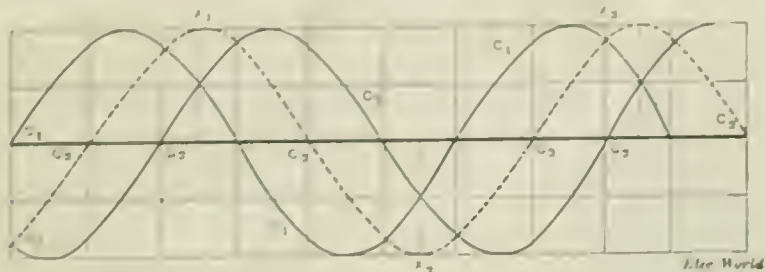


FIG. 53.

these currents to the point of distribution, where the step-down transformers change them back to biphasic currents in quadrature.

As remarked by Mr. Steinmetz, in his article, any polyphase system is readily transformed to any other polyphase system—biphasic currents to triphase currents, or the reverse, in a single transformer without any moving part. It is only necessary to use a transformer of the ring type or one in which polyphase currents of any order set up a rotating field; then evidently from the secondary of such a transformer polyphased currents of any other order may be derived. Not only this, but either biphasic or triphase currents may be in like manner transformed to a single alternating current that will tax the two biphasic or three triphase circuits equally, and thus secure an equal distribution of the single-phase load among the different circuits of a biphasic or triphase system, which is a salient feature of the system of distribution here presented. The latter transformation, when applied to changing biphasic currents to a single phase current, does not even require a rotary field transformer or one of the ring type, but may be of the ordinary form provided with a double primary winding supplied with separate alternating currents, having a phase difference of 90 degrees, and a single secondary that will have a resultant single phase current that, whatever its load, will tax the two biphasic currents equally. This transformation was explained and used by me several years ago.

The general features of the new system of distribution, which secures a combination of all three systems of working in one, and which also insures an equal loading of the multiphase circuits, under various conditions of supply, is shown in Fig. 54 by a diagram of circuits.

At the generating station a double machine generates two independent alternating currents. They are biphasic currents, but are not in quadrature relation to each other, the separate armature coils being so adjusted that the two currents have a phase difference of 120 degrees, and of the same E. M. F. These currents will be then represented by the two full line curves, C_1 and C_2 , Fig. 53, and the dotted line curve C_3 , same figure, would represent their resultant, or, if C_1 and C_2 were secondary currents derived from those first generated by the two armatures, then C_3 would represent a resultant secondary current derived from both primaries by using a transformer of the type referred to, and such a secondary would of course load both the primary biphasic circuits alike.

Owing, however, to the phase difference of 120 degrees between the two primaries, the resultant secondary current will be midway between the other two currents, C_1 and C_2 . It will be easy to arrange matters so that this secondary resultant will have the same maximum voltage as the others, when we will have three currents in triphase relation, having 60 degrees phase difference, and if the connections of the circuit conveying the current represented by the dotted curve be C_3 reversed at the translating device, we would have

three currents of 120 degrees phase difference and a balanced system.

Using these principles, we have, therefore, at the generating station three step-up transformers T_1 , T_2 , T_3 (Fig. 54), the latter only being a double transformer, as indicated. These transformers deliver the three currents C_1 , C_2 , C_3 in triphase relation to the lines m_1 , m_2 , m_3 . At the distant end a step-down transformer of the ring type, may be used, in which the triphase currents will produce a rotary field, and if we connect to the secondary of this transformer for four points, 1, 2 and 3, 4, we will have on the mains M_1 , M_2 , M_3 , M_4 two currents in quadrature relation for local distribution. To these mains biphasic motors will necessarily load the two circuits equally. To accomplish the same result with respect to lighting as well, the double transformer is availed of as indicated, that yields a single alternating current for lighting which taxes the two biphasic currents equally.

Again, if it is desired to operate triphase motors at the point of supply, another system of derivation by means of triple transformers similar to that used at the generating station for changing biphasic to triphase currents. Such a complete system is shown in Fig. 52, where the system of generation and transformation to triphase currents for line transmission is the same as before. At the point of distribution, however, the step-down transformers, instead of being rotary field transformers of the ring type, are triple

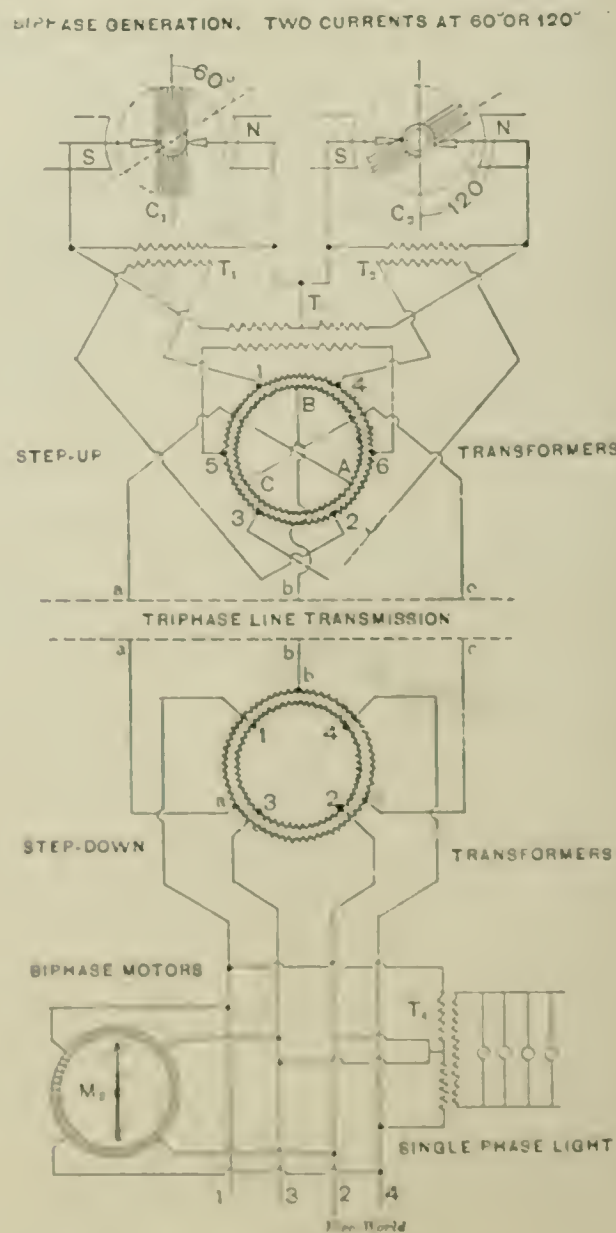


FIG. 54.

transformers like those at the generating station working backwards, yielding biphasic currents having 120 degrees phase difference, and these by using double primary circuits, as shown, give a single current for single phase motors or for lighting that loads the two circuits equally, whereas a triple transformer giving triphase alternating currents at 60 degrees may be used to operate triphase motors as at M_1 , Fig. 52.

We thus have in such a system facilities for operating both multiphase devices and single phase devices as single

phase motors and light, each of which individually is made to load the supply circuits equally in a way that is independent of the character of the translating device, and this is combined with whatever advantage can be derived from biphasic generation and triphase line transmission.

An Electrical Engineering School of the South.

The School of Electrical Engineering at the Agricultural and Mechanical College of Alabama was established by the board of trustees in June, 1891, for the purpose of supplying educational facilities for special instruction in the in-



FIG. 1.—EXTERIOR OF POWER STATION.

dustrial applications of electricity. It was intended to so combine theoretical and practical instruction as to give the student a knowledge of the science of electricity and magnetism in its most comprehensive sense.

The course of instruction extends through four years, and includes, besides work in electrical engineering, the study of physics, mathematics, mechanical engineering, chemistry,

ples of electricity and magnetism. The student is made familiar with the theoretical principles by experiments, illustrations, recitations and lectures. Six hours per week are devoted to work in the electrical laboratory. This includes management and construction of batteries and instruments, electrical measurements, and verifications of the principles upon which the measurements of current, electromotive force and resistance are based. The text books used in the junior year are Ayrton's "Practical Electricity," and Desmond's "Electricity for Engineers."

In the senior class the work is as follows: Five hours per week recitations and lectures on dynamo-electric machinery and the practical applications of electricity, three hours per week to the design of dynamo-electric machinery and six hours per week to work in the electrical laboratory, including efficiency tests of dynamos and motors, characteristics of dynamos, efficiency tests of plants, etc.

Trips are taken during the year by the senior class to different cities for the purpose of inspecting and testing plants.

There is a large number of well selected books on electricity and magnetism in the library, which are accessible to the student. Several prominent magazines on electrical engineering are received at this library.

The electrical laboratory, besides the apparatus necessary for first-year students, such as batteries, magnets, resistance coils, telegraph instruments, bells, etc., is well equipped with many fine instruments of precision for very delicate and accurate measurements, such as a tangent galvanometer (Societe Genevoise), tangent and sine galvanometer (Kohl), Edelmann's large mirror galvanometer, d'Arsonval and ballistic galvanometers, standard microfarad condenser, slide metre bridges, standard resistance boxes, etc. For measurement of current, Lord Kelvin's deka-ampere balance and graded current galvanometer, Siemens' electro-dynamometer, Weston ammeter, Queen magnetic vane ammeter, Kohlrausch ammeter, Ayrton and Perry ammeter, Deprez ammeter, and Wood ammeter, etc. For measurement of potential, Lord Kelvin's graded potential galvanometer, Wes-

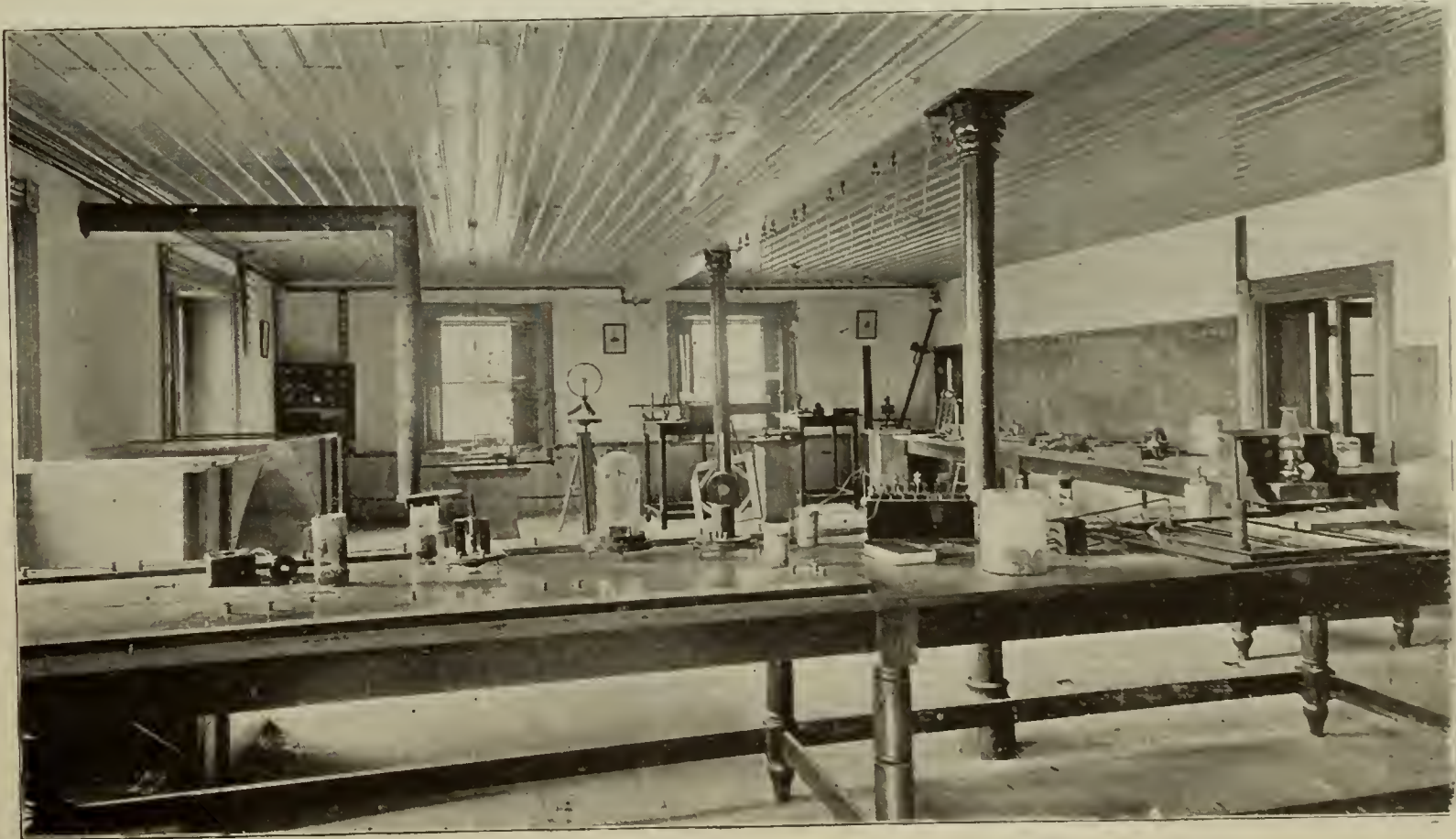


FIG. 2.—A VIEW IN THE ELECTRICAL LABORATORY.

mechanical drawing, French or German, and practical work in physical laboratory, wood shop, forge shop, foundry and machine shop. The special study of electrical engineering begins in the junior year. In this year five hours per week for the entire session are devoted to the study of the princi-

ton 150-volt and 600-volt voltmeters, Cardew voltmeter, Queen magnetic vane voltmeter, Hartman and Braun gravity voltmeter, etc. For measurement of power, Thomson's wattmeter and Prony brakes. For engine tests, Tabor and straight line steam engine indicators.

Fig. 1 shows an external view of the electric station, which has just been completed and equipped. Fig. 3 shows the interior of the same. The engines used are a 25-h. p. Atlas automatic, 225 revolutions per minute, and a Westinghouse 35-h. p. Junior, 350 revolutions per minute. These engines are belted to a 2 15-16-inch shafting, joined in the middle by a clutch coupling. The dynamos installed are a 12-kw. Edison compound, 125 volts, 94 amperes; a Weston shunt dynamo, 150 volts, 25 amperes; a Thomson-Houston motor of 10 h. p., which is used also as a dynamo; a Brush 6-light arc machine with lamps; a Crocker-Wheeler 1-h. p. motor, also used as a dynamo; a 400-volt, 20-ampere generator, and a 2-phase alternator, made by students.

This 400-volt generator furnishes current to the 10-h. p. motor (also built by students) at the experiment station farm. This motor operates a cotton gin and screw press, an ensilage cutter, a thresher, corn sheller, cottonseed crusher and a grinding machine. This plant has been in operation since April, 1892. This motor replaced a 15-h. p. engine, furnished with steam from a 15 h. p. boiler. A 125-volt motor,

The last equation shows that the shifting of phase depends upon three quantities—the exciting current, the useful current and the leakage.

$\cos \phi_1$ grows with the load current, and therefore with increasing slip s . But when s grows, the efficiency of the motor falls (vide equation (109)). As the amount of slip is consequently limited to small values, the exciting current must be kept weak in order to preserve as small a phase-shifting as possible, and the greatest stress must be laid upon the lessening of the leakage.

The watts consumed by the motor are

$$W_t = \frac{m}{2} E_1 I_1 \cos \phi_1, \quad \text{or} \quad W_t = \frac{m^2}{2} R_1 I_1^2 + \frac{m^2 s_2 p_1 (p_1 - p_2) M I_1^2 R_2}{8 r^2} \quad (105)$$

The watts lost through hysteresis and Foucault currents are taken into consideration by a corresponding increase in the resistances R_1 and R_2 .

The second term of the second member of equation (105)

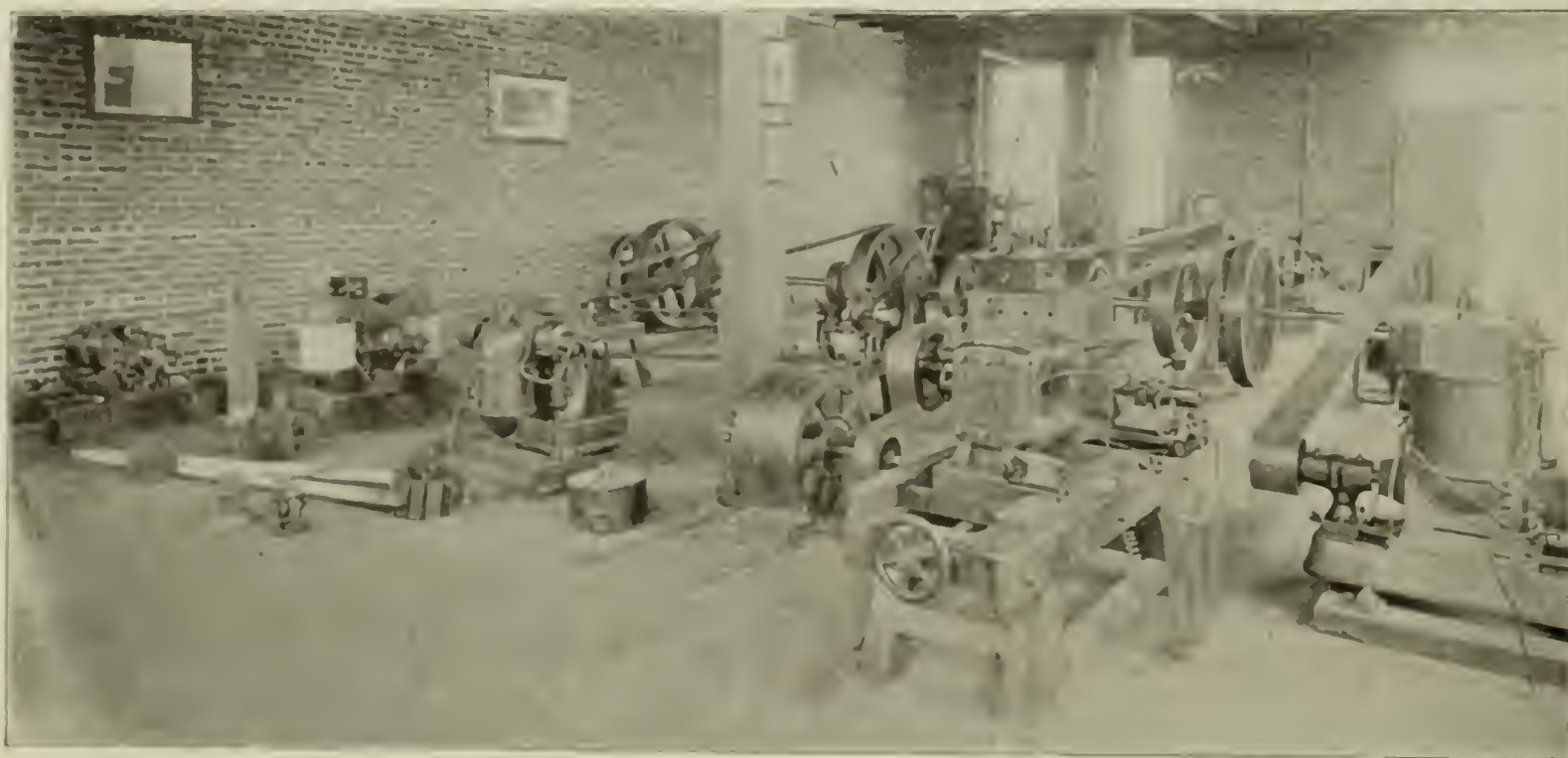


FIG. 3. INTERIOR OF POWER STATION.

operated by the Edison generator at the college, was first installed. Last spring the system was changed from a 125-volt to a 400-volt with increased efficiency. This plant affords the student a practical example of the electrical transmission of power.

Fig. 2 shows a view of the electrical laboratory.

The Calculation of Alternating Current Motors—IX.

BY E. ARNOLD

DETERMINATION OF THE SHIFTING OF PHASE ϕ_1 AND THE EFFICIENCY

From Fig. 19 it follows that

$$\cos \phi_1 = \frac{I_1}{E_1} \left(R_1 + \frac{m s_2 p_1 (p_1 - p_2) M}{r^2} R_2 \right) \quad (103)$$

By the employment of equation (73) we have

$$\cos \phi_1 = \frac{r}{\sqrt{N}} \left(R_1 + \frac{m s_2 p_1 (p_1 - p_2) M}{r^2} R_2 \right)$$

For small values of R_1 , L_1 and $(p_1 - p_2)$ we can place approximately

$$\cos \phi_1 = \frac{r}{\sqrt{N}} \left(R_1 + \frac{m s_2 p_1}{r^2} R_2 \right) \quad (104)$$

From equations (97) and (102) there results

$$\cos \phi_1 = \frac{r^2 I_1 \omega}{\sqrt{I_1^2 + I_1^2 \omega^2}} \quad (104 a)$$

gives the sum of the watt output of the motor and the watts consumed by the armature.

The first part is

$$W = \frac{m^2 s_2 p_1 (p_1 - p_2) M^2 I_1^2 R_2}{8 r^2} \quad (106)$$

the second part is

$$W_t = \frac{m^2 s_2 (p_1 - p_2)^2 M^2 I_1^2 R_2}{8 r^2} \quad (107)$$

Disregarding the friction losses W_h , the efficiency of the motor is

$$\eta = \frac{W}{W_t} = \frac{m^2 s_2 p_1 (p_1 - p_2) M^2 I_1^2 R_2}{4 m R_1 I_1^2 r^2 + m^2 s_2 p_1 (p_1 - p_2) M^2 I_1^2 R_2} \quad (108)$$

or, approximately,

$$\eta = \frac{p_2}{p_1} = 1 - s. \quad (109)$$

This efficiency is reached with a closeness of from 2 to 5 per cent.; with larger motors, from about 10 h. p. upwards. The choice of the slip s is, therefore, essential in determining the efficiency of the motor.

THE CONSTRUCTION OF THE FIELD AND THE ARMATURE.

The winding of the field and the armature can be carried out as ring, drum and pole winding. For motors with high primary potential, ring winding and pole winding are of advantage in having no crossing of the wires, but, on the

other hand, ring winding has the advantage of greater leakage. For larger motors and low primary potential drum winding with rods can be so arranged that the cross connections are carried out in two planes, whereby good insulation is made possible and a small leakage is attained.

The magnetic qualities of the field are calculated as with transformers. The induction of the former is

$$B_1 = \frac{\overline{E}_1 10^8}{4.44 F_1 N_1 n_1} \quad (110)$$

The induction in the armature iron is

$$B_2 = \frac{b E_1 10^8}{4.44 F_2 N_1 n_1} \quad (111)$$

Under the assumption that all the lines of force unite to

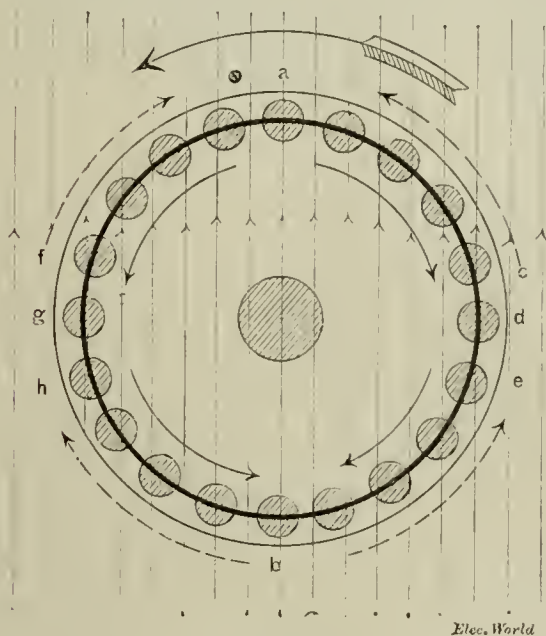


FIG. 20.

form a rotary field, the number of periods for the armature iron is only $= p_1 - p_2$, and the magnetic qualities of the latter can therefore be taken greater than for the iron of the magnetic field.

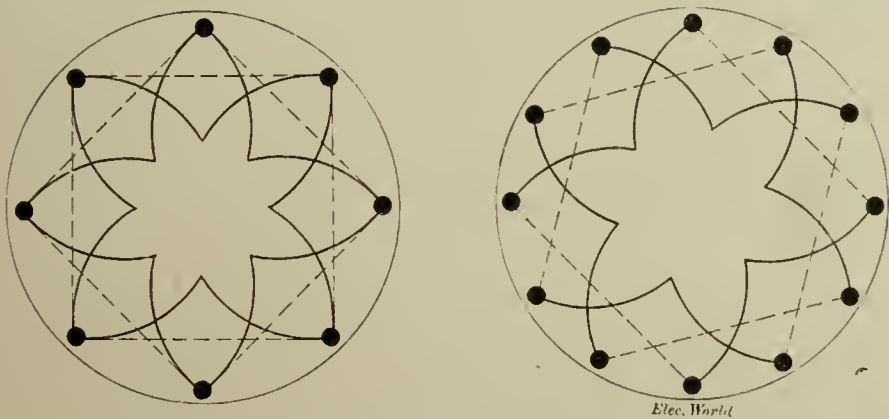
The closed circuited winding of the armature can likewise be carried out as drum, ring or pole winding, and each, indeed, in three different ways:

(1) The whole of the copper rods on every side of the armature are short circuited among themselves. (According to Dobrowolski.)

(2) All those rods on every side of the armature which are acted upon inductively in the same, or nearly the same, manner are short circuited among themselves.

(3) All those rods which are acted upon inductively in the same, or nearly the same, manner are connected in series and short circuited.

The first method of construction has the advantage of great simplicity, but several disadvantages are associated



FIGS. 21 AND 22.

with it. For larger outputs it is not possible to preserve a sufficient cooling surface with one short circuited ring, not even when the latter is in the form of a band, and then the induced currents partly take such a course that the secondary rotary field is weakened and the attractive power of the motor is lessened. In Fig. 20 the front view of such a

closed circuited armature is shown. Let us imagine the armature at rest and the magnetic field rotating in the direction of the upper arrow. The induced currents in the front short-circuited ring take a course indicated by the inner arrows, and those in the back ring a direction shown by the outer dotted arrows. The rods *c, d, e* and *f, g, h* experience no induction at the given moment, but in spite of this part of the current will find its way through these rods and weaken the secondary rotary field.

For these reasons I give the preference for those constructions proposed under (2) and (3).

In Figs. 21 and 22 are shown the diagrams of connections for a four-pole motor constructed according to the second and third methods, respectively.

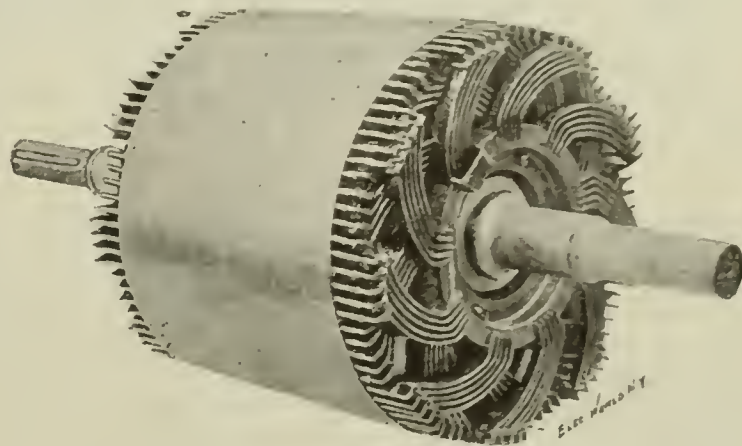


FIG. 23.

Fig. 23 gives a view of an armature constructed according to the third method by the Maschinenfabrik Oerlikon.

Letting R_0 represent the resistance of *one* armature rod, including the resistance of the cross connection, which goes with this rod, it follows from equation (91) that

$$R_0 = b^2 \frac{s_2}{W} \frac{N_2^2}{N_1^2} E_1^2 v (1 - v).$$

Now $s_2 N_2 = Z$, the total number of rods in the armature, and from this there follows the equation, good for all three constructions of the armature.

$$R_0 = b^2 \frac{Z \overline{E}_1^2}{W N_1^2} v (1 - v), \quad (112)$$

and the watt output is

$$W = b^2 \frac{Z E_1^2}{R_0 N_1^2} v (1 - v). \quad (113)$$

(To be continued.)

Recording Voltmeters.

We have received a communication from Mr. E. J. Richards, superintendent of the Belt Electric Line Company, Lexington, Ky., giving an account of the excellent results which he has obtained through the use of recording voltmeters. In Mr. Richards' station they operate about 7,000 incandescent lights of the alternating system, and as a matter of experiment a couple of recording voltmeters were put in about five months ago. The first charts taken showed that the pressure during the 24 hours varied anywhere from 49 to 56 or 57 volts. As a consequence, the dynamo men were instructed in regard to the matter of watching their pressure more closely, and knowing that any delinquency would be detected through the record left by the instruments, the improvement has been very great, some recent cards showing a very slight variation during the 24 hours. One of the instruments is located at the centre of distribution of one of the feeders, 11-4 miles from the station. From the good results he has derived from the use of these instruments, Mr. Richards is convinced that they are as necessary to a well equipped station as recording steam gauges, and states that the recording voltmeters which he has now in the station have paid for themselves in the past three months in the reduced number of lamp renewals.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

COMPILED FROM
PRINCIPAL FOREIGN
ELEC WORLD, N.Y.

ELECTRICAL JOURNALS
BY CARL HERING

ELECTRO-PHYSICS.

Alternating Currents in Parallel.—In the Lond. "Elec. Rev.," April 13, Mr. Rimington gives a graphical treatment of the problem of alternating current conductors in parallel; in a previous paper (see Digest, Jan. 13) he gave a graphical method of finding the apparent impedance of the primary of a transformer; in the present article he discusses the case of impedance in parallel.

Adiathermanous Glass.—The Lond. "Elec.," April 13, contains a short article and an editorial on this subject; the article gives the comparisons between a large number of substances.

Electricity of Drops.—The "Elek. Zeit.," March 15, abstracts an article by Mr. Wesendock from the "Wied. Ann.," volume LI., page 353.

MAGNETISM.

Magnetic Qualities of Iron.—The paper of Prof. Ewing and Miss Klaassen is continued in the Lond. "Elec.," April 13, including a large number of curves. This paper is doubtless one of the most important of those recently published on hysteresis and should be read in its entirety. Among other things they show that the result of special annealing after a wire ring is coiled was to make the stages of the cyclic process much more sharply differentiated than before, the curves being now exceedingly square shouldered; but the work lost in hysteresis was not reduced by the annealing; they believe that there is "a doubt whether all that is possible has yet been done by manufacturers of iron to produce a quality specially suitable for such uses as the construction of transformer cores. The conditions of manufacture which secure low hysteresis appear to be imperfectly known, or at least to be less generally recognized than electricians might wish." Some of the figures show in a striking way the extent to which the dissipation of energy in hysteresis may vary in different specimens, even of soft iron; high maximum permeability does not necessarily imply small hysteresis losses, a statement which is borne out by a number of their curves; the easy slope of some of the soft iron curves allows them to be crossed by curves for steel, even under moderate magnetizing forces; with a magnetizing force of 13, for instance, more magnetism will be produced in a rather hard steel specimen than in a very soft iron one; a comparison of permeabilities in this respect with any such force would furnish no criterion of magnetic softness; specimens, however, which are soft in a sense of having small hysteresis losses excel in permeability in the initial stage of magnetizing process. They made a critical examination of Mr. Steinmetz's formula, in which the hysteresis loss is equal to a coefficient multiplied by B to the 1.6th power; within a certain range of values of B this formula may be taken as giving a fairly close approximation to the real values; from $B = 2,000$

to 8,000, which includes the values generally used in transformer cores, they found for a certain thin sheet iron ring that the coefficient was 0.01 and the exponent 1.475; from $B = 8,000$ to 14,000 the coefficient is 0.00134 and the exponent 1.70; from 200 to 500 the exponent is 1.9; from 500 to 1,000 the exponent is 1.68, and from 1,000 to 2,000 it is 1.55; they conclude that no formula of that type with a constant index will represent the results within anything like the limits of experimental accuracy; the index begins with 2 degrees, is about 1.47 in the region of high permeability and then increases again to 1.7 when the turning point has been passed; while a formula of this type cannot be admitted to have any physical significance, it may still be serviceable in approximate calculations for the purpose of the electrical engineer; several tables of observed and calculated values are given; if the observed and the calculated curves are to coincide throughout in a short path, other and very different values must be given to the coefficient and the index. Editorially it is stated that this is the most important contribution to our knowledge of the actual material used by transformer makers that has yet been published.

Magnet for Very Intense Fields.—The "Elec. Zeit.," April 5, abstracts an article by Mr. De Bois from the "Wied. Ann.," volume LI., page 537, by means of which field intensities of 38,000 C. G. S. units (gausses) can be generated; unfortunately, no illustration is given, but the magnet has the form of a ring.

Designing Magnets.—See article by Mr. Marcher under "Dynamios."

UNITS, MEASUREMENTS AND INSTRUMENTS

Astatic Station Voltmeter.—In an Institution paper by Professor Ayrton and Mr. Mather, to be published in the Lond. "Elec. Eng.," and possibly in other journals also, they lay down the following conditions which should be filled by such an instrument: It should be unaffected by outside fields whether uniform or not, it should be unaffected by outside electrostatic disturbances such as those produced by cleaning the glass, it should have no temperature error, it should have a high resistance so as to measure equally well the true voltage at the end of long pilot lines or at the station itself, it should have a scale of large radius and a very open one at the working voltage, it should be dead beat. The first condition is fulfilled by using powerful stationary permanent magnets and a moving coil: it has been found from experiments that fields of 20 C. G. S. units (gausses), or equal to more than 100 times that of the earth, occasionally occur on switchboards of existing stations, while fields of six units are quite common; if the coil is wound astatically and acted on by two magnets it will be screened from a uniform field but not from a non-uniform one, such as that from a neighboring conductor; for this reason they use three

permanent magnets and a coil wound in three parts, the area of the middle coil being double that of the end one; the resistance of a 100 volt instrument is about 7,000 ohms, of which only 3 per cent. is composed of copper wire, the rest being manganin wire, the temperature error being therefore practically negligible and the consumption of energy is only 1.5 watts for 100 volts; the counter-action is produced by gravity; the current leads are made of very thin flexible silver strips; the open scale of 100 volts, as also the dead beatness, are obtained by shaping the air-gap; at 100 volts the one-hundredth part of a volt can be detected; the normal position of the pointer is indicated by an index which can be set to any desired point and is colored red while the arrow head pointer is colored black, and they are in such a position that when pointing correctly the red is covered by the black pointer, whereas if the voltage varies the red will show to the right or left of the pointer; the inside of the glass cover is coated with a layer of their transparent conducting varnish, described in the following paragraph.

Measuring the Insulation of Lines While in Use.—In an article by Dr. Froelich, mentioned in the Digest March 18, last year, he describes a method, which, however, requires the use of a calibrated galvanometer or voltmeter; in the issue of the "Elek. Zeit.," April 5, he describes a modification of this method, in which an ordinary galvanoscope can be used, that is, one which indicates a current without measuring it; the theory is given, which is best understood when read in connection with the former article.

Nomenclature and Symbols.—A long editorial in the Lond. "Elec.," April 13, discusses unfavorably the new names proposed for the magnetic units; it questions the need of a unit of magnetomotive force, which it claims is a clumsy analogical comparison to the expression electromotive force; it thinks that confusion is likely to arise if the factor 4π is to be suppressed; it is thought that the term, number of lines, is quite sufficient for all practical purposes, and that the unit gauss can be dispensed with. The block or Gothic letters for the magnetic units are preferred to the pen type letters recommended by the congress.

Meters.—In a paper by Mr. Wilson, reprinted in the Lond. "Elec. Eng.," April 13, he gives illustrated descriptions of the Aron and Thomson-Houston meters, without, however, giving anything new.

Electrodynamometer.—The "Elek. Zeit.," March 15, abstracts a description from "Wied. Ann." of an instrument intended specially for electro-therapeutical purposes.

Pocket Galvanometer.—An instrument made by Siemens & Halske is described and illustrated in the "Elek. Zeit.," April 5.

Testing Iron.—A paragraph on this subject will be found on page 596.

DYNAMOS AND MOTORS.

The Sayers System of Winding Armatures.—The Lond. "Elec. Eng.," April 13, reprints a paper by Mr. Mavor, in which he describes in detail the Sayers system, described in these columns last year; the present description is much more complete and clear than those previously published; he also shows a modified arrangement which will enable the dynamo to be run in either direction, the previously described arrangement being for one direction only; the connection of the commutator coil is exactly the same, but has two sides, an active and an idle side, the active side being that under the pole tip when the coil is connected to the brush.

Alternating and Multiphase Currents from Continuous Current Armatures.—The conclusion of Mr. Friese's article, abstracted in the Digest March 17 and April 7, is contained in the "Elek. Zeit.," March 15. He gives similar figures for

6, 8 and 12 phase currents and concludes with the development of general formulas.

Leakage Coefficient.—Mr. Mavor in the Lond. "Elec. Eng.," April 13, states that the ratio of the total field to the useful field of dynamos of ordinary design varies from 1.2 to as much as 2.0.

TRANSFORMERS.

Three-phase Transformer.—The transformer used at the Jura-Simplon workshops is illustrated and described briefly in the Lond. "Elec. Rev.," April 13; the primary and secondary are wound on three vertical laminated cores, united at the top and bottom by laminated circular discs, each core containing a primary and secondary; comparing this construction with three separate closed circuit transformers it was found that the weights are as 3 to 4 in favor of the three-phase transformer.

ARC AND INCANDESCENT LIGHTS.

Cored Carbon Litigation.—The "Elek. Zeit.," March 15, contains another lengthy communication on this subject.

TRANSMISSION OF POWER.

Series Transmission of Power.—A translation of Mr. Schultz' article, mentioned in the Digest April 14, is given in abstract in the Lond. "Elec.," April 13.

ELECTRIC RAILWAYS.

Overhead Contact Arrangement of the Genoa Railway.—A brief illustrated description is given in the Lond. "Elec. Eng.," April 13; instead of the trolley wheel there are two trolley arms with a long cross-bar at the top, forming, with the trolley arm, a device shaped like the letter T, the length of the upper part being almost equal to the width of the car; the upper part is made of a special metal and is easily renewable; it presses against the under side of the overhead conductor and one of the chief advantages is that much of the overhead straining or pull-off wires are rendered unnecessary at curves, since the trolley wire need not follow the rounded curve of the rails; the main object is to prevent the continual jumping away of the trolley wheel from the line.

Alternate Current Railway System.—At the Lyons Exhibition the Creusot works will exhibit the Lombard-Gerien overhead conductor system, using alternating currents of high potential in connection with transformers. The Fives-Lille Company will exhibit a railway using polyphase currents, which will be run experimentally only and will carry no passengers.

Electric Traction on London Railways.—In an article by Mr. Lea, in the Lond. "Elec. Eng.," April 13, he discusses the practicability of utilizing electric traction on the London City railways, which at present use steam power; the principal question involved is whether both steam and electric trains could be run, because some of the District railway trains in the underground railway run from suburban lines directly into the underground lines. The paper is entirely of local interest.

An article reprinted in the Lond. "Elec. Eng.," April 13, gives the itemized train mileage expenses for the City and South London line and those for the underground steam lines in parallel columns.

Heilmann Locomotive.—According to the Paris "Figaro," the Heilmann locomotive is to run regularly between Mantes and Paris, a distance (the length of which is not given) which will be run in 50 minutes. It is also stated that a second similar locomotive is under construction to develop 1,200 to 1,500 h. p.

Electric Locomotive.—The Lond. "Elec.," April 13, states that the Bernese Oberland Railway Company is contemplating the substitution of electric traction for steam, the scheme comprising 200-h. p. locomotives, with 10 trains on the line simultaneously, water power being used as the source.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Two-phase vs. Three-phase Currents.—In his serial in the Lond. "Elec.," April 13, on electromotive power, Mr. Snell discusses the relative merits of these two currents. Machines designed for similar outputs, whether synchronous or non-synchronous, are found to have about the same efficiency, starting torque and apparent watt consumption, the three phase, however, being the better, according to the engineer of the Oerlikon Works; for the simple transmission of power between two distant points a three-phase current system is generally cheaper than either a continuous, a one or a two-phase alternate current system; the main difference between the two systems lies in the relative weights of copper for the conductors and the ease with which the currents may be handled; he discusses this at some length from three points of view on the basis of effective pressure at the distributing station, on the basis of maximum difference of voltage and when the economic law is considered; the ratios of the weights of copper under these conditions are given in a large table; he concludes that as regards the prime cost of line the three-phase system is cheaper for long transmission than the single or double phase; continuous currents are the cheapest of all, but are not admissible for extra high voltages.

Leveling the Load Line.—According to the Lond. "Elec.," April 13, it has been recommended that the power developed at the station at Worcester should be utilized at the water works in place of steam, thus supplying work for the station during the daytime; the recommendation is heartily commended as a very practical one.

Fusible Cut-Outs.—A translation of the first part of the article by Mr. Anney, mentioned in the Digest March 31 and April 14, is published in the Lond. "Elec. Rev.," April 13, under the heading of "Present Conditions of Installing Electric Mains in the Premises of Consumers Supplied from Central Stations."

Aix-la-Chapelle.—In the "Elek. Zeit.," March 15, Mr. L'ppenborn gives a well illustrated description of this station, in which a three-wire direct current system is used with accumulators. The present description forms the fifteenth and last of the series described in this journal, and mentioned in the paragraph below.

Germany.—A list of the 15 stations which were very fully described and illustrated in the "Elek. Zeit.," is given, together with the reference numbers, in the issue of March 15; the list comprises the largest stations in Germany and adjoining countries, the illustrations having been, as a rule, large, well selected and executed.

Hanover.—Detailed statements of the output, accounts and other like data regarding this station are given in tabular form, in the "Elek. Zeit.," March 15.

Live's Destructor.—The Lond. "Elec. Rev.," April 13, contains a long editorial and letter on this apparatus.

TELEGRAPHY, TELEPHONY AND SIGNALS

Individual Telephone Call.—In the "Elek. Zeit.," April 5, Mr. Kohluerst describes the Reimer apparatus which is used in Munich, in which a number of subscribers are connected in series on a single line and in which each can be called individually; an apparatus for ten subscribers is described, a cut being given of all the connections. To call a station the required number of impulses for that station are sent to line, they are received by all the subscribers, but only the one set for this number of impulses will be operated by the subsequent negative impulse which operates the bell by means of a polarized relay.

Induction Telephony.—The Lond. "Elec. Rev.," April 13, mentions an experiment of Mr. Stevenson, in which communication was established between the mainland and a lighthouse by means of an induction system; the apparatus

is not described, but it is stated that two coils 200 yards in diameter of nine turns each of ordinary telegraph wire were erected on poles 800 yards apart; the coils were not earthed; messages could be sent with 10 cells with perfect ease, and even with only five; the experiments are said to have been entirely successful.

Railroad Signals.—The Perl's system for single track lines is briefly described in the "Elek. Zeit.," April 5.

MISCELLANEOUS.

Infantile Paralysis.—The Lond. "Elec. Rev.," April 13, contains a letter by Mr. Hedley from the "Lancet," on the electrical treatment, in reply to a recently published paper.

The Lighting of the Grand Central Station, New York City.

One of the best illustrations of interior lighting by the use of arc lamps is the Grand Central Station in New York City. The possibilities of interior illumination by the employment of arc lamps on incandescent circuits are now being generally recognized, as this instance shows. They have been found to give excellent results in theatres, halls, and other large interiors, but they have seldom been applied to the lighting of such great areas as has been done in this case.

The interest in this installation, however, centres in the fact that it was the first time that arc lights were commercially used with success on incandescent circuits, and for that reason the plant will continue to attract considerable attention. Prior to August, 1890, this immense structure was lighted by some 1,400 incandescent lamps. During that month, however, a few Ward arc lamps were introduced as an experiment, and the result proving an entire success, they gradually supplanted the incandescent lamps, until to-day the entire area of the ground floor, including the incoming and outgoing train sheds, waiting rooms, ticket offices, etc., is brilliantly illuminated by about 90 arc lamps, this being the number required to more than take the place of the 1,400 incandescents previously employed. The accompanying illustration gives a view of the station brilliantly illuminated at night.

The type of lamp used is the well known arc lamp manufactured by the Electric Construction and Supply Company, Telephone Building, New York City. The lamps are placed two in series on a 110-volt circuit. Current is furnished by an isolated Edison plant in the building. In the incoming station and baggage room, the dimensions of which are 600 by 130 feet, are placed ten lamps, while over the tracks in the outgoing depot fourteen are used. Six more are located in the ladies' waiting room, vestibules, etc., and two in the elevated railroad station, which forms a part of the incoming station. The outgoing station is 600 feet long and 225 feet wide, and this immense area of 135,000 square feet is brilliantly lighted by 32 Ward lamps, which took the place of 500 incandescents. In the station of the Harlem road four Ward lamps replaced 36 incandescents, while in the New York Central 67 incandescents were replaced by six Ward arcs. The rest of the lamps are scattered through the building in various places.

The 1,400 incandescent lamps with which the station was previously lighted consumed 700 amperes, while the 90 arc lamps require but 300, and at the same time illuminate the building five or six times as well.

This system of interior lighting has proved most satisfactory to the railroad authorities, combining, as it does, the convenience and flexibility of incandescent lighting with the brilliancy of the arc. The success of such a plant is dependent in a measure upon the care it receives and the good results obtained in this case are due in a considerable degree to the excellent supervision of Mr. E. L. Pollard, the electrician of the Grand Central Depot.



ILLUMINATION OF THE GRAND CENTRAL DEPOT, NEW YORK CITY.

New Book.

TRAITE DE TELEGRAPHIE ELECTRIQUE By H. Thomas, Ingenieur des Telegraphes Paris, Libraire Polytechnique Baudry, et Cie. 1904. 391 pages, 712 illustrations Price \$7.50.

In this book we unquestionably have a work of much merit, and one that cannot fail to be of great value not only to those for whom it has been especially written—the employes of the post-office telegraph service of France—but also to others who may be interested in the principal methods employed in that enterprising country in the operation of its telegraph service.

While, as the author points out in his preface, the systems at present employed in France are described in great detail, yet he has not confined himself to these alone, for there is also to be found described at some length within the covers of this valuable work the chief automatic system employed by the British post-office department, namely, the Wheatstone automatic telegraph. He has also passed in review many of the early systems of telegraphy employed in France and elsewhere, and has also found space to describe a number of systems, which, in this and other countries, have been tried and laid aside, such as Gray's harmonic telegraph and several others.

The book is written in a very lucid manner, and to facilitate the descriptions, illustrations to the number of 702, of a high degree of excellence, have been furnished, and it seems quite apparent that the great bulk of these illustrations have been expressly prepared for this work.

As was to be expected, the Baudot synchronous telegraph system, which is in extensive use in France, has received very full attention, and no pains have been spared by the author to explain this system to the minutest detail. The Hughes printing telegraph system has also received generous treatment, and it certainly will not be the fault of the author if any one familiar with the French language should hereafter remain in ignorance of the style of apparatus and mode of operation of either of these systems. The simple Morse system—open circuit method—which is in operation in France between points where the volume of business would not warrant the employment of the Hughes or Baudot systems, is also fully and clearly described.

Somewhat singularly, perhaps, the quadruplex system, which is in such extensive operation in this country, and somewhat extensively in Great Britain, is dismissed in one or two pages by M. Thomas, while Gray's telautograph, which is not in very extended practical use, if at all, is allotted several pages. This is not, however, intended as adverse criticism, as it is doubtless within the author's right to treat those systems which are not in operation in his own country according to his own notions of propriety.

An interesting chapter is deservedly given to the description of the telephone, more especially in its relation to simultaneous telegraphy and telephony, and in the course of this chapter many of the best known receivers and transmitters are shown and described.

A chapter is also devoted to a description of various forms of primary batteries; another to testing apparatus and testing, and another to the localization of faults on telegraph lines, etc. Among the testing apparatus described is the Thomson electrometer. This description could, perhaps, have been relegated to books more exclusively relating to testing, since it is an instrument rarely used by ordinary telegraphers in testing, and, indeed, requires such careful manipulation in the majority of cases as to be beyond the skill of any but the more expert electricians to handle. This, however, illustrates the completeness with which the author has performed his self-set task, and adds to the value of the book as a work of reference.

Telegraph construction, aerial, underground and submarine, has also received thorough treatment at the hands

of the author, the plan followed being, as a rule, that most commonly adopted by writers on telegraph engineering, the formulæ for tension, sag, etc., of wires, and for the angle of curve of conduits, etc., being given at full length. The space allotted to the laying and repairing of submarine cables is well employed. The author also pays considerable attention to many of the laws of electricity concerned in telegraphy, a chapter, for example, being devoted to "the propagation of the electric current in a telegraph line," in which the variable state of the current, the duration of the variable state, the effect of self-induction of conductors, etc., are discussed with the aid of numerous graphic illustrations, the latter being a method frequently and advantageously adopted throughout this work.

While the book as a whole is quite elementary in its treatment of its different subjects, yet recourse is had quite frequently to mathematics, whenever the author has deemed this method advisable. To some readers it may seem that he has adopted this plan of treatment at greater length than is essential, but as in the majority of cases these mathematical explanations are placed in footnotes and in smaller type than usual, and are, generally speaking, merely additional explanations, they may without serious detriment be omitted by the non-mathematical reader. When it is considered that the volume under consideration contains 21 chapters and 901 pages, it will readily be perceived that the foregoing remarks touch upon but a small fraction of the subjects discussed therein.

In view of the extent of the work the typographical errors are remarkably few, and much credit is certainly due the enterprising publishers for the excellent appearance of the type, engravings and press work.

Three-Phased Power Transmission.

The first important application of electrical power transmission to textile manufacture has just been installed by the General Electric Company at Taftville, Conn., the power being transmitted from Baltic to Taftville, a distance of nearly 4 1/2 miles. It is a typical transmission by three-phase currents, in which motors of the synchronous type are used not only to operate one of the largest cotton mills in this country, but also the power station of the Norwich, Conn., Street Railway.

In the basement of the Baltic mill, on the Shetucket River, are the wheel and dynamo rooms of the generating plant. The mill is of four stories, built of stone, and will presently be used, as are the Ponemah mills at Taftville, in the cotton weaving industry. Four hundred feet above the mill a fine stone dam 525 feet long has been thrown across the river. The effective head on the turbines is 32 feet, and the water available, even in the driest seasons, is sufficient to furnish not less than 1,500 h. p.

Fig. 1 is a plan of the basement of the mill, in which the power plant is located. It will be seen that the turbines are belted to pulleys on the main line shaft, extending the whole length of the wheel room and continuing through the partition walls into and along one side of the generator room. The pulleys are thrown into, or out of, action by Hunter clutches mounted with pulleys on quills, so that any or all of the wheels can be applied to driving the shafts. Similar pulleys and clutches are furnished in the dynamo rooms for throwing in or out the various machines that may there be placed.

In the wheel room are three double 42-inch horizontal turbines and one double 27-inch turbine, the former developing 800 effective horse power each, at 157 revolutions per minute, and the latter 300 h. p. at 244 revolutions per minute. The belts pass obliquely upward to the pulleys on

the line shaft, and the turbines are kept at speed by Schenck electric governors, which have proved themselves capable of doing very fair service. The wheel plant and shafting were made and installed by the P. C. Home Company, of Gardiner, Me. The line shafting is supported by heavy iron girders set on stone piers and additionally braced by timbers.

In the dynamo room are two 250-kw. General Electric three-phase generators, delivering current to the line at 2,500 volts. Each machine is provided with its own exciter, a

this end the board is furnished with synchronizing apparatus, the acoustic synchronizer being mounted on the face of the switchboard, and the equalizing switch being at the back. The most interesting novelties on this switchboard are the high voltage switches on the lower part of the board. These are mounted on marble bases with substantial barriers erected between the switch blades, so that the circuit at full load and voltage may be broken without the slightest dan-

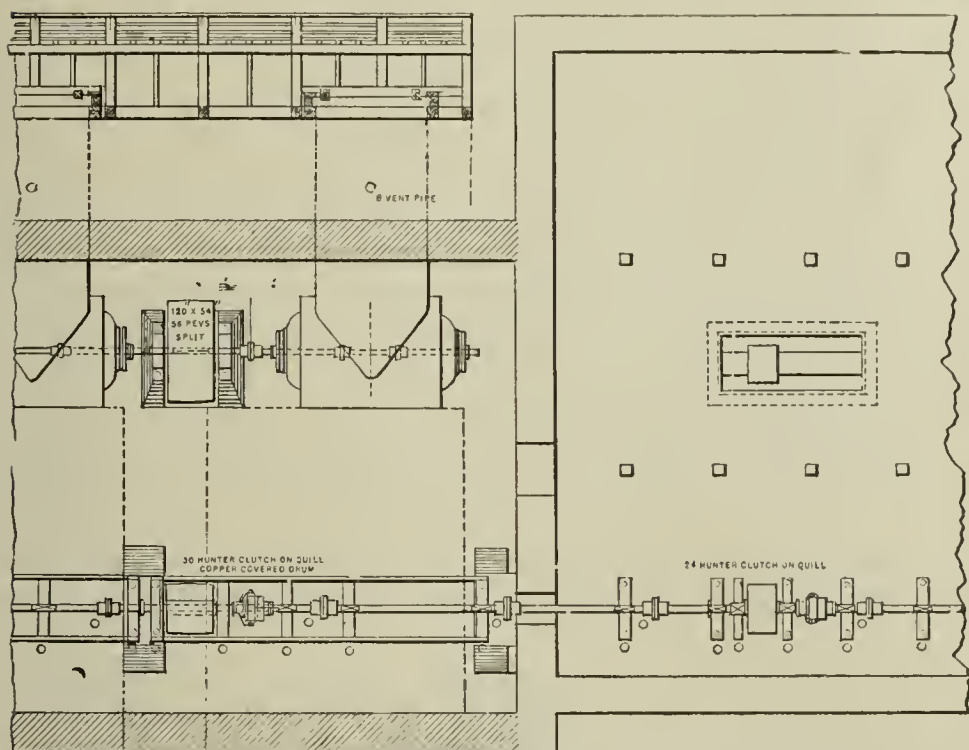


FIG. 1. PLAN OF POWER PLANT IN BASEMENT OF MILL.

3-kw. bipolar dynamo. The three-phase machines run at 600 revolutions per minute, and are set so firmly on substantial foundations as to run with scarcely a perceptible vibration. The driving pulleys on the main shaft are fitted

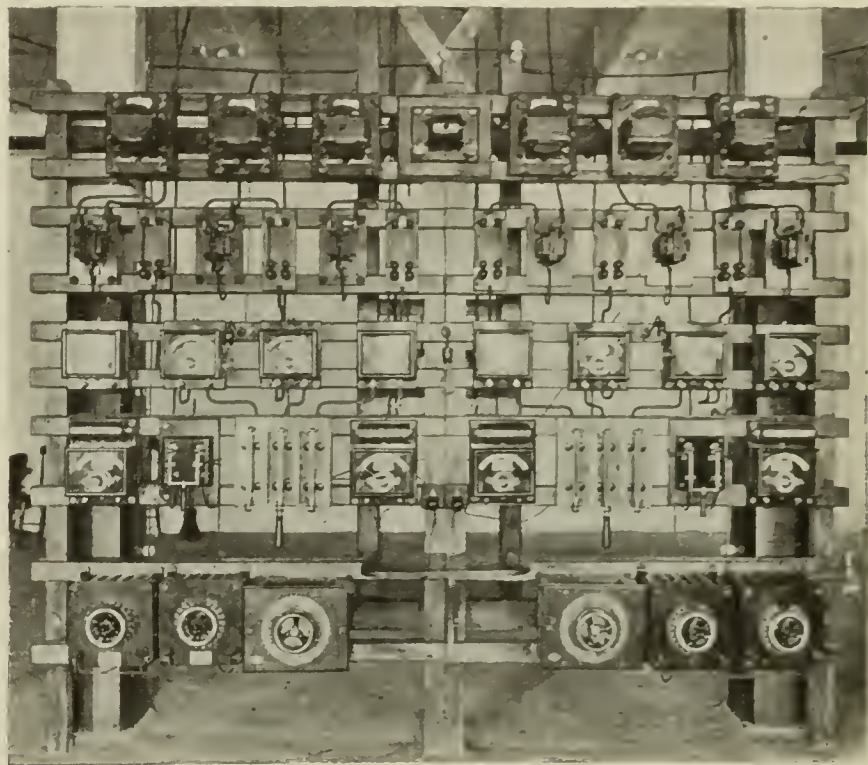
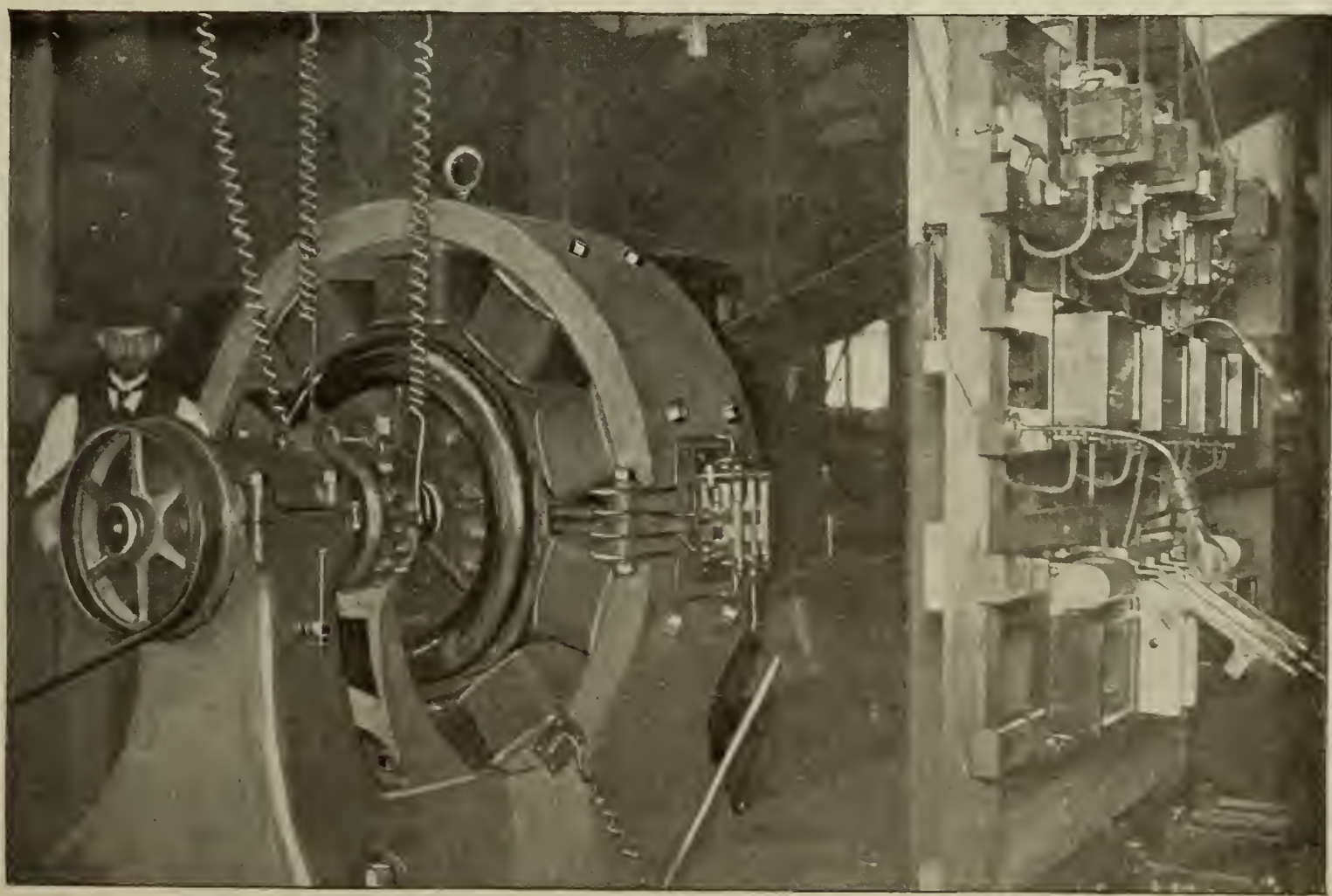


FIG. 2. THE MAIN SWITCHBOARD.

ger of arcing across from point to point. They have been amply tested and have proved their ability to cope with the trying work required of them with the greatest ease. The generators fall into parallel easily and run as smoothly to-



SYNCHRONOUS MOTOR AND ITS SWITCHBOARD.

with Hunter clutches, so that either machine can be dropped out without the slightest disturbance to the service.

The generators are connected to a common switchboard, Fig. 2, and may be run in parallel whenever desirable. To

gether as would a couple of railway generators. No artificial load is used in throwing them together, none having proved necessary.

The line is on substantial wooden poles, placed 100 feet

apart. There are two cross-arms, the wires on the upper one being of No. 6 bare copper and form the original three-phase circuit designed for the transmission. The wires on the lower cross arm are No. 0000 insulated wire, and are four in number. They were originally intended for a railway circuit, the generators for which were to be installed at Baltic to feed the Norwich Street Railway; but as the amount of copper necessary to do the work successfully appeared too great, the system was changed, a second three-phase generator and motor were added, and three of the four proposed feeder wires were utilized for the three-phase circuit. All are supported on the General Electric Company's standard oil insulator, the fourth No. 0000 wire forming a convenient relay in case of accident to any of the others.

At Taftville the three-phase circuits are led into the basement of the new mill, where they drive two three-phase synchronous self-starting motors, Fig. 3, identical in size with the generators at Baltic. These machines replace the two Corliss engines of 350 h. p. previously used. One motor, with its switchboard, is shown in Fig. 3, which also gives an excellent view of the high voltage switch before referred to. These motors are belted to the jack shafting previously driven by the engine, the pulleys on the shaft being equipped with friction clutches so that the load can be thrown from engine to motor, or back again, without any interruption of service.

The motors start entirely unaided, coming up to synchronous speed in about 50 seconds from the time the current is thrown on. They are, like the generators, separately excited, the exciters being driven from the pulleys on the end of the motor shaft.

The efficiency of the complete transmission at full load, from the power applied to the dynamo pulley to that delivered to the motor pulley, is just 80 per cent. In originally starting the mill, before the second motor was ready for operation, it was the custom to bring the motor up to speed and then gradually throw in the clutch connecting it to the shafting already running from one of the engines. When the clutch was fully in and engine and motor running together, the engine was disconnected by its clutch and the power transferred entirely to the motor. This could be done without producing the slightest disturbance in the speed, and in the same way, now that both motors are in and the engines shut down, the load can be shifted from one motor to the other, if desirable. Ordinarily, however, there is work enough for both, when driving the 1,700 looms in the new mill, operating the lighting plant and the three 80-h. p. General Electric railway generators, installed in another part of the basement. The first motor was started more than two months ago, and the complete plant, entirely installed by the Power and Mining Department of the General Electric Company, has now been in operation for several weeks, entirely displacing the steam service and performing its duties in a highly satisfactory manner.

The New Bain Arc Lamp.

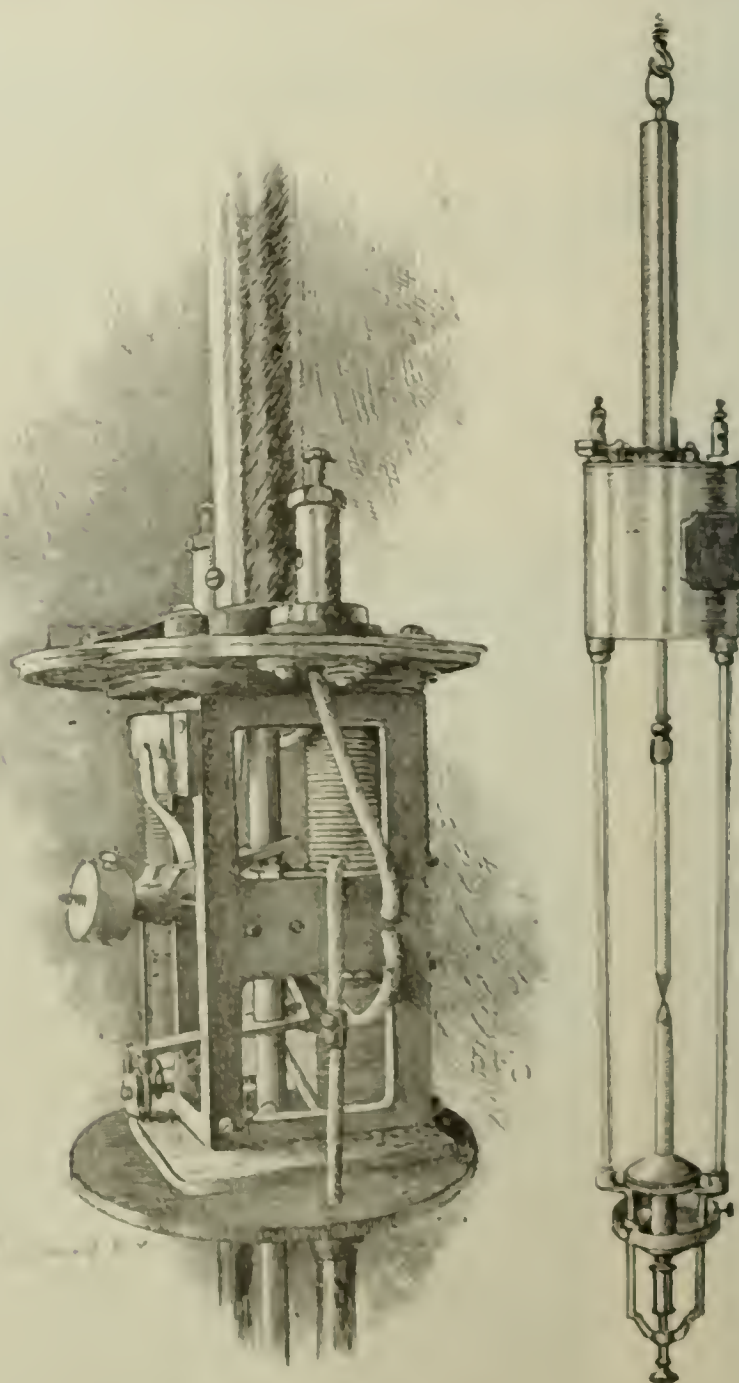
The new Bain arc lamp has been recently put on the market by the Great Western Electric Company, of Duluth, Mich., and the illustrations show the general appearance and the mechanism of the lamp. The latter is quite simple, there being but two hollow magnets or solenoids, the main or lifting magnet being placed above the shunt or feeding magnet. The use of but two magnets makes a lamp of lighter weight and less cost, while the action is sufficiently strong and delicate to serve every purpose, so that a satisfactory working lamp is assured with the least amount of mechanism.

The clutch consists of a simple bar of brass, perforated for the rod, one end being suspended from the lifting bar

by a double link, the other end connected with the opposite end of the lifting bar by an adjusting screw, thus making the action differential and more delicate than is usual in such lamps. The lifting bar is counterbalanced by an adjustable weight, thus providing for more delicate adjustments than could be obtained by a single contrivance and yet retain the desired simplicity.

The automatic cut-out consists of a strip of brass attached to a supplementary piece, pivoted above the lifting bar and facing a contact piece, which is insulated from the other portions of the lamp by being secured to a plate of non-conducting material. Sufficient resistance is supplied, in the short circuit made by the cut-out, to insure that the cut-out will not fail to maintain the conditions for which it is provided, so long as the other mechanism of the lamp fails to operate in the proper manner, a condition never found so long as the lamp has the necessary care. The cut-out is brought into action by the pull of the shunt magnet, so that it can be relied on to act in case anything should happen to call for such service.

The solid rod of the lamp is of hard brass, which cannot be easily bent, thus providing against another defect found in some lamps. The lower end of the rod is fitted with an ad-



THE BAIN ARC LAMP

justable carbon holder that permits of the carbons always being placed in proper alignment with the least amount of trouble and with a saving of time, a feature of importance when many lamps are to be recarboned in a short time. A simple but efficient switch for cutting the lamp out of circuit is placed on the top, where it is out of the way of accidental closure, but easy of access when required. The shadeholder contains a receptacle for all carbon dust which inevitably forms from the consumption of the carbons.

This holder can be easily removed from the lamp and cleaned without removing the shade from the holder. All parts of the lamp with which a person is liable to come in accidental contact are carefully insulated.

New Westinghouse Electric Railway Equipment.

In order to meet the requirements of street railway companies that may desire, for reasons of their own, motors lighter than the standard type, and especially having less weight upon the car axle, the Westinghouse Electric and Manufacturing Company has recently brought out a new type, known as Nos. 10 and 12, the former being of 40 and 50 h. p. and the latter of 20, 25 and 30 h. p. In addition the same company has developed a new type of controller, diverter, fuse block, switch and lightning arrester, thus enabling it to offer a complete new car equipment.

The new motor differs materially from the older type only in the absence of an iron supporting frame, which has been incorporated into the upper half of the field in the new motors, and thus also forms part of its magnetic circuit, while giving sufficient strength to hold the armature shaft always in perfect alignment with the car axle. On the side which is farthest from the axle of the car, the two halves of the yoke are hinged together, so that the interior parts of the motor are made easily accessible without the necessity of dismounting.

The lower field casting has three openings, one directly below the commutator and the others at opposite ends of the casting. These openings are closed by water-tight covers, which may be removed to give access for the purpose of repair or removal of dust or dirt.

The field coils are wound and insulated in the same manner as in the older type, although the capacity of the winding has been somewhat increased and the insulation is made, if possible, even more thorough.

The two brush holders, 90 degrees apart on the top of the commutator, are held in position by a frame which is so

one for controlling the speed and the other the direction of travel of the car. The handles are provided with locking devices, which prevent their removal, except when in the position for no current. The electrical combinations of the motors made by the new controller are improved over those of the earlier type, in that the motors divide the work equally, and the car starts more easily and attains its maximum speed more smoothly. The construction and operation of the new controller are similar to that of the old type, and it is designed with special reference to making inspection as simple and as easy as possible. The controller drum is so supported that it can be swung clear of the contacts, the sup-

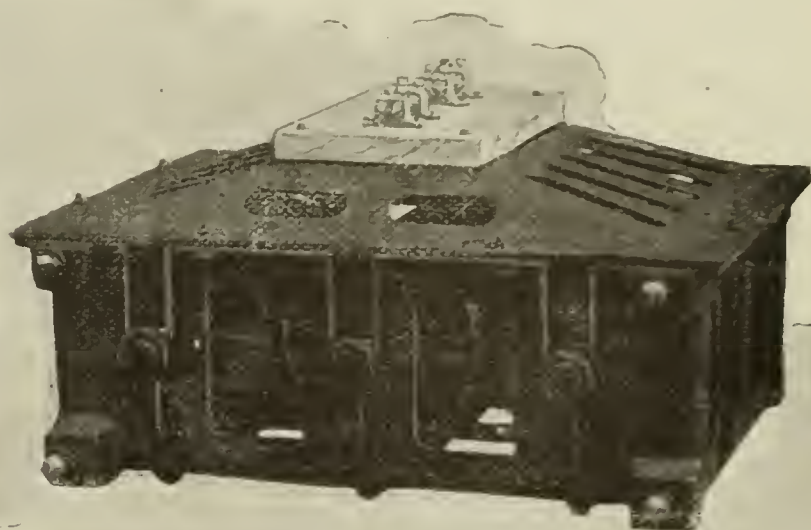
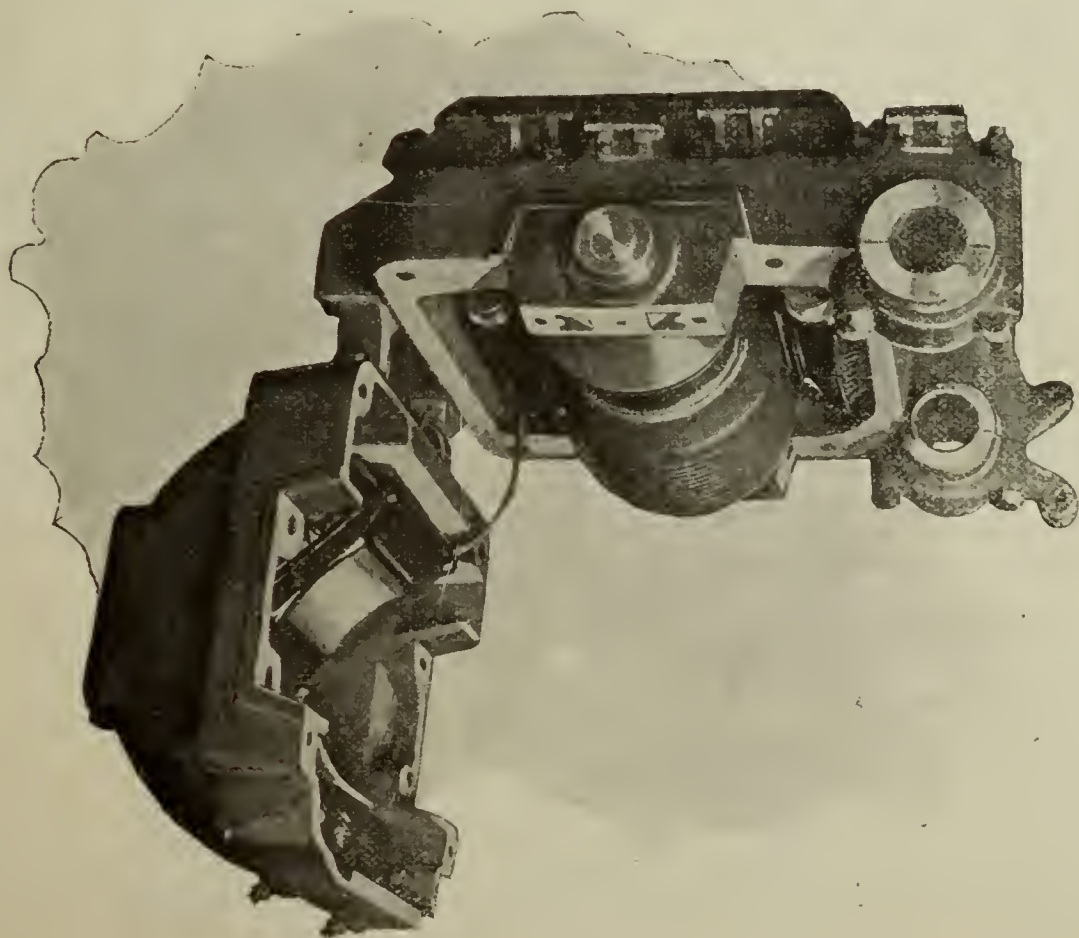


FIG. 3.—NEW DIVERTER.

ports for the two bearings of the drum shaft being hinged at one side of the controller back, thus giving ready access to the drum and contacts.

The controller is made both fire and waterproof. The cover of sheet iron, lined with asbestos cloth, is easily and quickly removed. The cylinder or drum is built up of thick



FIGS. 1 AND 2. NEW STREET RAILWAY MOTOR AND CONTROLLER.

designed as to constitute a part of the end of the upper field, and, together with a lid, completely encloses the commutator end of the motor, and entirely protects the inner parts. The lid is hinged and normally kept closed by a stiff spring.

The new platform controller has two removable handles,

porcelain and vulcabeston rings, the latter extending sufficiently beyond the porcelain to render arcing from one contact to another impossible. By raising the points of arcing above the surface of the insulator, any tendency to disintegrate the porcelain is avoided. The contact strips are made

with replaceable tips. At the left of the drum are placed the contact blocks, which resemble short, thick fingers split diagonally into two sections, to secure perfect contact and even wear. Either motor can be cut out of circuit by the removal of a plug, thereby rendering unnecessary the use of the usual cut-out box within the car. The reversing handle projects from the side of the stand, a single throw of which reverses the current in both motors.

The new diverter differs somewhat from the former styles, and has been designed for use with the above controller. The resistances are made up of strips of sheet iron placed between strips of mica, the whole being then wound compactly into coils. The coils are enclosed in iron cells, which are afterward threaded on an insulated support and thus built up into short cylinders. Three of these cylinders, thoroughly insulated, are supported in a light, cast-iron frame box. The terminal block consists of a marble slab, carrying four binding posts, to which are connected the wires to the controller. Thus the diverter is made completely fireproof, and at the same time there is provided the very best ventilation. One of these diverters is used on each car, its function being to reduce the current while the motors are being started, thereby preventing the sudden jerking of the car and unnecessary strains on the motors.

Three other pieces of apparatus comprising the equipment are a canopy switch, fuse block and lightning arrester, all of which display in their design the most careful consideration of the practical points involved.

The method of suspension relieves the axle of practically all the direct weight of the motor, and avoids what has been termed "hammering" of the rail joints. By reason of the increased strength of the upper field yoke, it is possible to suspend the motor directly in the line of its centre of gravity, by means of suspension bars, which run parallel to the sides of the truck, and have their ends supported upon spiral springs. The motor is thus freed from jars, and yet ac-

armature and of the copper in the windings, it has been possible to effect a material reduction in the weight of the new motor. This has been done only so far as it was believed consistent with a margin of mechanical strength adequate to meet the severe conditions of electric traction.

Reference to Fig. 1 shows the ample provision which is made for the rapid yet thorough inspection of the fields and armature. The hinged lid, already referred to, permits ready handling of the brushes and inspection of the commutator. The openings in the lower field afford access to the lower part of the motor. When it is desired to gain access to the whole interior of the motor, the car is run over a pit and the lower half of the field opened down, either with or without the armature, as may be desired. The armature bushings are carried in pillow blocks, which, when the motor is closed, are secured to both the upper and lower field. By removing the bolts holding the pillow blocks to the upper half of the field, the lower half may be opened down with the armature, which can then be rolled out upon a board, thus avoiding the necessity of lowering the armature into the pit and again raising it. By removing the bolts between the pillow blocks and the lower half of the field, the armature is kept in the upper half of the field, permitting removal of the field coils, etc., in the lower half. The lower half of the field is readily opened down by the use of a rope passed around the axle, which is thus made to take the part of a pulley block. By the above construction and arrangement of parts, all repairs can be easily made from the pit, and consequently the grease and dirt accompanying repair work is not introduced within the car, a feature which will be at once appreciated.

Power Plant for Cotton Mills.

The Columbia Cotton Mills Company, of Columbia, S. C., is to use electricity for power, and a generating plant of 1,400 h. p. has been installed. The power plant consists of



DIRECT-CONNECTED VICTOR TURBINES AND DYNAMOS, AT COLUMBIA, S. C.

curately maintains the meshing of the gears while yielding to the motion of the truck. This important feature of the new motor will be easily understood by reference to Fig. 1.

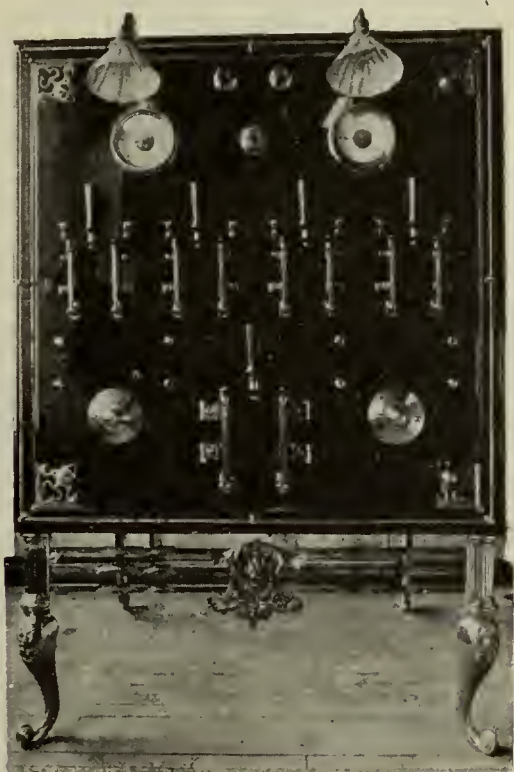
By reason of improvements, which have been introduced, and of a more efficient utilization of the iron in the fields and

two pairs of 48-inch cylinder gate Victor turbines on a horizontal shaft, with a single 24-inch horizontal Victor turbine for driving the fire pump. The two pairs of 48-inch turbines are connected together and at each end are direct connected to a generator of 700-h. p. capacity, made by the Gen-

eral Electric Company. This is the second instance in America where an entire cotton mill will be driven by electricity. The entire power plant was designed and furnished by the Stilwell-Bierce & Smith-Vaile Co., of Dayton, Ohio, in connection with the plans for the mill, which were furnished by Lockwood, Greene & Co., of Boston, Mass. The cut shows the Victor wheels in position with direct connection to dynamos.

Incandescent Switchboards.

The Electric Engineering and Supply Company, of Syracuse, N. Y., has placed on the market something new in the



INCANDESCENT SWITCHBOARD.

line of switchboard fittings, a small illustration of which is herewith given. All the unsightly apparatus, so far as practical, is mounted on the back of the slab, thus not only en-

general appearance of a dial on a safe lock, the degrees on the dial corresponding with the steps of the rheostat. Voltmeters and ammeters are similarly mounted, bringing the dial flush with the slab, and set off with polished metal rings. To conform with the rules and regulations of the State Board of Fire Underwriters, the company is prepared to furnish numerous designs for mounting these boards upon metal standards and frames, neatly wrought out of brass or iron. The highly finished E. E. & S. station switches form an attractive part of the outfit.

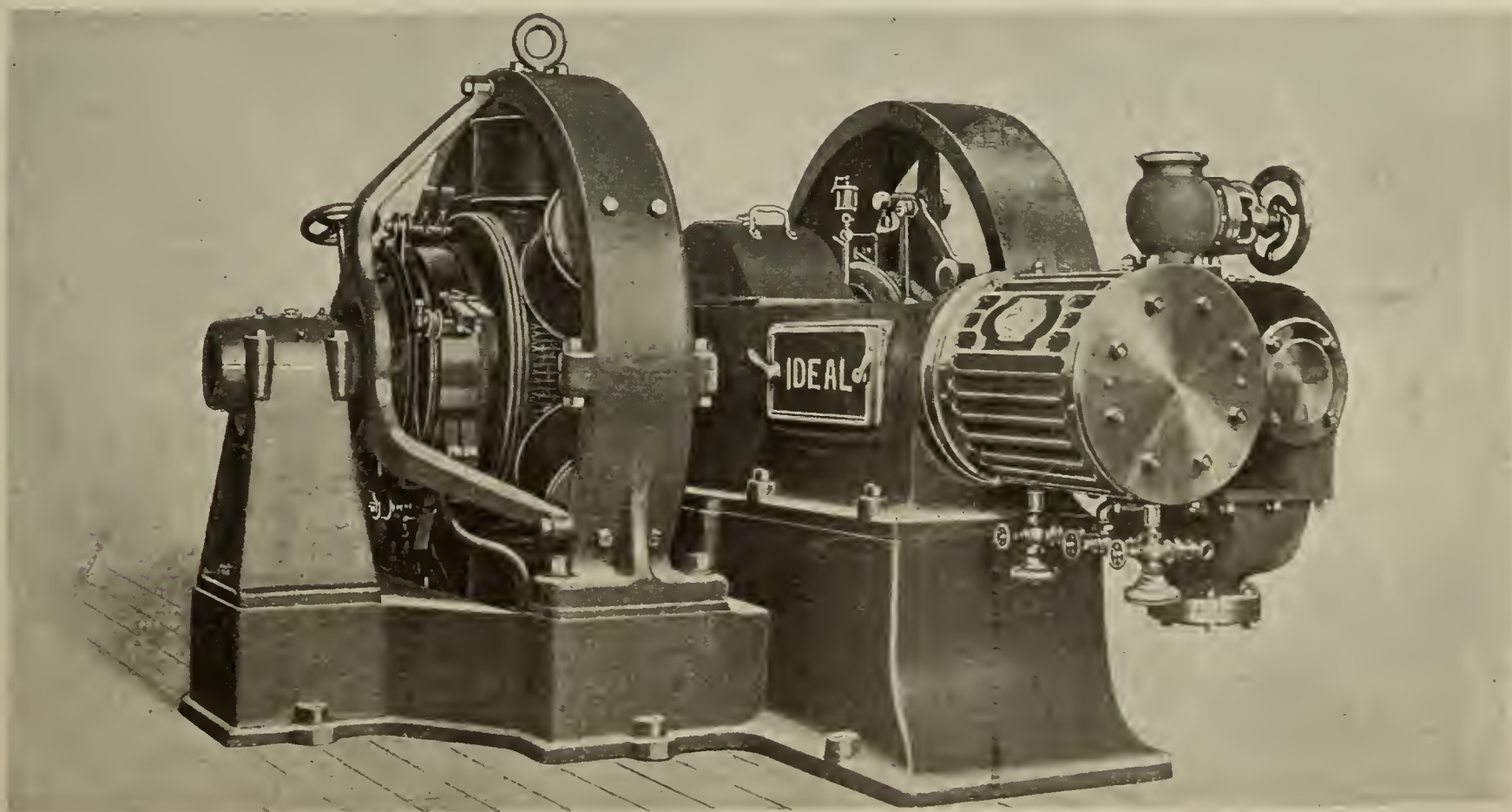
Direct-Connected Engines and Dynamos.

That the day of belted dynamos is drawing to a close is evident from the increased attention given by engine builders to the design of engines for direct connection, as well as from the tendency toward electrical generators of low speed, and we illustrate herewith one of the most recent of these combinations, which our readers will find of interest.

The engine is the "Harrisburg Ideal," self-oiling pattern, manufactured by the Harrisburg Foundry and Machine Works, Harrisburg, Pa., and has a cylinder 12 inches in diameter and 12 inches stroke. The dynamo is one of the General Electric Company's multipolar type, with a capacity of 50 kw., giving 450 amperes at 110 volts, the speed being 275 revolutions per minute.

The self-oiling, outboard bearing feature in the engine shown is designed on a generous model, and has the latest arrangement of a movable sleeve with ring oilers, being, except for increased weight and size, of almost the same construction as the standard Edison bipolar dynamo bearings, which have been proved by years of service to be so excellent.

A test of the combination shown was made recently in New York City, in the presence of several gentlemen well informed on steam and electrical matters. The engine was started in the usual manner under steam, and when running at the desired speed, of 275 revolutions per minute, the brushes were adjusted and the engine and dynamo prepared



DIRECT-CONNECTED ENGINE AND DYNAMO.

hancing the appearance of the board, but in many instances economizing space. In mounting rheostats, for example, an adaptation of a graduated dial and index finger is used, which is all that appears on the face of the slab, and has a

for taking on the load. The switchboard was also arranged so that the entire current generated would pass through two switches side by side, and a 5-cent nickel balanced on edge on the outer end of the cylinder head, the engine running

at friction load. The two switches were then taken in hand and thrown in instantly, whereupon the ammeter showed 340 amperes; the switches were then thrown out at the end of seven seconds, then in and out again, thus throwing upon the engine practically the full load of the dynamo twice within fourteen seconds, during which the 5-cent piece remained balanced on the cylinder head, showing the combination to be operating absolutely without any vibration whatever. There are now, we are informed, between 30 and 40 combinations of this type in successful operation.

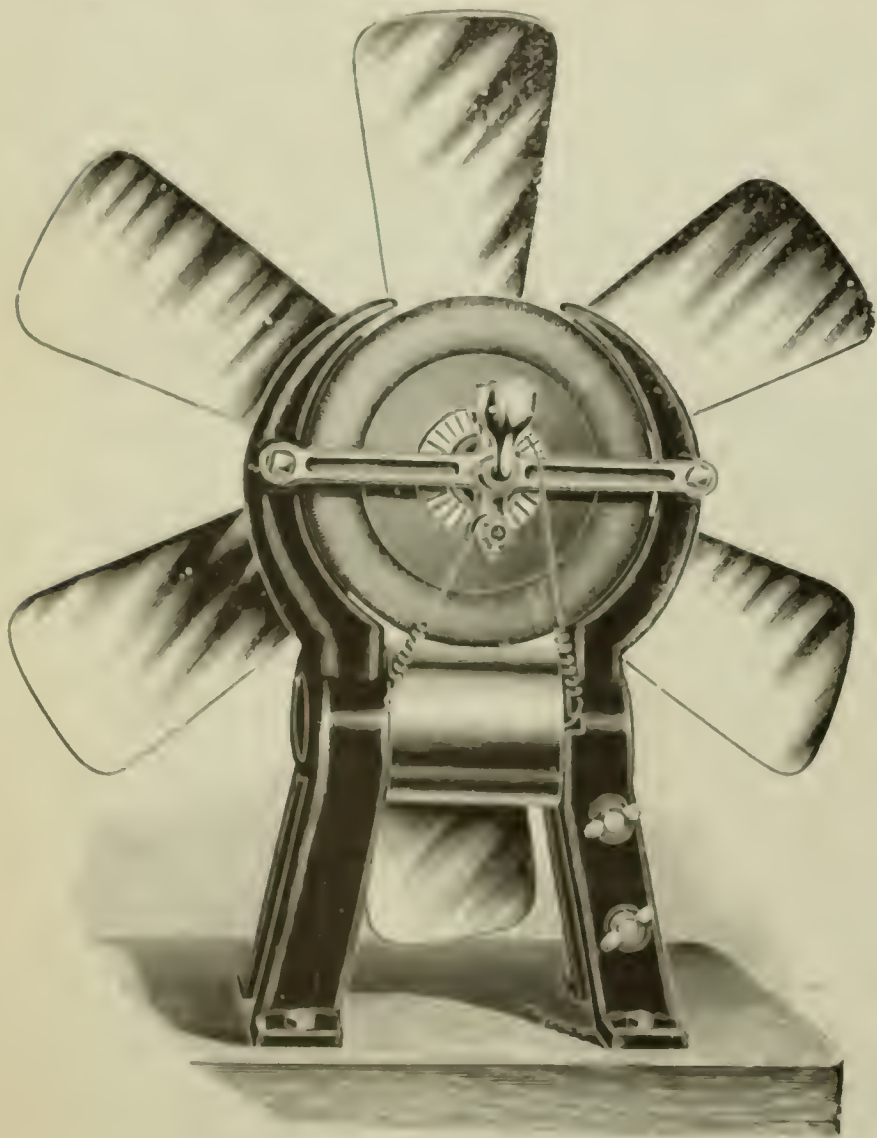
Metropolitan Fan Motors.

The fan motor shown herewith is manufactured by the New Haven Insulated Wire Company and presents a new feature in electric ventilating apparatus, inasmuch as it carries a 24-inch wheel. Run at quarter or half speed, the fan creates a very pleasant breeze, not so sharp as that created by a buzzer, but much more diffused, and makes no noise, taking a trifle over a half ampere on a 110-volt circuit.

At full speed the fan makes 720 revolutions per minute and takes about one and a half amperes, and exhausts about 7,500 cubic feet of air per minute, doing fully as much work with a less expenditure of power as any 24-inch exhaust wheel making the same number of revolutions driven by belt either from a line of shafting or direct from a motor.

The fan is of very strong construction, has tempered copper commutator, self-feeding carbon brushes and large oil cups; all running parts are protected so that they cannot be come clogged with dust or dirt; it requires the minimum amount of attention.

It is nicely finished in black japan and nickel, and is a

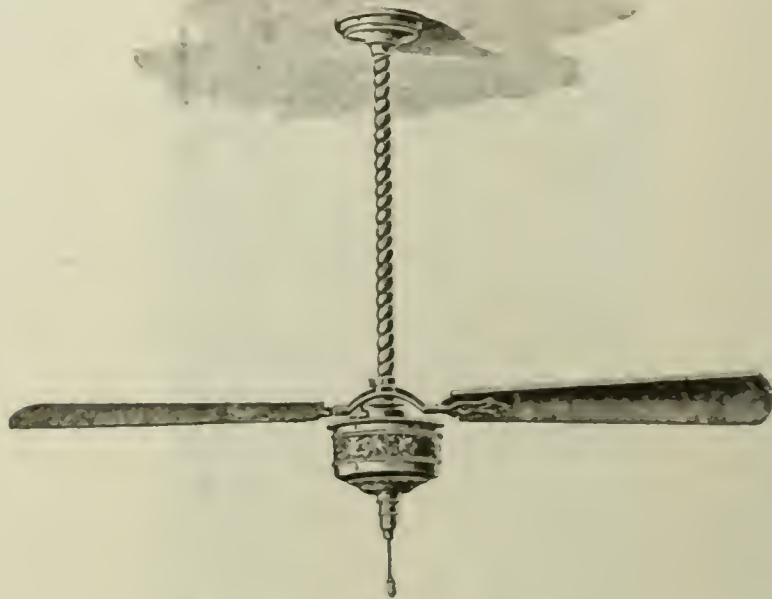


NEW FAN MOTOR.

very neat looking machine. A speed regulator is furnished with every fan, whereby four speeds may be obtained. They are ordinarily wound for 110 volts direct current, but are also made for 220 and 500 volt circuits and for arc light currents. Doubleday, Mitchell & Co., 136 Liberty street, are agents for New York City and vicinity.

Electric Ceiling Fan.

A new type of electric fan motor, now being placed on the market by the Interior Conduit and Insulation Company, 44 Broad street, New York, under the name of the "Lundell 1894 model," consists of a 4-pole field carrying a stationary vertical steel spindle attached firmly to an under spider. The armature is built up of the usual laminations of soft iron on a gray iron centre and all carried on a composition sleeve, which sleeve slips over the stationary spindle and rests upon a shoulder at the bottom. The armature



ELECTRIC CEILING FAN.

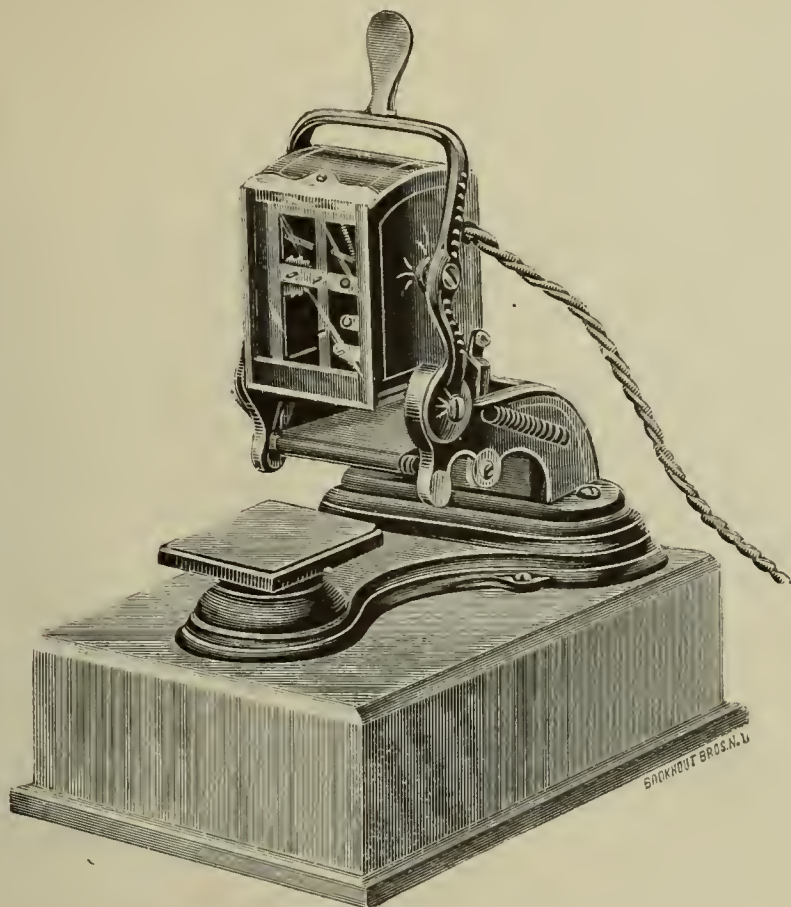
sleeve also carries the holder for the fan blades. The stationary spindle on which the armature sleeve revolves is channeled out for the free passage of oil to all wearing parts; and as a part of the bottom spider, a large oil cup or recess is formed which when properly filled with three tablespoonfuls of thin oil will insure perfect lubrication for several years. The oil is introduced to the motor at the upper end of the composition sleeve which carries the armature. A very simple device is employed for attaching the motor to the ceiling, consisting of a flexible insulated connection. Over the hanger pipe is placed an ornamental piece of brass rope tubing. Wires from the motor are furnished of sufficient length to pass up through the hanger pipe to the outlet at the top over the canopy. A single pull switch is attached to the bottom spider of the motor. As the illustration shows, the combination presents a very neat appearance.

Automatic Electrical Date and Time Stamp.

A date and time stamp has come to be accepted as a necessity in the conduct of a business involving a large correspondence, and where it is a matter of importance to have a record of the exact or approximate time when a certain matter received attention. As a rule, the stamps for these purposes heretofore put on the market have not been entirely satisfactory, and it was to obviate many or all of their defects that the Hoggson automatic electrical time and date stamp, which we illustrate, was devised, and now being placed on the market by the Automatic Electrical Specialty Company, 136 Liberty street, New York.

The mechanism of the stamp is contained in a case 2 by 3 by 3 inches in size, and prints the exact time, together with the day, month and year, changing every minute, requiring setting only once a month. The machine consists of a system of endless rubber printing bands, which are so arranged as to move automatically, bringing the proper characters into position to print the exact time and date. Rubber printing bands are not new, but in this instance a number of them are grouped upon one or more shafts, each turning independently of the other, so that the utmost exactness is

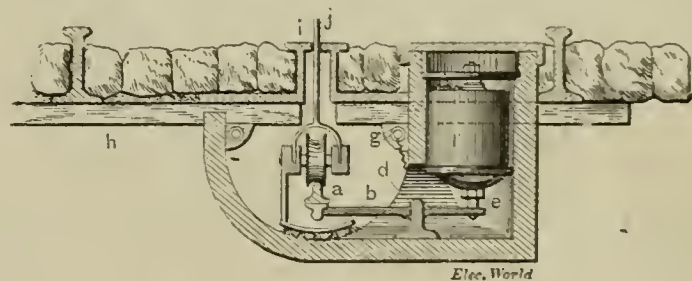
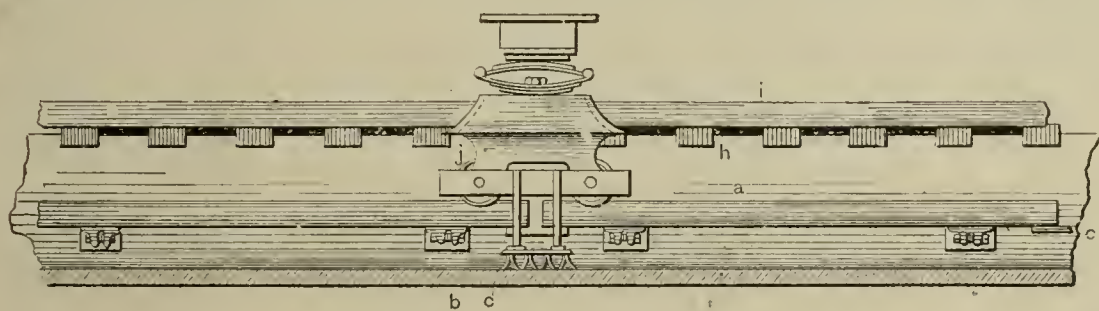
obtained in getting an impression. A set of these bands are grouped about in the case in such a manner that a small current, such as generated by a Lelanche cell, passes through an electromagnet in the case and actuates an armature, which, in turn, by means of a lever, moves the first or minute band.



AUTOMATIC DATE AND TIME STAMP.

one notch, which changes the minutes. At the end of the ninth minute the 10-minute band receives an impulse, which changes that band, and a similar movement at the end of 60 minutes changes the hours, and, at the proper time, the A. M., M., or P. M. bands are also changed. At midnight the day band is changed, and only once a month does the stamp need setting.

The stamp can be connected with any clock and any number of stamps can be connected with one clock, which serves admirably in factories or offices as a combined employees' time stamp, watchman's clock and general check system.



LONGITUDINAL AND VERTICAL SECTIONS OF STREET RAILWAY CONDUIT.

In railroad or telegraph systems all the stamps can be connected to one master clock, which will operate all at the same instant.

The stamps can also be so arranged as to print the time in connection with fire alarm, police and messenger registers. Any die up to 2 by 2 1-2 inches may be used in connection with the stamp and can be instantly removed if desired. As the entire impression is made from rubber the machine requires no pounding to operate. The ink is fed by an automatic device, which renews at every impression.

The Lawrence Conduit for Street Railways.

A new departure in conduits for electric railways has been brought out by the Lawrence Electric Company, of 13 Astor place, this city. Its operation is entirely mechanical, and for reliability, simplicity and low cost of construction it is claimed to be a strong competitor of the overhead trolley.

A road has been built in the yards of the Harlan & Hollingsworth company, at Wilmington, Del., in which the system has been put to the most severe tests since March 14, with most gratifying results. Nearly the whole track during the recent severe storm was flooded with salt water to a depth of three feet, the car having been left at the top of a slight grade, which saved the motors, as the water only reached to the lower edge of them. The electrician procured a boat and rowed out to the car and, getting aboard, turned the switch; the car answered nicely, and was run back and forth several times as far as the water would permit without immersing the motors, everything working perfectly.

The car is a T.-H. open summer car, weighing nine tons. It has been run on this track loaded at a speed of twelve miles per hour, the length of the track precluding any higher rate, but there is no reason why it will not be successful at any speed.

The conduit as now constructed consists of an inverted T-shaped girder rail, *a*, resting on two balanced arms, *b*; these rails are 32 feet long and joined together at their ends by means of pieces of vulcanized hard fibre boards, *c* screwed to the under side, making practically a continuous flexible rail, with an insulating air space between each section. The balanced arms, *b*, are fulcrumed on a spindle at *d* and are connected to a rod, *e*, that enters the box *f* through the flexible bottom. A branch of the feed wire *g* enters the top of the box and makes electrical contact with the rod when the latter is raised by the weight of the trolley at the other end of the arm *b*. The current then goes through *b*, and *a* to the trolley wheels. The collector *j* is a compound affair; that is, has two wheels, one placed about six inches forward of the other and electrically connected. This prevents any break in the circuit in going from one section to another and prevents arcing in the boxes.

The conduit proper is made of vitrified clay moulded in the form of an elliptic cylinder and cut lengthwise, forming two lengths from each casting. These are placed end to end. The ties *h* are laid directly on, and project over to form a support for the cover *i*, which consists of two iron pieces of L-shaped section, one on each side, with

a space between to allow the trolley to pass. Then the track is paved with stone and concrete. The trolley runs equally well backwards or forwards, and cannot possibly leave the girder rail; consequently there is no danger of losing the current at critical periods. In a double track the box is placed between the tracks, the one box acting for both tracks, but is so constructed as to make electrical connection to only one track, unless there is a car upon each track, when it makes electrical connection to both.

At the office of the company, at 13 Astor place, there is a small working model of the system. A track is arranged around the room, on which a small car runs, illustrating the system very clearly. An incandescent lamp held at any section, except the one that the car is on, shows no light, but lights up instantly as soon as placed at that section.

Messrs. Hicks Bros., of 59 Wall street, of which firm Mr. George E. Hicks is president, are the financial agents of the company.

Financial Intelligence.

The Electrical Stock Market.

New York, April 5, 1894.

GENERAL ELECTRIC.—The transactions in this chief electrical security have been of little consequence during the week, and the stock has dropped a fraction over a point. The depreciation is due primarily to the prevailing dullness in the exchange in all electrical and industrial stocks, and to the lack of any good news which would increase its position. For General Electric, of all the stocks, seem to need constant rumors of big contracts and great profits ahead to maintain its standing. As a result of no inside "boom" the heavy have had their own way with the stock, and succeeded in making the closing bid for the week at 38½. There is no definite information as yet whether the company will reduce its capital stock or not, but it is thought quite probable that it will do so. The officials of the company are still at work cutting down all superfluous expenses and attending zealously to the manufacturing interests, so that the stock may in time regain its former prestige.

WESTINGHOUSE ELECTRIC.—The good talk on this stock continues, and though trade is not large, there is unflagging confidence in the stock's future. The company's business for the past 12 months has been excellent, and it is thought if it continue at the same rate for a year, the company will be out of debt and in a position to again declare dividends. Current reports have it that at present the company owes less than \$1,000,000 and has over \$2,500,000 due to it. Every effort is being made by the management to put the company's affairs on a profitable basis. The annual report of the directors will be out about May 10, and the officials say it will show the company in a very favorable light.

THE AMERICAN BELL TELEPHONE COMPANY is now doing a remarkably big telephone business. The company's instrument output for the month ending April 20 makes the best showing in many months, and the number of new instruments is nearly five times as great as that of the previous month. The stock has advanced to 191 during the week, and with the prospect of good business ahead, quotations will probably appreciate considerably in the near future.

THE COMMERCIAL CABLE.—A majority of the stockholders have certified at Albany that of the \$10,000,000 authorized capital stock \$9,618,100 has been issued and paid in, in cash and property. The existing debts are declared not exceeding \$700,000, consisting of adventure bonds and sundry obligations, while the assets are certified to amount to \$12,000,000, including all of the machinery and real estate of the company. The stock does not vary much, and is now bid at 130.

WESTERN UNION TELEGRAPH stock is now receiving much adverse criticism, and is not making any advances either in quotations or in market standing. It is asserted by a number of financial journals that though Western Union was a leader in stock transactions during the early part of the winter, the stock is now rather inactive, and while most of the stocks have gone up in quotations, Western Union has depreciated. There has also been a report recently that the company had reduced wages, but this rumor lacks confirmation. It is said that owing to the long prevalent light business, the company is gradually reducing its force of operators, and is cutting all expenditures to the lowest figure.

New Incorporations.

THE TAYLOR-BELDING ELECTRIC COMPANY, Chicago, Ill., capital stock \$10,000, has been incorporated by C. H. Taylor and others.

THE INTERNATIONAL ELECTRICAL SUPPLY AND MANUFACTURING COMPANY, Detroit, Mich., has been incorporated. The capital stock is \$500,000.

THE SHELBYVILLE WATER AND ELECTRIC LIGHT COMPANY, Shelbyville, Ky., capital stock \$40,000, has been formed with Louis Channing as president.

THE UTAH-NEVADA COMPANY, Council Bluffs, Iowa, capital stock \$5,000, has been formed to contract for railway work, telephones and telegraph lines, etc.

THE ST. JOSEPH AND LAKE SHORE ELECTRIC RAILWAY COMPANY, St. Joseph, Mich., capital stock \$75,000, has been formed to construct an electric railway.

THE MARTINSVILLE ELECTRIC COMPANY, Martinsville, Ind., capital stock \$10,000 has been formed. J. K. Scott, J. R. Starkey and H. A. Smock are interested.

THE NATIONAL HEAT AND POWER CONSTRUCTION COMPANY, Philadelphia, Pa., has been incorporated by L. G. McColey and others. The capital stock is \$150,000.

THE ALLEGHENY AND BUTLER RAILWAY COMPANY, Pittsburgh, Pa., capital stock \$500,000, has been formed to construct and operate an electric railway. W. I. Mustin, C. K. Hill and F. Gwinner, Jr., are interested.

THE ETNA AND GLENSHAW STREET RAILWAY COMPANY, Pittsburgh, Pa., capital stock \$50,000, has been formed to

build and operate an electric railway. W. I. Mustin, C. K. Hill and F. Gwinner, Jr., are the organizers.

GREGORY REED COMPANY, Chicago, Ill., capital stock \$50,000, has been formed to promote, engineer and construct electric light plants, waterworks and other public works. J. H. Gregory, W. S. Reed and M. L. Coffeen are interested.

THE BAKER CITY ELECTRIC LIGHT COMPANY, Baker City, Ore., capital stock \$50,000, has been formed to construct and operate an electric light plant. J. A. West, C. W. Nibley, Jr., and C. W. Nibley, all of Baker City, are interested.

THE ECONOMIC GAS COMPANY, Buffalo, N. Y., maximum capital stock \$100,000, has been formed to generate, sell and distribute electricity and gas to be used for heat, light, power, etc. J. Busch, G. F. Laver and W. C. Busch are interested.

THE KNOXVILLE LIGHT, HEAT AND POWER COMPANY, Knoxville, Pa., capital stock \$2,000, has been incorporated to supply light heat and power by electricity. W. J. Hunter, Wm. Hunter and James F. Grimes, all of that town, are the organizers.

THE SAVOY MACHINE COMPANY, New York, capital stock \$2,500, has been formed to manufacture electrical and other machines. The promoters are J. Bradley, 5 Dey street; F. M. Archer, 5 Dey street, and W. M. Earl, 32 West 128th street, New York.

THE VICTOR LIGHT, WATER AND MOTOR COMPANY, Victor, Colo., capital stock \$100,000, has been incorporated to furnish electric light. J. E. Downey, J. R. Perry, J. Downey, J. B. Downey and C. M. Lawson, Pueblo, Colo., are those interested.

THE CHICAGO HEIGHTS WATER, LIGHT AND POWER COMPANY, Chicago, Ill., capital stock \$100,000, has been formed to construct electric, gas and water works, and fixtures for same. H. L. Wallace, H. Abbott and M. H. Kilgallen are interested.

THE ST. LOUIS ELECTRIC BRAKE COMPANY, East St. Louis, Ill., capital stock \$2,000,000, has been formed to acquire patent rights and to equip electric, steam and street railway cars. J. L. Black, Samuel Resh and W. V. Wolcott are the incorporators.

THE MILWAUKEE STEAM HEATING AND ELECTRIC CONSTRUCTION COMPANY, Milwaukee, Wis., capital stock \$25,000, has been formed to do electrical construction, also general steam and hot water heating. The promoters are H. Jane, G. Kuntz and G. Croke.

THE WORLD MANUFACTURING COMPANY, Columbus, Ohio, capital stock \$100,000, has been formed to make and deal in all kinds of electric motors, telephones, engines, boilers, machinery, etc. The organizers are W. P. Harrison, H. F. Gray, H. A. Williams, L. G. Addison and Lincoln Fritter.

THE SAN DIEGO, PACIFIC BEACH AND LA JOLLA RAILWAY COMPANY, San Diego, Cal., has been incorporated with a capital stock of \$25,000. Herbert Dabney is among those interested. It will build and operate a street railway from Pacific Beach to La Jolla Park, a distance of four miles.

THE BURTON ELECTRIC HEATING AND FORGING COMPANY, Berwick, Me., capital stock \$1,000,000, has been formed to manufacture and deal in all kinds of electrical machinery and apparatus. F. J. Hutchinson, Hyde Park; A. Wiswall, Woburn, and G. D. Burton, Boston, Mass., are the interested parties.

THE JOHNS MANUFACTURING COMPANY, First National Bank Building, Jersey City, N. J., capital stock \$100,000, has been formed to manufacture carbon for electrodes, glass cylinders, globes, shades, etc. The incorporators are G. H. Low, 660 East 23d street, Paterson, N. J.; W. N. Southworth, 160 West 129th street, and C. R. Harris, 250 West 36th street, New York.

THE ELECTRIC SMELTING AND ALUMINIUM COMPANY, Chicago, Ill., capital stock \$100,000, has been incorporated for the operation of the processes of electric smelting and electrolysis for the production of aluminium and other metals and alloys, the purchase and ownership of patents relating to such processes, and to manufacture and sell goods from such products. Alfred H. Cowles, Loren Prentiss and Chas. M. Vorse are the interested parties.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, New York, April 5, 1894.

MR. MORTIMER NORDEN, 136 Liberty street, New York, will shortly place upon the market a new electric fan motor.

MR. WM. H. MCKINLOCK, president of the Metropolitan Electric Company, Chicago, was in New York during the past week.

THE KNAPP ELECTRIC AND NOVELTY COMPANY, 34 Warren street, New York, is securing quite a run on its No. 15 fan motor outfit.

MR. FRANK A. MAGEE, travelling sales agent for The E. S. Greeley & Co., 5 and 7 Dey street, New York, was in town for a few days last week.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Brooklyn, N. Y., has placed an order with Wm. Todd & Co., of Youngstown, Ohio, for two 1,200-h. p. engines.

"MICANITE," manufactured by the Mica Insulator Company,

218 Water street, New York, continues to grow in favor as an insulating material not only in this country, but also abroad.

MR. J. E. HAM, general agent for Kerite, manufactured by W. R. Brixey, 203 Broadway, New York, reports having closed several large orders for this well known wire during the past week.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 32 Cortlandt street, New York, is pushing its works to their utmost capacity, filling orders for telephones. Its Mesco dry battery continues in public favor.

MR. J. C. MOULTON, formerly connected with the A, B, C Company, now represents Messrs. J. Jones & Son, 67 Cortlandt street, New York, manufacturing electricians and dealers in electrical supplies. Mr. Moulton's territory embraces New York City and vicinity.

THE KNAPP ELECTRIC AND NOVELTY COMPANY has removed its office and salesroom to 47 Warren street, where it is prepared to do a large business. The sales of this company for April were larger than last year.

MR. O. P. LOOMIS, of Bound Brook, N. J., referring to a note in a recent issue of The Electrical World, that an old subscriber had on exhibition a copy of the March 8, 1884, issue of this journal, writes to say that he has been a subscriber since May, 1883, and has in his possession each issue since Jan. 1, 1884.

MESSRS. J. JONES & SON, of which firm Mr. Ernest A. Lowe is manager, now occupy the entire first floor of 67 Cortlandt street, New York. Messrs. Jones & Son recently purchased from the receiver the stock of the A, B, C Company, which, together with their own, places them among the first of the large electrical supply houses.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., April 30, 1894.

THE STATE SENATE has passed to be engrossed a bill providing for the heating of street cars.

THE IONA MANUFACTURING COMPANY, of Boston, reports exceedingly good business for its electrical specialties. It is running full time and full force.

MR. H. C. HAWKS, of the Hawks Electric Company, of Boston, has been greatly bereaved recently through the death of his estimable wife, and regarding which we beg to assure him of our sincere sympathy and that of all of his many friends and acquaintances.

THE MATHER ELECTRIC COMPANY reports the sale of two 120-kw., 500-volt railway generators to the Fox Electric Railway Company, of Green Bay, Wis. This sale was made through Mr. J. Holt Gates, of 1140 Monadnock Building, Chicago, Ill., Western contractor for the Mather company.

IT IS REPORTED that the Schuyler Electric Company, of Middletown, Conn., will close its works May 1, awaiting the result of a reorganization. The company is said to be in good financial condition, and the plan is to reorganize it independently of the General Electric Company, with which it has so long been closely associated.

THE CITY OF LOWELL has been sued by the Municipal Signal Company for alleged infringement of patent, by using the Gamewell signal service. The city is protected by an agreement made with the Gamewell company. The recent decision in favor of the Municipal company as against the other company for infringement is the base of complaint.

G. M. ANGIER & CO., 116 Bedford street, Boston, have been appointed exclusive agents in New England for the Kester arc lamp, the Climax ironclad rheostats and stage dimmers and the Sechrist automatic switch, all of which are first-class electrical specialties in their particular lines, and for the introduction of which a more energetic or reliable firm could not have been found in New England.

THE BOSTON INCANDESCENT LAMP COMPANY, through an unfortunate error in this column last week, was reported as having been served with an injunction, as the result of the lamp suit argued on April 14. No opinion has yet been rendered, and the remarks from the bench, as reported in our editorial columns last week, are regarded as very favorable toward the contention of this company.

MR. FREDERICK W. GORE has invented a street railway system, which he calls the "tandem, compound, electric system." The locomotive and cars rest on flat platforms, which run close to the floor or pavement, and are carried on trucks which are below the surface. The slot in the floor or pavement is only three-quarters of an inch wide, and only light surface rails are required, as the weight is nearly all supported by the underground construction.

THE ELECTRICAL FORGING COMPANY, of Boston, has decided to locate its factory at Woburn, Mass., where it has purchased two acres of land directly adjacent to the Boston and Lowell tracks. Work upon the building will be commenced May 1, and the contract calls for its completion by June 1. The factory will be run by water power, and will possess all improved facilities. President G. D. Burton is to be congratulated upon the progress

he is making for his company, which, without the saying almost, is entirely due to his untiring energies. Mr. Burton has also been successful in organizing a company for the six New England states, to be known as the Burton Electric Heating and Forging Company, organized under the laws of Maine, and with a capital stock of \$1,000,000, of which he is president and F. J. Hutchinson, of Hyde Park, treasurer.

CAPT. WM. BROPHY, the well known electrical and insurance expert, is prominently mentioned in connection with the underground wire question in Boston, and should it finally become a law, it is reliably stated that he will undoubtedly receive the appointment of chief official. It is almost needless to say that his appointment would meet with universal favor among the electrical and insurance fraternities, and the public may rest assured that the duties of the position will be discharged upon honest business principles and that politics will cut no figure whatever. Captain Brophy is not seeking the position, but has been urged so strongly by his friends for permission to present his name, that he has finally yielded and given them permission to do so.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
936 Monadnock Building CHICAGO, April 23, 1894.

THE FIRM OF BOWDEN & SEARS, Cambridge City, Ind., has succeeded W. Q. Sayers in the electric lighting business.

GEORGE CUTTER reports large orders for his new swivel pole pulley, the improved form of this being evidently "just the thing."

THE WALLACE ELECTRIC COMPANY has moved to its new quarters, 307 Dearborn street. It reports a large and increasing business in the sale of the Wirt improved dynamo brush and the W. W. lightning arrester.

THE MOSHER ELECTRIC COMPANY takes pleasure in stating that recent sales of its new alternating lamp have been unusually heavy. Its other arc lamps are also meeting with favor wherever installed.

JAMES A. ROSE & CO., Title and Trust Building, Chicago, Ill., have purchased the entire stock of incandescent lamps of the Ansonia Electric Company, and are now offering them for sale. Most of them are 16 c. p. and of various makes, voltages and bases.

THE STANDARD ELECTRIC COMPANY is very much gratified at the reception which has been accorded its new alternating apparatus. Already it has sold several generators, and the number of inquiries indicate that its sale will be unusually large during the present season. The active appearance of its factory would also indicate a very large sale for its other types of apparatus.

THE CENTRAL ELECTRIC COMPANY.—President McKinlock is now comfortably settled in his handsome office on Adams street. The finishing touches are being put on to the store, which certainly presents a handsome appearance. Three floors are required to accommodate the stock of this company, covering in all about 37,000 square feet. Mr. McKinlock reports business as unusually good.

BARTHOLOMEW, STOW & CO., who have long been agents for the Nutting arc lamp, have now an arc lamp of their own, which possesses many features of value. Their old store at 57 Michigan avenue, having proved inadequate, they have arranged to move to new quarters at 19 North Clinton street, where they will have factory, storeroom and offices combined. This is another Western firm that reports business as unusually good.

THE ELECTRIC APPLIANCE COMPANY has been busy during the past few weeks taking possession of a largely increased floor space, and extending its facilities for receiving and shipping goods, particular attention being given to arrangements for the better handling of material in carload lots. These arrangements have been carried to a point where a carload of material can be received and put into stock or loaded for delivery within a very few hours, by means of special loading facilities, without in any way interfering with the receipt or delivery of regular orders.

News of the Week.

Telegraph and Telephone.

SUFFOLK, VA.—The Nansemond Telephone Company will purchase an equipment.

AUGUSTA, GA.—Daniel J. Murphy is in the market for telephone improvements.

SUFFOLK, VA.—L. P. Harper is interested in the organization of a telephone company.

CORDELE, GA.—Moore, Kirkland & Co., lumber dealers, are in the market for telephone equipment.

DELTA, PA.—Meetings of residents are being held in the matter of establishing a telephone system for Delta and vicinity.

CUMBERLAND, MD.—The Citizens' Telephone Company has been organized with L. D. Rohrer president. Capital stock is \$40,000.

ANN ARBOR, MICH.—The Michigan Automatic Electric Tele-

phone Company will establish a plant, to include Ann Arbor and Ypsilanti.

SONTAMAN, CAMBRIA COUNTY, PA.—The Pennsylvania Telephone Company has been organized. Dr. Geo. R. Glass is president, J. J. McDonnell is treasurer and F. H. Young is secretary and general manager.

CLARKSDALE, MISS.—Proposals are solicited for building a telephone line from Clarkdale to Filar's Point, 13 miles of double wire will be required, with 25 poles to the mile. Proposals will be received for all or parts of the work. T. G. Dabney is chief engineer.

NIAGARA FALLS, ONT.—James Bampfield and John J. Bampfield, of Niagara Falls, Ont., and J. C. Pflieger, of Buffalo, N. Y., have formed the Colonial Telegraph and Telephone Company, capital stock \$25,000, with headquarters at Niagara Falls, Ont.

LANCASTER, PA.—Owing to the fact that a local telephone company is being organized, the ordinance granting the use of the streets to the Pennsylvania Telephone Company has been tabled. Councilman Baumgardner is behind the Pennsylvania Telephone Company.

EAST AURORA, N. Y.—The Buffalo Valley Telephone Company has elected H. W. Richardson, of East Aurora, as president; N. J. D. Wooster, of Wales Center, as secretary, and Harry S. Gall, of Wales Center, as treasurer, and will at once begin work on its proposed telephone line to connect East Aurora with the villages between there and Java village.

Electric Light and Power.

VALPARAISO, IND., contemplates erecting an electric light plant.

WAPAKONETA, OHIO, is to put in a plant for electric lighting purposes.

PORTLAND, ME.—The Consolidated Electric Light Company is to increase its power plant.

CUBA, N. Y.—It is now almost certain that Cuba will put in a municipal electric lighting system.

HELENA, ARK.—The Helena Gas Company has received authority to erect an electric plant.

KERVANNA, IND., is to put in an electric light plant. Address the city clerk for particulars.

DELANO, MINN.—The town has voted to issue \$10,000 in bonds for waterworks and electric light plant.

CORDELE, GA.—C. G. Barfoot, of Albany, Ga., has purchased the Edison lighting plant and will operate it.

LANCASTER, KY.—The Lancaster Ice, Light and Water Company is to construct an electric light plant.

TRAPPE, MD.—The mayor will answer inquiries regarding the electric light plant to be established in Trappe.

KINGSTON, N. C.—The mayor would like circulars and particulars as to cost of establishing an electric light plant.

ALBION, NER., is considering the project of putting in an electric light plant. E. J. Mack, city clerk, may be addressed.

GREENVILLE, N. C.—An electric light plant is to be established. The mayor can be addressed for further particulars.

OSHKOSH, WIS.—The matter of awarding the contract for electric lighting of the city has been laid over for three weeks.

LONG PRAIRIE, MINN.—Pedersen & Luderad, of Etrick, Wis., will put in an electric light plant at Long Prairie, to cost \$10,000.

COLUMBIA, S. C.—An electric light plant will probably be erected by the city. Information may be obtained from the mayor.

GENESEEO, N. Y.—The Village Trustees have awarded the contract for electric lighting for the village to the Geneseo Gas Light Company.

LAWTON, MICH.—The contract for the building of the electric light plant has been let, and prices are wanted for apparatus and equipment.

WASHINGTON, PA.—The electric light company proposes to extend its lines to Homestown, where it will light the church and business houses.

MARBLEHEAD, MASS.—It has been decided at the town meeting to leave to the electric light committee the matter of site for the proposed new plant.

WINSTED, CONN.—Fire has destroyed the large incandescent machine at the electric light works at The Falls, 75 telephone instruments were burned.

STUYVESANT FALLS, N. Y.—Mr. Frisbee proposes to make many improvements at Island Park this summer, to include electric light for the grounds.

ROCHESTER, MINN.—The Council will call for bids for enlarging the new electric light plant, to enable the city to furnish light for commercial purposes.

ST. PAUL, MINN.—Sealed proposals will be received to May 1 for electric work on the new City and County Hospital. Thos. A. Prendergast is secretary.

LEADVILLE, COL.—As the result of a decision of Judge Dickson, the Citizens' Electric Light Company will go ahead with the work of constructing its lines.

TARPON SPRINGS, FLA.—A recent fire burned out a large part of the electric lighting plant of the Florida and West Coast Company, and the plant is shut down.

OSHKOSH, WIS.—The electric light committee reports that a plant capable of lighting the city should be established for \$50,000, and cost of maintaining same \$16,000.

TOPEKA, KAN.—An electrical building is to be annexed to the State University, and bids are desired. The Legislature has appropriated \$72,000 for the purpose.

KINGSTON, N. Y.—A representative of the Western Electric Company is in town to submit estimates to the Common Council for a municipal electric lighting plant.

HAMILTON, OHIO.—Frank B. Rae, electrical engineer, 27 Cleland Building, Detroit, Mich., is to prepare plans and specifications for waterworks and electric light plant.

BELLEVUE, KY.—The three electric light companies have consolidated. The new company will extend the lights on Fairfield avenue, and will soon make other extensions.

OSHKOSH, WIS.—Bids will be received to May 7 for lighting the city by electricity, as per specifications on file at the Board of Public Works, of which H. Stopper is chairman.

HACKETTSTOWN, N. J.—The lamp committee has been instructed to call for bids for lighting the streets of the city during the coming year with 85 or more electric lights.

PARIS, KY.—The Paris Electric Light Company is adding new machinery, including a 150-h. p. engine and boiler, a 50-light arc dynamo and a 2,700-light incandescent dynamo.

ELLSWORTH, ME.—The electric light company at Ellsworth asks for an increase for the coming year, or they will not run the plant. The town authorities are not likely to comply.

PHILADELPHIA, PA.—An electric light plant is wanted for the new morgue on Wood street, including a dynamo and gas engine. Chief Elshever, of the Bureau of City Property, may be addressed.

ENFIELD, CONN.—Henry C. Douglas, of Windsor Locks, has sold his property at Terry's Island to Hon. E. B. Bailey, of Windsor Locks. Mr. Bailey will give all details of the proposed dam and electric power plant.

MONTROSE, PA.—It is stated that the Consumers' Water Company will, in the near future, put in an electric light plant, and will purchase another boiler and engine for the pumping station.

JERSEY CITY, N. J.—The Hudson County Board of Freeholders has awarded the contract for the electric light plant at Snake Hill to the Complete Electric Construction Company at \$93,232.20.

FREEPORT, ILL.—The Freeport "Democrat" states that the electric light plant will be purchased by the new owners of the street railway company, and that the road will be operated by electricity in July.

NEW BEDFORD, MASS.—Alderman L. L. Ashley, chairman City Council committee on street lights, states, as the result of his investigations, that New Bedford can operate a plant at about two-thirds the cost of the present system.

ANN ARBOR, MICH.—The committee on building and grounds of the State University reports in favor of advertising for bids for the erection and equipment of a central heating and electric lighting plant for the buildings on the campus.

SOUTH BETHLEHEM, PA.—Sealed proposals will be received to May 7 for lighting the streets of the borough of South Bethlehem for a period of five years with electric arc lights of 2,000 c. p. Frank Gorman is chairman of the lamp committee.

SACRAMENTO, CAL.—The entire electric plant of the Capitol Gas Company, which holds contracts for lighting the city and running street cars, has been burned, and 24 dynamos were destroyed. The plant was one of the largest on the coast, and cost \$300,000.

WAUKEGAN, ILL., wants bids for street lighting, including 80 arc lamps of 2,000 c. p., burned on the Philadelphia moonlight schedule, to 12 o'clock, to 2 o'clock or all night, for terms of three or five years. Bids will be opened May 14. Henry Thacker is city clerk.

BELAIR, MD.—The Henry Rockford Manufacturing Company, of Belair, Md., proposes to run the machinery in its flouring mill by electricity instead of steam, and is negotiating with the town authorities in the matter of furnishing electric light for the town of Belair.

WASHINGTON, D. C.—A bill to incorporate the National Gas and Electric Light and Heat Company has been introduced in the House by Mr. Campbell. The incorporators are J. Wesley Boyce, John W. Childers, John F. Chamberlain, Davies Murdoch and Chas. C. Lancaster. The capital is \$2,000,000.

NEWBERRY, MICH.—Sealed proposals will be received to June 2 for the erection of a power house, electric light and pumping plant at the Upper Peninsular Asylum. Claude W. Chase is chairman of the building committee. Charlton & Gilbert, architects, Marquette, Mich., will give details.

COVINGTON, KY.—The consolidation of the Covington Electric Light Company, Citizens' Electric Light Company, of Dayton, and the Suburban Illuminating, Heating and Power Company, of Newport, has been consummated, and the name adopted is the Subur-

ban Electric Company. The capital is \$250,000, and J. E. Lowes, of Dayton, Ohio, is the president.

The Electric Railway.

DEERING, ME.—The Portland Electric Street Railway Company is to build a new power house.

WINDSOR, CONN.—Selectman J. E. Higinbotham states that the proposed electric road is now a certainty.

CORTLAND, N. Y.—Final action on the franchise for the electric street railway has been postponed to May 1.

YORK, PA.—The York Street Railway Company is asking for bids for the extension of its lines, the work to begin immediately.

ST. JAMES, MINN.—The village will vote April 30 in the matter of issuing bonds for waterworks and electric lights.

BRADFORD, PA.—The ordinance to grant a franchise to the Bradford and Kendall Railway has been laid on the table.

RICHMOND, VA.—The Virginia Electric and Railway Company has petitioned the City Council for permission to construct a viaduct.

MEMPHIS, TENN.—The Citizens' Railway has consolidated the East End dummy line with its lines, and has it now electrically equipped.

FREDERICK, MD.—A company has been organized to build the Frederick and Middletown electric road. D. E. Kefauver is secretary.

WASHINGTON, D. C.—The Metropolitan Street Railroad Company wants, and has not yet contracted for, an underground electrical equipment.

HIGHLAND, N. Y.—Superintendent W. Price informs the "Republic" that the New Paltz and Highland Electric Railway will surely be built this summer.

MIDDLETOWN, CONN.—The Common Council has decided to grant the petition of the Middletown Horse Railroad Company to equip the road with electricity.

CALAIS, ME.—The electric railway company will start the building of a road from St. Stephens, N. B., to Calais. Amos S. Gerald, Waterville, Me., is the manager.

POTTSVILLE, PA.—The Schuylkill Electric Railway Company proposes to issue \$55,000 in bonds for improvements during the coming summer, to include motors, cars and new rails.

VERMILLION, OHIO.—An electric railway will be built from Wellington, Ohio, via Oberlin to Vermillion, and is estimated to cost \$200,000. The distance is 24½ miles. Dr. R. F. Quigley can be addressed.

NORWALK, CONN.—Officers of the Norwalk Tramway Company have voted that new stock be issued to the amount of \$60,000 to meet the expenses of the Roton Point extension. The company expects to have the road completed about May 30.

AMSTERDAM, N. Y.—President Clement, of the Amsterdam Electric Railway, is conferring with Hon. David A. Wells, of Johnstown, and Lawrence Caten, of Gloversville, regarding the proposed electric road from Amsterdam to Gloversville.

NIAGARA FALLS, N. Y.—E. B. Osler, of Toronto, Ont., and William Hendrie, of Hamilton, Ont., president and vice president of the Niagara Falls and Park Railway, are in Niagara Falls, Ont., looking over the ground for proposed extension to Chippewa.

LYONS, N. Y.—A special to the Buffalo "News" states that Lyons is to have an electric railroad. The power house will be located in the northern part of the village. Orlando F. Thomas, president of the Manhattan Silver Plating Company, is the prime mover in the enterprise.

EAST WEYMOUTH, MASS.—Thirteen thousand dollars of the \$20,000 required for the proposed electric connection of East Weymouth with Quincy and Boston has been subscribed, and President John R. Graham, of the Quincy and Boston Railway, states that the road will surely be built.

WASHINGTON, D. C.—The petition of the National Rapid Transit Company for a franchise for an elevated electric road from Washington to New York, as promoted by Mr. Hemphill, ex-Chairman of the District of Columbia Committee of the House of Representatives, has been referred to a sub-committee.

CHICOPEE, MASS.—An electric railway company, with \$100,000 capital, has been formed to build a line from Holyoke through Willimansett to Chicopee, thence to terminate at Springfield. It will be called the Chicopee Street Railway Company, and will be about 10 miles long. The directors are Charles C. Abbey, ex-Senator Gibson and James H. Loomis, of Chicopee; William Kichham, of Worcester; J. E. Delaney, of Holyoke, and Selig Manilla, of Springfield.

Miscellaneous Notes.

THE MAGNETIC CLUB DINNER at Jaeger's, corner 59th street and Madison avenue, New York, on Tuesday evening, April 24 was one of the most largely attended meetings ever held by the club. The special guest of the evening was Mr. Charles Selden, of Baltimore, president of the Old Time Telegraphers' Association.

The Postal Telegraph Company was represented at the dinner by more than a dozen of its officers and principal employes, who occupied a table by themselves. President Cockey, of the Magnetic Club, good naturedly suggested that this was the way the company chose to announce to the members that its new building was completed, just as young ladies have been known to attend church apparently to show off new dresses. The Magnetic Club is in a prosperous condition, and every one present at the dinner evidently enjoyed the occasion and the hearty and spontaneous sociability.

Personal Notes.

MR. BIRDSALL HOLLY died at his home, at Lockport, N. Y., on Thursday, April 27. Mr. Holly was an engineer by profession. He devised a new waterworks system, and was the inventor of the well known Holly system of district steam heating.

A CORRECTION.—By one of those unfortunate mistakes, which occur in every well regulated printing office, in the biographical sketches of the officers of the Pettingell-Andrews Company, it was stated that Mr. Frank X. Cicott occupied the position of secretary and general manager of the company. It was intended that this clause should be inserted in the sketch of Mr. C. B. Price, the actual occupant of that position, but unfortunately an error was made. Mr. Cicott, as is well known, is manager of the railway department.

MR. G. H. BUCKMINSTER, purchasing agent for the Pettingell-Andrews Company, of Boston, was born in Nashua, N. H., but his boyhood days were mostly spent in East Boston, where he was given an excellent grammar school education. His entire business life has been confined to the electrical supply business, in which he has had an experience of over eight years, and with which he is thoroughly familiar. At the age of 16 he entered the employ of the Electric Gas Lighting Company, of Boston, remaining with it for four years, and becoming, through ability and faithfulness, one of its principal salesmen. Leaving this company, he identified himself with the Eastern Electric Supply Company, of Boston, as purchasing agent and chief salesman, which position he



held until the company went out of business, in August, 1892. He then connected himself immediately with the Pettingell-Andrews Company, and with the reorganization of the company, in 1893, was made its purchasing agent, which position he fills with profit to the company and credit to himself. Mr. Buckminster is a worthy representative of the younger element so conspicuously identified with the electrical business generally.

Trade and Industrial Notes

THE STANDARD PAINT COMPANY, 2 Liberty street, New York, reports increased demand for its P. & B. insulating compound.

THE HARRISON INTERNATIONAL TELEPHONE CONSTRUCTION COMPANY, 44-46 Wall street, New York, has recently decided to sell, as well as lease, its telephones.

THE NEW YORK STATE ELECTRICAL COMPANY, of Canisteo, N. Y., has purchased the plant of the Malleable Iron Company at Youngstown, Ohio, and will manufacture electrical supplies.

HARRY S. SMITH & CO., 607 Chestnut street, Philadelphia, have issued a handsome catalogue, describing the different forms of fans and fan motors sold by them, which are illustrated in great variety. The motors are for direct and alternating circuits, and furnished as required for the different voltages in use.

W. R. FLEMING & CO., 203 Broadway, New York, and 620 Atlantic avenue, Boston, the New York and New England representatives of the Harrisburg Foundry and Machine Works, have sold between 30 and 40 of the Harrisburg Ideal direct connected engines and dynamos in their territory.

THE PECKHAM MOTOR TRUCK AND WHEEL COMPANY, Havemeyer Building, New York City, has in use over 1,500 trucks in New York, Brooklyn and Jersey City. Orders are constantly being received from all parts of the country, which necessitates the operation of the works at Kingston, N. Y., both day and night.

THE AMERICAN DISTRICT STEAM COMPANY, Lockport, N. Y., has contracted with the Economy Heat, Light and Power Company, of Scranton, Pa., for the construction of a steam heating and power plant, with underground mains (Holly system), to cost \$150,000. The officers of that company are Wm. Connell, president; Lemuel Amerman, vice president; Lieut.-Gov. Watres, treasurer, and I. H. Burns, secretary.

THE CENTRAL ELECTRIC HEATING COMPANY, 26-28 Cortlandt street, New York, is busily engaged equipping cars through-

out the country with its electric heater, which is fast superseding the old and inconvenient way of heating cars by stoves. Street railway companies generally are taking time by the forelock and are having their new cars wired, during construction, preparatory to placing electric heaters in them.

MR. C. J. MILLER, well known in electrical circles in Philadelphia as the former superintendent of the Novelty Electric Works, the inventor of the Novelty wire gauge and other electrical specialties, which take so well among wire men, has opened an office store and works of his own at No. 42 North Fifth street. Mr. Miller expects to handle a full line of standard electric materials, and do electrical engineering and special experimental and model work.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., has designed and built the roofs for the new electric light and power station for the Brush Electric Light Company, at Baltimore, Md., which will be one of the finest in the Southern States. The boiler room is 83 feet wide by 129 feet long. The dynamo room is 120 feet square, the floor space being entirely free from posts. The roofs are made entirely of iron, covered with anti-condensation corrugated iron roof covering.

THE CLARK ELECTRIC COMPANY, 192 Broadway, New York, has recently brought out an arc lamp, which, it is said, runs very successfully upon the Helser system. It has been supposed that this was one of the most difficult things to accomplish, for the reason that the Helser is a series incandescent system, the current being only five amperes. The Clark company claims that it is the only concern that makes arc lamps which can be used upon any and every known system, and asserts that it has never put out an apparatus which has not given entire satisfaction to the purchaser.

KENNEDY AND DU PEROW is the firm name of an electrical supply house recently established at No. 1421 F street, N. W., Washington, D. C., and is the only purely electrical supply house in that city, all other electrical firms combining construction with supply business. Mr. Kennedy was formerly with the Royce & Marsen Electrical Company for many years, filling the position of buyer, and Mr. Du Perow was connected with the Postal Telegraph Company, occupying the position of electrician for many years, and has also been manager of the District Telegraph Company, of Washington.

THE HARRISON SAFETY BOILER WORKS, Germantown Junction, Philadelphia, also manufactures the Cochrane feed-water heaters, and have issued a 40-page catalogue, illustrating and describing the various forms of these apparatus. Besides the usual form of feed-water heaters, there are manufactured combined feed water heaters and purifiers, and special feed water heaters and receivers, the latter for use where the exhaust is employed for heating purposes. Much information of general technical value will be found in the pamphlet, while the sectional views of apparatus show very clearly their construction and operation.

THE INSTITUTE FOR HOME STUDY OF ELECTRICITY, of Cleveland, Ohio, of which the Scientific Machinist Company is the proprietor, and Messrs. N. S. Amstutz and John C. Lincoln are the directors, has recently enrolled several students from foreign countries, and is sending its catalogue to almost every civilized land. Since its inception, in 1893, a large amount of money has been spent in preparing and improving its facilities for making its instruction thorough and effective. The proprietors will soon make an announcement that will be of interest to every one engaged in electrical or mechanical work, or who is contemplating taking up the study of electricity.

THE VULCANIZED FIBRE COMPANY, of Wilmington, Del., has issued a 40-page catalogue, giving information relating to vulcanized fibre and the great variety of uses to which it is applied. We learn that this material, which now has been on the market for over 20 years, is made by treating specially prepared vegetable fibre with powerful chemical agents, whereby the exterior portion of each separate fibre becomes glutinous, and while in this condition the whole mass is consolidated under very heavy pressure and becomes practically homogeneous, after which the chemicals are extracted. Two varieties are manufactured—hard fibre, which closely resembles horn, and flexible fibre, which has the appearance of closely grained sole leather. For electrical insulation the hard fibre is used and applied to almost every conceivable purpose where good insulation is a necessity.

HUGO REISINGER, 28 Beaver street, New York, importer of the celebrated "Electra" high grade Nuernberg carbons, which received a premium at the Chicago World's Fair, calls attention to the following paragraph in an article by Prof. H. S. Carhart that appeared in *The Electrical World*: "The days of cheap and inefficient carbons should soon be passed, for wherever a highly efficient service is desired, instead of merely a cheap one, it is of the utmost importance to use the best carbons obtainable." The tendency of the trade seems to be for the more general adoption of low tension direct and alternating current arc lamps, for which a high grade carbon is required in order to obtain highly efficient service, and leading electric lighting stations of this country, who have adopted the "Electra" carbons exclusively for their arc lighting, speak in the highest terms of their superior quality and efficiency.

THE E. S. GREELEY & CO., 5 and 7 Dey street, New York, have found it necessary to acquire more space to better facilitate the handling of their enormous business. The Postal Telegraph Company, which is now installed in its new building, Broad-

way and Murray street, formerly occupied the floors immediately over the warehouses of the E. S. Greeley & Co. Since the leaving of the Postal company, the Greeley corporation have leased the entire buildings known as 5 and 7 Dey street, consisting of five floors and basement, 55 by 90 feet. An electric elevator of their own manufacture has been installed, the better to handle heavy and cumbersome articles. The basement, as heretofore, will be used chiefly for storage purposes, the ground or street floor as warehouses, while the four remaining floors will be devoted to the manufacture of light electrical apparatus; and here also will be carried on the experimental work for which this house is justly celebrated.

MR. C. M. GIDDINGS, who has been for the past six years in charge of the Sioux City Engine Works, has recently connected himself with The Brownell & Co., of Dayton, Ohio, the well known manufacturers of boilers and engines, who have bought the exclusive right to manufacture under his patents, and have established a department of engineering, with Mr. Giddings as superintendent. The Brownell & Co. will make a specialty of high grade automatic engines, both simple and compound, and have purchased the entire stock of drawings, patterns, finished and unfinished automatic engines of the Sioux City Engine Works. These engines are well known in the trade as the Russell single valve automatic. Mr. Giddings was in charge of the engineering department of the Sioux City Engine Works for four of the seven years he was with them, and while there designed and patented his well known governor and valve. The Brownell & Co. have recently added to their boiler shop equipment a set of 20-foot rolls 18 inches in diameter, capable of rolling the heaviest plate, and making 20-foot boilers in two sheets. This, with the special machinery of their own design and make, puts them at the head of well equipped boiler manufacturers.

THE DEWEY ELECTRIC SIGNAL COMPANY was last week incorporated under the laws of the State of New Jersey, the following named gentlemen being the incorporators: Messrs. Arthur M. Dodge, J. F. Tams, F. G. Ingersoll, Edw. B. Wyman and Geo. B. Hollister. As the name implies, the object of the company is to introduce an electrical system of signal bells and alarm gongs for use on cars propelled by electricity. The system consists of a signal bell at each end of the car, under the hood, and an alarm gong on the roof of the car, both of which are operated by current taken from the main line or trolley. The signal bells, used by the conductor for signaling the motorman to start or stop the car, are operated by simple push buttons, conveniently located at different intervals throughout the inside of the car, and under the hood at each end. This system avoids the unsightly strap or cord, which is usually employed to operate the signals, and enables the conductor to communicate easily and instantly with the motorman. In the alarm gongs a great many advantages exist over the present method. One gong only is necessary, one or more may be used, if desired, and is operated by the motorman by the simple pressure of his foot on a push button, and the gong will continue ringing loudly until the foot is removed, thus doing away with the continual movement of the foot up and down, and enabling him to devote his entire attention to the controller and brake. At critical times, when quick action is necessary on the part of the motorman, he has only two things to think of, where this system is employed—that of using one hand to operate the controller and the other to operate the brake. The importance to railway companies and the public of this feature of the system cannot be overestimated, and it enables inexperienced men to become competent motormen in half the time usually required. The amount of current necessary to operate the signals and gong is scarcely noticeable, and they are entirely independent of the conditions of the motor circuit. The headquarters of the Dewey Electric Signal Company are in the Havemeyer Building, Cortlandt, corner of Church streets, New York.

Business Notices.

FOR ADVERTISEMENT of the celebrated Law Battery Company, of 85 John street, New York, see page xi.

BATTERY CUT-OUT CHEAP—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

MR. C. J. MILLER, a reputable electrical man of Philadelphia, has opened an office and store at No. 42 North Fifth street, where he will be pleased to represent parties with any reliable electrical materials.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell, the Hayden carbon porous cup No. 2 cell, a Leclanche clay porous cup cell, a standard Fuller cell, a No. 2 Fuller cell, a single cylinder carbon cell, a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOUCKER MFG. CO., 2140 DeKalb St., St. Louis, Mo.

THE ALLGEMEINE ELEKTRICITAETS-GESELLSCHAFT, Berlin, Germany, announce herewith that, owing to the general appreciation which their exhibition has met at the World's Fair, it is their intention to appoint selling agents in New York, Chicago, Cincinnati, Atlanta, San Francisco, Boston, Philadelphia, St. Paul, Washington, Denver, etc., for the sale of their manufacture. Trustworthy electrical firms inclined to handle their goods are requested to forward offers to the head offices, 22 Schifffbauerdamm, N. W., Berlin.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED APRIL 17, 1894.

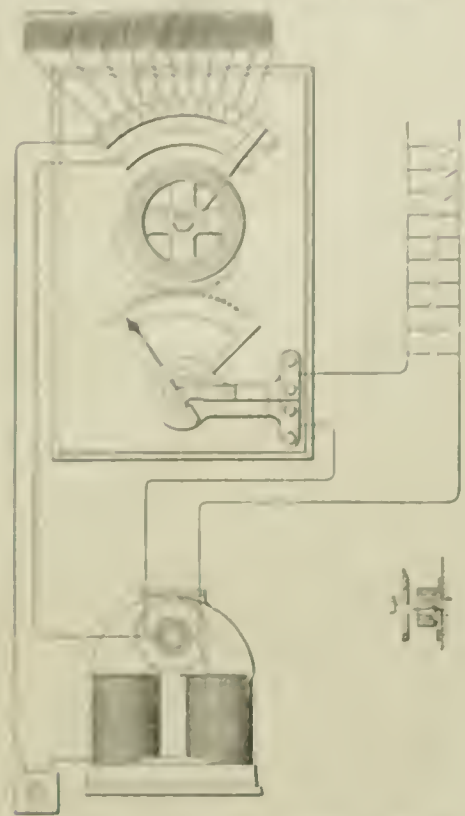
(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

- 518,213. INSULATING TURNBUCKLE; H. P. Ball, Schenectady, N. Y. Application filed Dec. 22, 1893. This comprises a central shank, a cup adapted to rotate about such shank, insulating material interposed between the two, an eye bolt threaded into the shank and an eye plate secured to the cup.
- 518,214. CEILING CLEAT; H. P. Ball, Bridgeport, Conn. Application filed Jan. 12, 1894. This comprises a body portion and lugs forming diagonal channels upon the end of the cleat, adapted to hold a wire in place.
- 518,217. MEANS FOR EXCITING FIELD MAGNETS OF ALTERNATING CURRENT DYNAMOS; L. Bell, Boston, Mass. Application filed Nov. 17, 1893. The combination of dynamos having their field magnet coils connected in a common circuit and motor generators actuated by alternating current and delivering continuous current to the circuit.
- 518,218. REGULATOR FOR DYNAMO ELECTRIC MACHINES; L. Bell, Boston, Mass. Application filed Nov. 28, 1893. This comprises an ampere meter having a movable scale, a rheostat and means whereby the movement of the rheostat arm actuates the scale of the ampere meter. (See illustration.)
- 518,221. ELECTRIC MOTOR CAR; H. P. Brown, New York, N. Y. Application filed Dec. 21, 1891. This comprises a reducing gear with pinions and sleeve pinions, in combination with an internal gear, and a spider made in a separate piece from the internal gear.
- 518,231. ELECTRIC SWITCH; A. Ekstrom, Lynn, Mass. Application filed Dec. 24, 1890. This comprises a closed box, two sets of terminals therein, a cam within the box, and a supplementary spring.
- 518,232. REGULATOR FOR DYNAMO ELECTRIC MACHINES; W. H. Elkins, Cambridge, Mass. Application filed Jan. 3, 1893. This comprises shifting commutator brushes, a motor magnet, with a controlling magnet and two or more sets of contacts controlled by the controlling magnet.
- 518,236. RHEOSTAT; J. P. B. Fiske, Lynn, Mass. Application filed Feb. 25, 1893. This comprises a frame and a tier of removable trays supported therein, each tray containing a resistance coil.
- 518,244. CUT-OUT METER; C. D. Hopkins, Lynn, Mass. Application filed Sept. 19, 1892. This comprises a meter and a switch held closed by a detent, but adapted to be released by the closing of an electric circuit by the meter.
- 518,245. DAMPING DEVICE FOR ELECTRICAL MEASURING INSTRUMENTS; F. Holden, Lynn, Mass. Application filed March 3, 1893. This consists of a hermetically sealed chamber, having a plain inner surface and inclosing a viscous liquid.
- 518,254. CONTROLLER FOR ELECTRIC RAILWAY CARS; W. H. Knight, Lynn, Mass. Application filed Dec. 21, 1893. A controller actuated from a source of fluid pressure carried on the car, and an indicator adapted to show the position of the controller.
- 518,263. TELEPHONIC APPARATUS; C. Milde, Paris, France. Application filed Oct. 31, 1893. This consists of a corrugated box partly filled with granulated coke, the box having a carbon stud extending through it at each side and carrying a weight, one of the studs being connected to the vibrating transmission plate.
- 518,265. ELECTRIC MEASURING INSTRUMENT FOR MULTIPHASE SYSTEMS; E. W. Mix, Lynn, Mass. Application filed March 21, 1892. An instrument having relatively movable field and armature sets of coils connected in circuit with an in-shunt across the several lines, and arranged to produce two non-coincident polarities revolving in the same direction.
- 518,290. ARMATURE FOR DYNAMO ELECTRIC MACHINES; E. Thomson, Swampscott, Mass. Application filed Jan. 19, 1892. An armature shaft having a hub secured thereto with flat faces tapering in a direction parallel to the shaft, in combination with a two part spider shaped to fit the hub, and thereby attached to the shaft.
- 518,291. MODE OF COOLING ELECTRIC MOTORS; E. Thomson, Swampscott, Mass. Application filed Nov. 30, 1892. The combination of an electric motor, a closed casing therefor, provided with projecting studs or lugs adapted to increase its radiating surface, a pipe communicating with such casing, and a water jacket surrounding a portion of the pipe, all arranged to provide a waterproof inclosing casing adapted to dissipate the heat generated therein.
- 518,293. ELECTRIC RAILWAY SYSTEM; C. D. Tisdale, Boston, Mass. Application filed April 26, 1893. This consists of a car truck having insulated wheels, furnished with auxiliary wheels for taking the current from one conductor and returning it to the other conductor.
- 518,301. CEILING CLEAT; H. C. Wirt, Boston, Mass. Application filed Oct. 27, 1893. This consists of a block having at one end a wedge-shaped convex bearing, and at the other end a similar concave bearing.
- 518,310. UNIVERSAL PHASE ALTERNATE CURRENT MOTOR; T. Duncan, Fort Wayne, Ind. Application filed May 22, 1893. The combination of field magnet, armature, bearing

heads, diverter, lever, worm gear, adjusting shaft and a plug or switchboard. (See illustration.)

- 518,311. ELECTRIC METER; T. Duncan, Fort Wayne, Ind. Application filed Aug. 2, 1893. The combination of a motor driven by the energy to be measured, and a compound drag or brake armature revoluble with the motor spindle and within a constant field of force established by theoretically adjustable magnets.
- 518,312. ARMATURE; E. Egger and F. A. Wessel, New York, N. Y. Application filed May 17, 1893. The combination of a core having grooves, insulated iron plates fitting in the grooves, and conductors wound between the plates and on the core.
- 518,331. TELEPHONE EXCHANGE SYSTEM; J. I. Sabin and W. Hampton, San Francisco, Cal. Application filed Jan. 19, 1894. This comprises an individual annunciator and battery at central station in a bridge of a metallic circuit, a normally open telephone circuit at the subscriber's station, means for closing the telephone circuit, and means for cutting out the annunciator and battery.
- 518,332. TELEPHONE SYSTEM; J. I. Sabin and W. Hampton, San Francisco, Cal. Application filed Nov. 14, 1893. In a trunk line, the combination with a condenser in one limb thereof, of a battery and an indicator in a bridge between the two limbs of the trunk line, and means for connecting the bridge upon either side of the condenser.
- 518,333. TELEPHONE EXCHANGE SYSTEM; J. I. Sabin and W. Hampton, San Francisco, Cal. Application filed March 3, 1893. This consists of a subscriber's metallic circuit normally open at the subscriber's station, a normal connection to ground one limb of the circuit at the central station, containing a calling device, and means whereby the subscriber may close the circuit to include himself directly in circuit with the operator.
- 518,334. TELEPHONE EXCHANGE SYSTEM; J. I. Sabin and W. Hampton, San Francisco, Cal. Application filed April 13, 1893. This comprises a metallic circuit, a pair of contact anvils, and a switch at the subscriber's station.
- 518,337. ELECTRIC TOWER CLOCK; C. D. Warner, Ansonia, Conn. Application filed April 6, 1893. This comprises a motor and a circuit therefor, and mechanism for opening the circuit and permitting the motor to run by acquired momentum.
- 518,345. CONTROLLER FOR ELECTRIC MOTORS; W. Cooper, Minneapolis, Minn. Application filed Aug. 28, 1893. This comprises resistance sections arranged in two groups with a gap between the same, a contact brush to sweep over the sections, a four point switch, and means in connection with the arm for operating the switch as the brush passes over the gap.
- 518,349. REGULATOR FOR DYNAMO ELECTRIC MACHINES; C. L. F. Muller, Milwaukee, Wis. Application filed May 13, 1889. This consists in dividing the several armature coils into sections and of providing a device whereby the sections of each coil or each pair of coils may be combined in series, multiple arc or groups for producing currents of different degrees of quantity or intensity.
- 518,357. AUTOMATIC TROLLEY WIRE FINDER; T. Straus, Baltimore, Md. Application filed Jan. 26, 1894. A trolley arm bent upwardly near its outer end, of a spring projected sliding extension, a trolley wheel and inclined guides pivotally mounted in the extension, the guides being automatically operated by the pressure of the trolley upon the wire.
- 518,359. ELECTRIC CURRENT REGULATOR; A. G. Waterhouse, Hartford, Conn. Application filed Nov. 26, 1892. The combination with a branched electric circuit, of an electrolytic cell or cells having non-attackable electrodes in a branch, and a current generator, this current generator and the electrolytic cell being in series with one another on the local circuit formed by the branches.
- 518,360. METHOD OF REGULATING ELECTRIC CURRENTS; A. G. Waterhouse, Hartford, Conn. Application filed April 13, 1894. The combination with a main circuit, the current in which is to be maintained below a fixed limit, of a regulating shunt circuit, including an electrolytic pile having non-attackable electrodes, and a resistance.
- 518,362. TROLLEY WHEEL; J. D. Ansley, Cambridge, Mass. Application filed July 27, 1893. This consists of a bushing of pure copper for trolley wheels and loose pulleys.
- 518,365. RHEOSTAT; A. C. Dinkey, Allegheny County, Pa. Application filed Dec. 1, 1893. A rheostat having a cylinder provided with a projecting piston rod, and a pipe leading from the cylinder.
- 518,367. MULTIPLEX TELEPHONY; W. W. Jacques, Newton, Mass. Application filed Nov. 22, 1893. A telephone circuit, grounded or metallic, and two telephones or telephone sets at each end of the telephone circuit, two vibrating switches, one also at each end of the circuit adapted to connect and disconnect therewith each of the telephones or telephone sets at the same end at every vibration, and mechanism for vibrating the switches synchronously and with rapidity.
- 518,392. TELEPHONE TRANSMITTER FROM SECONDARY BATTERIES; J. J. Carty, New York, N. Y. Application filed April 14, 1891. The combination with a storage battery or secondary battery of low internal resistance, of telephone transmitters connected in parallel between its poles, and deriving current therefrom.

518,494. ELECTRIC STARTING SWITCH, F. V. Henshaw, Brooklyn, N. Y. Application filed June 2, 1892. The combination with an electric motor and with main line conductors, of circuit closers closed between both conductors, and the motor, and variable resistance between one conductor and the motor, and



NO. 518,418.—REGULATOR FOR DYNAMO ELECTRIC MACHINES.

in series with the field magnet, and having terminals in the path of the last named circuit closer, and means for short-circuiting the resistance with respect to the field magnet.

518,414. BOND FOR ELECTRIC RAILWAYS; J. Meyer, New York, N. Y. Application filed Jan. 18, 1891. In electric railways, the combination, with conductors, of a bond or bonds connecting same, a container, means for attaching the container to the conductors, the container being provided with outwardly bulging side portions, and insulating material in the container.

518,411. DYNAMO ELECTRIC MACHINE; H. E. Dikeman, Berkeley, Cal. Application filed Feb. 13, 1891. In a dynamo electric machine the combination of a base, sliding standards thereon, means for adjusting the standards to and from each other, a shaft journaled in the standards and carrying an armature, and the separate field magnets also journaled upon the standards in independent bearings.

518,471. ELECTRIC SWITCH, J. R. Smith, Manchester, N. H. Application filed Oct. 19, 1892. In a circuit for electrical distribution, the combination of one or a pair of switch levers located in the circuit, a magnetic field energized by the circuit and having two opposed windings, one arranged as a shunt to the circuit, and the other in series with it, a movable armature acting to hold the switch closed when the electrical pressure in the circuit equals a predetermined amount, and to open the switch and break the circuit in each wire of the main line when the electrical pressure falls below a certain amount, or when the current in the circuit increases above a certain amount.

518,481. ELECTRICAL CONTACT MECHANISM, J. F. Blake, New Haven, Conn. Application filed Feb. 22, 1894. A base or support and a pressure actuated spring mounted thereupon, a circuit closer composed of two carbons, one carried by the base or support, and the other carried by one end portion of the spring, an electromagnet and resistance in the circuit of the circuit closer, an armature actuated by the electromagnet, and a secondary circuit closer composed of two carbons, one carried by the base and the other carried by the armature.

518,511. ELECTRIC RAILWAY SIGNAL, R. F. Rex, St. Louis, Mo. Application filed March 1, 1892. In combination with a trolley, a housing supporting and including the same, and brushes pivoted to the lower outside edges of the housing.

518,525. AUTOMATIC ELECTRIC SIGNALING DEVICE FOR CROSSINGS, E. A. Hermann, St. Louis, Mo. Application filed In an automatic signaling device, an electromagnet mounted in a box or inclosure constructed to be connected to a pole, a semaphore or arm having a bracket connected to one end, carried by the armature shaft to the electromagnet, detachable stops or rills connected to the front side of the inclosure for limiting the movement of the arm or semaphore, and electrical conductors leading to and from the electromagnets for energizing the armature for operating the semaphore or arm.

518,531. ELECTRIC CURRENT RECORDER, J. W. Th. Ohio, New York, N. Y. Application filed July 7, 1892. In an electric current recorder the combination of a vibrating arm or pointer, a coil or magnet for moving it along, a record sheet moved by time mechanism, an armature carried by the vibrating free end of the arm or pointer, an electromagnet for moving the armature and means carried by the arm or pointer to mark the sheet

518,540. ELECTRIC RAILWAY CONDUIT; P. P. Banholzer, Philadelphia, Pa. Application filed Nov. 16, 1892. A conductor for underground systems composed of a plate having a series of prongs on one face to anchor the plate in a plastic material.

518,542. THERMO-ELECTRIC GENERATOR; H. B. Cox, Hartford, Conn. Application filed April 28, 1892. A thermo-electric pile having the closely fitted metallic jacket forming its outer surface.

518,543. METHOD OF APPARATUS FOR AMALGAMATING ORES; H. F. Edwards, Butte, Mont. Application filed March 17, 1893. An electrolytic tank provided with electrodes secured to the sides thereof and insulated from the bottom of the tank, in combination with agitators adapted to move close to the bottom of the tank to agitate the mercury, which is adapted to be placed in this tank.

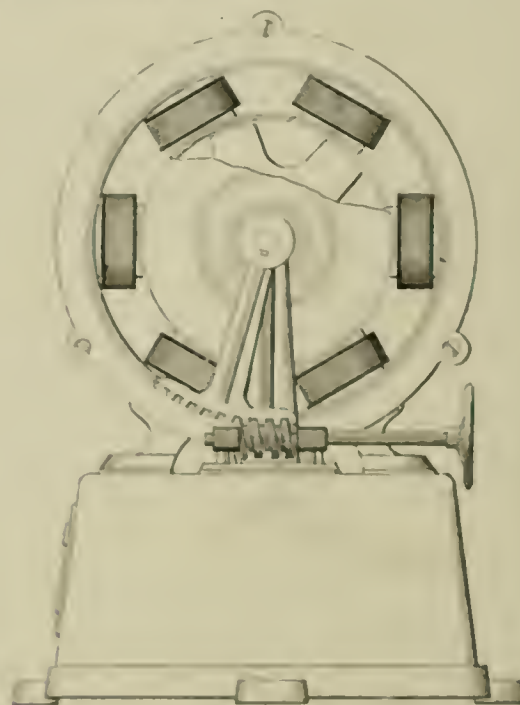
518,561. ELECTRIC MOTOR; H. P. Brown, New York, N. Y. Application filed Jan. 26, 1893. In an electric machine or motor a pivoted brush holder furnished with a hollow counterbalance arm adapted to receive a counterbalance weight.

518,562. ARMATURE FOR ELECTRIC MOTORS; H. P. Brown, New York, N. Y. Application filed Feb. 6, 1893. A commutator furnished with segments and mica strips between the segments and provided with a hollow ring or space between the shaft and the segments containing burned shellac.

EXPIRED APRIL 3, 1894.

189,116. DYNAMO ELECTRIC MACHINE; D. F. J. Lontin, Paris, France. Filed March 1, 1876. This comprises a set of movable induced magnets, a stationary induced magnet having its core extended and provided with one or more separate coils, from which alternate currents in opposite directions may be taken.

189,184. AUTOMATIC TELEGRAPHY; J. W. Brown, Port Huron, Mich. Filed May 21, 1875. The combination of a perforated strip, marking, compensating and reversing pens, battery and resistance, and circuit connections whereby a dash is transmitted by using first a strong initial current, second the compensation therefor, third a current similar to the initial current, and lastly a reversing current.



NO. 518,410.—UNIVERSAL PHASE ALTERNATING CURRENT MOTOR.

189,276. MULTIPLE TELEGRAPHS; G. Smith, Astoria, N. Y. Filed Feb. 19, 1875. A receiving instrument having one armature so arranged as to respond to changes in the strength and in the polarity of the line current, either or both, in combination with two independent sounding or recording instruments.

EXPIRED APRIL 10, 1894.

189,391. ELECTRO-PNEUMATIC MUSIC PLAYING APPARATUS; W. F. Schmoede and H. Schmoede, Jr., Philadelphia, Pa. Filed Feb. 25, 1874. The combination of an electromagnet and armature with an internal pocket or train of pockets.

189,532. PROCESS AND APPARATUS FOR ELECTRO-PLATING WIRE; W. Wallace, Ansonia, Conn., and L. L. Smith, Passaic, N. J. Filed Feb. 5, 1877. This consists in distributing the convolutions forming the coil in substantially an axial line with each other and then subjecting them to the action of the coating bath during their gradual rotation.

EXPIRED APRIL 17, 1894.

189,779. GALVANIC BATTERIES; M. W. Parrish, Jackson, Mich. Filed Jan. 11, 1875. The combination with the jar of a galvanic battery, and with the positive element contained therein, of a negative element made in two sections.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, New York.

The Electrical World.

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1881 " 28 " "	1888 " 175 " "
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1883 " 63 " "	1890 " 289 " "
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The first issue of 1894 contained 320 different Advertisements.

No announcements of the publisher are included in this list.

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THE ELECTRICAL WORLD

253 Broadway, New York.

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THE FIELD ELECTRIC RAILWAY PATENT.

The decision of Judge Townsend against the Field patent, which covered all forms of street railway traction, clears up the atmosphere in this field of litigation, though the effect of the decision had been largely discounted. The appearance of the General Electric Company as defendant in this suit, notwithstanding the former close connection of the Edison and Field interests, is explained by the facts that the Edison Electric Lighting Company withdrew its interest in the Field patent in 1889, and that it inherited the case just decided from the Sprague company. Judge Townsend, in his decision, held that an English patent issued to one Clark in 1864 anticipated every point in the Field patent, except the motor controller, and that the latter could not be considered as adding the character of an invention to the system claimed. In reply to a point made to the effect that the Clark patent named a magneto-electric machine, which the Field patent included a modern motor, the court said that if that argument were to prevail, the inventor of the modern form of motor and not Field should be the beneficiary. The decision in this case marks the growing tendency of courts to discourage "blanket" patent claims, and the remarks on the patent of Clark have a bearing on the claims for the invention of the trolley device, now under litigation.

THAT \$50,000 PRIZE.

In our last issue we referred to the passage of a bill at the closing session of the Legislature on the subject of a prize for the inventor of the most economical street railway traction system. As predicted, the bill, which has been signed by the Governor, is one authorizing the State Railroad Commissioners to act as umpire in the alleged competition of the Metropolitan Traction Company. The bill was signed on Wednesday of last week and on Thursday the president of the Metropolitan Traction Company gave the following statement to the press: "Last fall we sent a letter to Messrs. Alfred C. Chapin, Michael Richard and S. A. Beardsley, the State Railroad Commissioners, asking them to act as judges in a competition we proposed setting on foot. We offered a prize of \$50,000 to any inventor who would offer an economical system of street railway traction which could be made available in this city, where the overhead system would not be permitted. The competition was to be open to all the world. We were flooded by letters from inventors. Between three and four thousand methods were sent us from all over. We could not wait for the Legislature to decide the question of the commissioners acting for us, however, and our offer had to be withdrawn." In other words, several thousand American inventors were put to an expense, which, in time and money, would amount to the value of the prize offered several times over by what, in the light of subsequent events, can only be denominated a sham competition. As remarked by us before, the time limit was so manifestly short that all who entered into the competition doubtless took it for granted that the company, which was presumably acting in good faith, would accord the necessary extension. The condition that the Railroad Commissioners should act as umpires was recognized by many as an impossible one in the absence of special legislation, but this was regarded, wrongly it now seems, as an oversight. The entire proceedings have an equivocal appearance, so much so, in fact, that it is probable that inventors who submitted plans will scrutinize with some interest the details of any system which the Traction company

may finally lay down. As to the Railroad Commissioners, it would be interesting to know in what light they regard the part which they have been made to play in the matter, particularly as their selection as umpires gave the appearance of good faith to the competition.

ELECTRIC CONDUIT STREET RAILWAYS.

The announcement of the Metropolitan Traction Company, that it has under serious consideration offers from two electric companies to lay down an underground conduit street railway and has accepted the proposition of one of them, is encouraging, though, with the knowledge obtained of the methods of this company through its recent sham inventors' competition, to which we refer elsewhere, its announcements are to be received with some caution. It has been officially stated, however, that two of the large electrical companies, one of which is the Siemens-Halske company, have made offers to put down an experimental road. The details of the latter system have been examined by engineers of the Traction company, and, on the strength of their favorable report, a trial of it will be made on Lenox avenue, where the company has recently obtained the right to lay tracks upon an understanding with property owners that an underground conduit system would be used. Three miles of road altogether will be laid at the expense of the Siemens-Halske company, and, if accepted, four miles more will be built at joint expense. The system proposed by the Siemens-Halske company is the one that has been in use in Budapest (described and illustrated in *The Electrical World* of Dec. 10 and Oct. 24, 1891, and May 14, 1892), the first line of which was laid down on July 30, 1889. This system is of the simplest construction, consisting of a conduit of pear-shaped section with two angle irons on one side, one for the in-going and the other for the return current. Sliding contact is made by means of shuttle-shaped sliders. Sixty cars are now run over the lines at Budapest at an average speed of 12 miles per hour, and at a cost of 5 1-2 cents per car-mile, carrying in 1892, 14,000,000 passengers, an increase of 5,500,000 over the preceding year, and paying a dividend of 7 per cent. in 1892, with a considerable surplus carried over. It would thus seem that this system has demonstrated its practicability at Budapest, and it remains to be seen if the conditions at New York would militate against its success there. It may be noted that in a report of the United States Consul at Budapest, made about a year ago, it was stated that the operation of the road was several times interrupted by unusually heavy falls of snow, though otherwise its operation was declared successful. That the day of underground conduit roads has come cannot be doubted. It now only remains for actual practice to overcome the difficulties inherent in such systems, and we venture to predict that such practice will show that these difficulties are of much less moment than has generally been supposed.

INCANDESCENT LAMP LITIGATION.

Our budget of incandescent lamp cases this week, while extensive enough for the period when the litigation was at its zenith, probably marks the end of what in the future will be referred to as a series of causes celebres. A reversal of the present law, limiting the life of domestic by foreign patents, by the United States Supreme Court in its expected decision on the Bates refrigerator case, would prolong the life of the Edison patent to 1897, and thus cause a revival of the battle, but it is not thought there is any probability of this. As the law now stands the Edison lamp patent will expire in November of this year, and the intervening period is so short as to scarcely justify any important legal proceedings in the meantime. In the recent cases the honors are about equally divided. The General Electric Company was successful at Milwaukee, its opponent at Cleveland

scored another victory, while in the Boston case no decision has yet been handed down. While the decision of Judge Jenkins in the Oconto case is not conclusive as to Goebel's alleged prior invention of the incandescent lamp, relating, as it does, only to the question of the existence of a reasonable doubt on testimony not subject to thorough sifting, yet its terms are little favorable to the claims advanced. That Goebel, in view of the struggle of the scientific world for decades to solve the very problem which he claimed to have solved as early as 1854, should, the court declares, "thus hide his light under a bushel, passes comprehension." The decision also lays stress upon the circumstance that Goebel was acquainted with the value of patent protection, and in small matters sought such protection; in the opinion of the court, it challenges belief that "he should have been so careful to secure his rights with respect to trifling matters and evince such utter disregard of his interests in a matter of great moment." The decision of Judge Ricks in the Buckeye case disposes of the plea on the part of the General Electric Company that the enormous blunder made when a wrong date was indorsed on the Edison patent should be held not to affect injuriously those who took no part in the act. The opinion, while accepting the plea of non-participation in the act of indorsement, holds that subsequent acquiescence disbars relief. This decision seems to definitely secure the status of the Buckeye company, as it does not appear possible for the complainant to secure any further hearing in court, no appeal being provided for by law. The case of the Boston Incandescent Lamp Company is interesting from the very considerable improvement in the manufacture of incandescent lamps which the claim at issue is declared to involve. A difference of over four cents in the cost of terminals is indeed an important one, representing, in fact, a saving of perhaps more than 20 per cent. in the cost of a lamp. The main point of law involved is also of interest, as it relates to the definition of an "equivalent," or the quality necessary for a substitute for one of the parts of a combination in order that the patent relating to the combination may not be infringed. This case is somewhat similar to the recent Novak case, but the point at issue is less ambiguous than was the question of relative vacuums in the latter.

Electrical Legislation at Albany.

But few laws of importance to the electrical world were passed by the Legislature that has just adjourned at Albany. A comprehensive review of the legislation pending was given in these columns on April 14, and the prediction then made that but few of the bills introduced would ever become laws has been amply verified.

Of the several schemes to incorporate big power companies, but one got through—the Niagara, Lockport and Ontario plan being the fortunate one. All the philanthropic schemes to reduce telephone rates, to cause trolley wires to be insulated, etc., went down in the general wreck.

Up to date the Governor's signature has been placed to the following new laws bearing on electrical matters:

Chapter 119.—Authorizing the Dunkirk and Fredonia Railroad Company to furnish light, heat, power and electricity.

Chapter 156.—Legalizing the incorporation of the Poughkeepsie City and Wappinger's Falls Electric Railway Company.

Chapter 207.—Extending for three years, from Nov. 1, 1894, the life of the Board of Electrical Control of New York City.

Chapter 260.—Authorizing the village of Springville, Erie County, to establish an electric lighting system.

Chapter 440.—Incorporating the St. Lawrence Electric Townsite Company.

The measures remaining in the Governor's hands are these: Incorporating the Niagara, Lockport & Ontario Power Company, repealing the law allowing electrical experiments on the canals, authorizing electric light and power companies to become railroad corporations empowering the water commissioners of incorporated villages to establish an electric lighting system after first submitting the proposition to the people.

American Institute of Electrical Engineers.

The eleventh annual meeting of the Institute will be held at the house of the Engineers' Club, 1,122 Girard street, Philadelphia, Tuesday, May 15. The preliminary programme, subject to slight changes, is given below in full.

At 10 A. M. Tuesday morning Mayor Stuart, of Philadelphia, will deliver an address of welcome to the Institute. At this meeting the yearly reports will be submitted, officers elected, and other business transacted, including action on a resolution favoring legalization of the units adopted at the Chicago Electrical Congress.

TUESDAY, MAY 15, 1894.

Opening Session.

The opening session of the general meeting for the reading and discussion of papers and reports will begin at 2 P. M.

1. "A Review of the Progress of the American Institute of Electrical Engineers."

An address by the president, Prof. Edwin J. Houston, of Philadelphia.

2. "On Light Distribution and the Use of Lamps," by Prof. Wm. A. Anthony, of Vineland, N. J.

3. "Discriminating Lightning Arresters and Recent Progress in Means for Protection Against Lightning," by Alexander Jay Wurtz, of Pittsburgh. Experimental demonstrations will be shown through the courtesy of the Philadelphia Traction Company.

A reception will be given in the evening by the engineers and manufacturers of Philadelphia, under the auspices of the Engineers' Club, and the Electrical Section of the Franklin Institute.

A theatre party for the ladies will also be organized in the evening.

WEDNESDAY, MAY 16, 1894.

Morning Session, 10 o'clock.

4. "Central Station Economy," by Mr. C. Reginald Van Trump, of Wilmington, Del.

5. "Unipolar Dynamos for Electric Light and Power," by Prof. Francis B. Crocker and Mr. C. Howard Parmly, New York City.

6. "Relative Advantages of Toothed and Smooth Core Armatures," by Mr. Alton D. Adams, of Worcester, Mass.

(Intermission.)

WEDNESDAY, MAY 16, 1894.

Afternoon Session, 2 o'clock.

7. "Test for Closed Coil Arc Dynamo," by Prof. R. B. Owens, of Lincoln, Neb.

8. "Alternating Currents and Fuse Wires," by Prof. Dugald C. Jackson and Mr. R. J. Ochsner, of Madison, Wis.

9. "Some Storage Battery Phenomena," by Mr. W. W. Griscom, of Haverford, Pa.

In the evening the annual dinner will be served in the Hotel Metropole, the price of which has been fixed at \$2.50 per plate. This will be a purely social gathering. Friends may be invited.

THURSDAY, MAY 17, 1894.

Morning Session, 10 o'clock.

10. "The Waste of Zinc in Open Circuit Batteries When Standing Idle," by Henry A. Lardner, of Madison, Wis.

10. "Standardizing Electrical Measuring Instruments: (a) by the Potentiometer Method; (b) an Improved Direct Reading Potentiometer," by Mr. Elmer G. Willyoung, of Philadelphia.

Thursday afternoon will be devoted to an inspection of Cramp's Shipyard, followed by an excursion down the river to Gloucester, where a shad dinner will be served. While the members are visiting the shipyard Thursday afternoon, the Manufacturers' Club will entertain the ladies at the clubhouse, followed by a "tallyho excursion" to points of interest in and about the city.

FRIDAY, MAY 18, 1894.

Morning Session, 10 o'clock.

12. "Resonance Analysis of Alternating and Polyphase Currents," by Prof. M. I. Pupin, of New York City.

13. "Some Facts About Polyphase Motors," by Dr. Louis Bell, of Boston.

14. "The Law of Hysteresis (Part 3), and the Calculation of Ferric Inductances," by Mr. Charles Proteus Steinmetz, of Schenectady, N. Y.

15. "Experiments with Two-Phase Motors," by Dr. Louis Duncan, of Baltimore.

(Adjournment.)

The Electrical World takes pleasure in tendering the use of its branch office, 927 Chestnut street, to the members of the Institute and their friends who expect to attend the annual meeting. The office is within two minutes' walk of the Engineers' Club, where the papers are to be read, and within five minutes of the Franklin Institute and the Hanover Hotel. Members may have their mail addressed there and will be welcomed at all times.

The Cost of Producing Electricity.—II.

BY JAS. B. CAHOON.

Only a short time ago I had occasion to visit a lighting station and a railway power station in the same town; and as illustrative of the economical handling of coal and the method of keeping tally, these will serve as good examples, the one of the kind to look after things, the other of the hit or miss kind. In the central station the coal was taken in carts from the coal shed, run over a scale, carefully weighed, and then dumped directly in front of the furnace door, and a strict tally kept of every individual load. After the day's run the ashes were taken from the pits and floor in dump carts and also carefully weighed, so that in this way the manager could tell at any time the total amount of coal used, the amount on hand, and also the useful amount of coal consumed. At the other place they purchased their coal in 1,000-ton lots, and their method of keeping tally was by the guess of the fireman as to how many pounds he shovelled in; while as regards ashes, he never gave these the slightest attention. Therefore, when I asked for some figures in regard to the amount of coal used, in order that I might learn something in regard to the efficiency of a certain make of boiler which they used alternately with one of another make, they were unable to give me any data at all that were worth considering. I called the attention of the president of the road to this condition of affairs and suggested the advisability of keeping run of his coal, mentioning that it would be handy for him to know how much he had on hand at any time, so as to be in the market in ample season to replenish his supply. A short time afterward I saw him again, and he said: "I had a very good illustration of what you were saying about coal shortly after you left. According to the reports, we had on hand enough coal to last us for another month, but I discovered, on investigation, that we had hardly enough to last us ten days, the fireman having underestimated his coal consumption. We have now started in to weigh every pound of coal burned."

It is just the same with coal as it is with the testing of machines; if the data are worth keeping at all, they are worth keeping well and accurately; it does not involve any great amount of extra work, and ought to prove of very great value, especially to stations that are running pretty close to the wind and may find it necessary to institute comparisons between different kinds of coal to ascertain which kind is best suited to their boiler and class of attendants to give the most economical results. Having once ascertained this, they should be conservative about changing to another kind, the most uniform results being obtained by using the same kind of coal right along; for nothing will demoralize a fireman so much as changing the kind of coal continually; even the very best fireman in the world will kick at this, and if persisted in for any length of time will make them leave for a more rational place.

There is a point in regard to the economical use of coal entering as a factor directly into the cost of the production of electricity which seemingly has escaped the attention of many central station managers. If we refer to Messrs. Robert W. Hunt & Co.'s tables for the cost of evaporating 1,000 pounds of water, it will be seen that so far as the fuel is concerned the cost varies directly as the price of coal and inversely as the rate of evaporation per pound of coal, though the ratio therein expressed is an odd one. As, for instance, the table shows that it costs the same to evaporate 1,000 pounds of water with coal at \$4 per ton, where the coal is capable of evaporating 10 pounds of water per pound of coal, as it does where the coal costs \$2 per ton, and the rate of evaporation is 5 pounds of water per pound of coal. The question, then, as to which will be the more economical for the company to use will depend on the price of labor in

handling the coal, as it will be readily seen that with the cheaper coal it will be necessary to handle twice the amount in order to evaporate the same quantity of water as with the higher priced coal; therefore, this factor wants to be taken into account in determining which quality of coal shall be used. If we consider, now, the cost of the labor required in evaporating 1,000 pounds of water, these same tables show another point which is also apt to escape the attention of the station manager. We find roughly that the labor cost varies inversely with the size of boilers, and in an irregular way with the number of boilers, and also varies directly as the price of labor. The main point to which we wish to call attention is the fact that the minimum cost is obtained when each man has all the furnaces to tend that he can comfortably handle, and if another boiler be added, necessitating the services of another man, the costs immediately jump up, because we have gone beyond the limit of the power of the single man. When the other is added the combined work of both is about the minimum of value, because neither has enough to keep him wholly occupied, and nothing is so expensive as idleness where the cost of labor enters as a factor. I have found in quite a number of instances that station managers in reckoning up the cost of power have neglected to reckon in the amount it cost them to dispose of their ashes; this, in some cases, especially with the poor kinds of coal, amounts to quite an item, and in order to obtain correct results should not be neglected in any case.

Another factor which enters not a little into the cost of producing electricity is the arrangement of steam piping throughout the station, and the utilization of the exhaust steam or waste gases to heat the feed water. Many of our small stations throughout the country, who are running non-condensing, will find it a very great advantage to make use of their exhaust steam in this way, as every degree of heat gained in the temperature of the feed water means that it takes so much less coal to get the desired result. No matter by what diversified paths we go in seeking economy, we find they all eventually end in the coal pile, and all the various economizers and devices to produce economy of this or that are, in effect, an arrangement to save waste in the coal pile; and therefore the wise station manager will do everything that he can to save at this point.

So much has been said in regard to the gain that can be made by the introduction of condensers, that it seems trite to add anything further, but a very good example of this came to my notice a short time ago, and I give it, in the hope that it will lead other station managers who are now running non-condensing to investigate their surroundings, and if possible to change their stations over, so as to run their engines condensing. The station which I have in mind has a maximum output of about 1,500 h. p. divided into small units. The general manager of this station, who is one of the ablest in the field, and fortunately possesses a good knowledge of steam engineering, shortly after his appointment saw the advantages to be gained by running condensing, and after a careful investigation laid the matter before the board of directors, and kept at it until the change was authorized. In order to obtain the necessary supply of water it was found that they must either use city water or run a line of piping on their own account into the harbor some 1,200 feet distant, and draw their supply from that source. The latter plan was finally decided upon, and has been consummated with the result that it has effected an average actual saving of \$25.71 per day in their coal consumption, which, at the price they pay for coal, is equivalent to 7 3/4 tons per day. To offset this saving lies the interest on the cost of the pumps and the laying of the piping, together with the cost of the horse power for driving the pumps; this last, of course, being quite small and hardly noticeable in a day's run. The whole of the items men-

tioned are not equal to half the amount mentioned above as being saved; thus, through the foresight of a competent manager, the company is enabled to add about \$5,000 a year to its dividend. It is quite needless to remark that this pays.

The Field Electric Railway Suit.

Judge William K. Townsend, of the United States Circuit Court, at New Haven, Conn., on May 3, rendered an important decision on a final hearing of a bill in equity, alleging infringement on letters patent, granted to Stephen D. Field, July 16, 1889, for improvements on electric railways and assigned to the complainant, whose motion was finally denied.

The evidence of infringement, as stated in the decision, applies to the combination of a stationary dynamo-electric generator driven by a suitable motor and circuit of motors, composed in part of an insulated or detached section of the line of rails of the railway track and the electric magnetic motor mounted on a wheeled vehicle and used for propelling the same, and included in a circuit of conductors; also a current controlling device placed upon such vehicles. The defense was a denial of infringement, anticipation by prior patents, publication, and prior inventions.

Judge Townsend states that the complainant admits that every element in the invention existed in art before the combination was made, and he finds that there was a question in the Patent Office in 1879, as to whether patents could be granted to Field, because of a prior patent, known as the Clark, which embodied the same principle.

The Oconto Lamp Case.

The United States Circuit Court of Appeals handed down a decision on May 1 at Milwaukee affirming the preliminary injunction granted by Judge Seaman against the Oconto Lamp Company, a full report of which appeared in our columns at the time.

The opinion, which was written by Judge Jenkin, after reviewing the law in regard to preliminary injunctions, both in relation to the lower court and the Circuit Court of Appeals, concludes that the former properly interpreted the rule applying, and that the latter has a right to review to the fullest extent the decision of the lower court.

The conclusion of the court is based upon grounds not conclusive of the fact of Mr. Goebel's alleged prior invention, but effective in the consideration of the question whether the case presented is so clear and satisfactory that it overcomes the presumptive force, which, under the rule adopted, must be conceded to the patent. Two grounds are named.

The first is that the evidence offered in favor of the Goebel defense as to his prior invention of the incandescent lamp is entirely ex parte, and that the court cannot accept the doctrine that ex parte evidence can be relied upon to establish the very improbable claim of Goebel.

The second circumstance is that the story of the invention is rendered more improbable by the fact that Goebel never attempted to take out a patent, because he well understood, as shown by applications for patents on other inventions, the protection to be derived from such an action.

The court concludes that without assuming to say that the story of this invention is untrue, and without designing to suggest what result should be reached upon final hearing, it is compelled to say that the story is surrounded by such an atmosphere of improbability that until it shall have been thoroughly sifted and sustained upon final hearing, the claim ought not to be permitted to invade the monopoly accorded another for the same invention, whose claim has passed safely the ordeal of judicial scrutiny. The court below, therefore, well held that the patent of Mr. Edison should be protected from invasion pendente lite, and the order appealed from is affirmed.

ELECTRICAL FEATURES OF THE MIDWINTER FAIR

The most conspicuous feature of the Midwinter Fair is the Bonnet tower, which stands in the centre of the ground court or plaza. This graceful structure is seen by the visitor long before he enters the grounds, and the light from the mammoth searchlight which crowns its top, under proper atmospheric conditions, is visible more than 100 miles away. The level of the court upon which the tower stands is depressed some ten feet below the level of the ground upon which the main buildings rest. Upon this higher level is also the principal roadway and the cement walk, which main thoroughfare together form the and promenade for the visitors.

As seen from this elevation, the tower, when illuminated at night, offers a view of surpassing beauty, some idea of which is given in the illustrations. These cuts are reproduced from original photographs taken by Mr. Joseph E. Mullenden, of Taber & Co., for the souvenir album soon to be issued by the San Francisco "Examiner," and through the courtesy of that paper they were secured by the special representative of The Electrical World. As night views the photographs are perhaps the finest that have ever been taken, and show in a marked manner the excellent photographing qualities of the electric light.

The contract for the lighting of the tower was awarded to the Western Electric Company, and all the details of the design of its illumination and of the electrical construction were placed in the hands of that company. The tower rises 265 feet from the level of the court and 3,260 incandescent lamps

of 16 c. p. were utilized in its decoration. Of these about 1,000 were employed for outlining the tower, 1,000 for the fixed decorative light effects and 1,260 in the changing geometrical designs placed midway between the different platforms of the tower. Current is supplied to the tower by rubber covered conductors placed underground in wooden conduits. The general distributing point of the dynamo circuits is located in one of the booths of the

kiosks under the tower, where the conductors terminate. The controlling switch-board is also located here. The automatic switch which controls the geometrical designs was very completely described in the last section of this article.

In carrying out the electrical construction work it was necessary to bear in mind the necessity of making it conform to the general design of the structure so as not to impair its delicate outlines. This was accomplished by mounting the lamps upon wooden strips where the lights followed the principal lines of the tower. In the case of the geometrical designs it was necessary, however, to devise some other means. This was very successfully accomplished by the use of wire netting of about one-inch mesh stretched on frames, the lamps being supported by means of two wooden discs clamping the wire netting, the discs being scarcely larger than the base of the lamp sockets employed. The frames with this wire netting were raised and fastened to the sides of



ILLUMINATION OF THE ADMINISTRATION BUILDING.

the tower by means of clamps and steel tie wires.

In the daytime it is scarcely possible to see the electrical features of the tower, as its graceful outlines have been per-

fectly preserved. On the extreme top of the tower is the large searchlight which was mentioned in these columns last

among the first to come to the relief of the fair committee, and offered two 60-light arc machines, which are now used for lighting the central court. Later the company, through the Chicago headquarters, made a further contribution of a large alternator of 3,500 lamps capacity. It has 24 poles, and furnishes current for lighting the Administration Building, Festival Hall and the general offices of the exposition. It is by no means the least important of the exhibits, its neat appearance and location on the main aisle, where it runs all day, causing it to be examined by many visitors. Views are given of this machine and the company's arc dynamos, which are located near it.

The local agents, the Electric Improvement Company, who came to the front at an opportune time, when some encouragement was necessary in order to induce others to assist, deserve credit for their faith in the outcome of the undertaking.

The only other company furnishing machines for lighting purposes is the Standard Electric Company, which has four 50-light arc dynamos used for the illumination of the Arcade, Horticultural Hall and part of Mechanical and Liberal Arts Building.

INTERIOR OF STIERINGER FOUNTAIN WHILE IN OPERATION. The brilliant effects of its rays may be seen in the accompanying illustration.

All companies furnishing machines also supply the lamps and apparatus necessary for making them operative.

An electric elevator carries passengers to the third

The Siemens & Halske company offered a 6,000-light ma-



THIRD MANUFACTURES AND LIBERAL ARTS BUILDING.

platform, which is about two hundred feet from the ground. The Fort Wayne Company, through its local agents, was

chine, but no suitable engine could be obtained for running it, and the offer was regretfully declined.



THE MIDWINTER FAIR AT NIGHT.

None of the foreign exhibitors at Chicago considered it worth while to make any display here, and the electrical manufacturers of the coast have felt that it was unnecessary for them to show what they can do.

The tower is fitted with a Hale elevator, which is run by an Eickemeyer motor. This motor can scarcely be considered an exhibit, as it is placed in a dark room under the tower, the only access to which is by means of a steep stairway, the door of which is usually closed. The elevator and machinery is the same one that was in use at the World's Fair, running to the roof of the Manufactures Building. After the Chicago Exposition it was purchased by the Bonet Tower Company and brought to San Francisco. The motor requires 20-kw. electric power when the elevator is loaded with 15 people, and it raises the loaded car a distance of 220 feet in one minute.

Perhaps one of the smallest electrical exhibits excites the most wonder amongst the rural visitors. In Machinery Hall is a cascade run in connection with a rotary pump exhibit.

trician W. F. C. Hasson, and to him is largely due the success achieved. There are altogether 2,300 lamps on the cornices of the main buildings, the distance apart being two feet. This distance was found to be as close as was necessary, and from no very great distance the tower has the appearance of a pillar of light, and the cornices appear as though wreathed in continuous luminous lines.

In attempting to give some idea of the difficulties encountered, nothing better can be said than to give some quotations from an article by Mr. Hasson in the "Overland Monthly" for April, 1894, as he had all data at hand, and the difficulties overcome were still fresh in his mind when the article was written. He says:

"The General Electric Company contracted to wire the main buildings for the exterior decorative lights, and it was a daily struggle on the part of the wiremen to accomplish more than painters, plasterers and carpenters could destroy. The utilization of a railway generator for this lighting involved the adoption of a series system of arranging lamps.



MAP OF THE MIDWINTER FAIR GROUNDS.

and placed behind glass shields are a number of colored lamps, which have the appearance of being in the water when viewed from a distance, and visitors from the interior can frequently be seen gazing with open-mouthed wonder at burning lamps, which do not appear to be affected by water. They seem to think there is something wrong about their previously entertained ideas of fire and water.

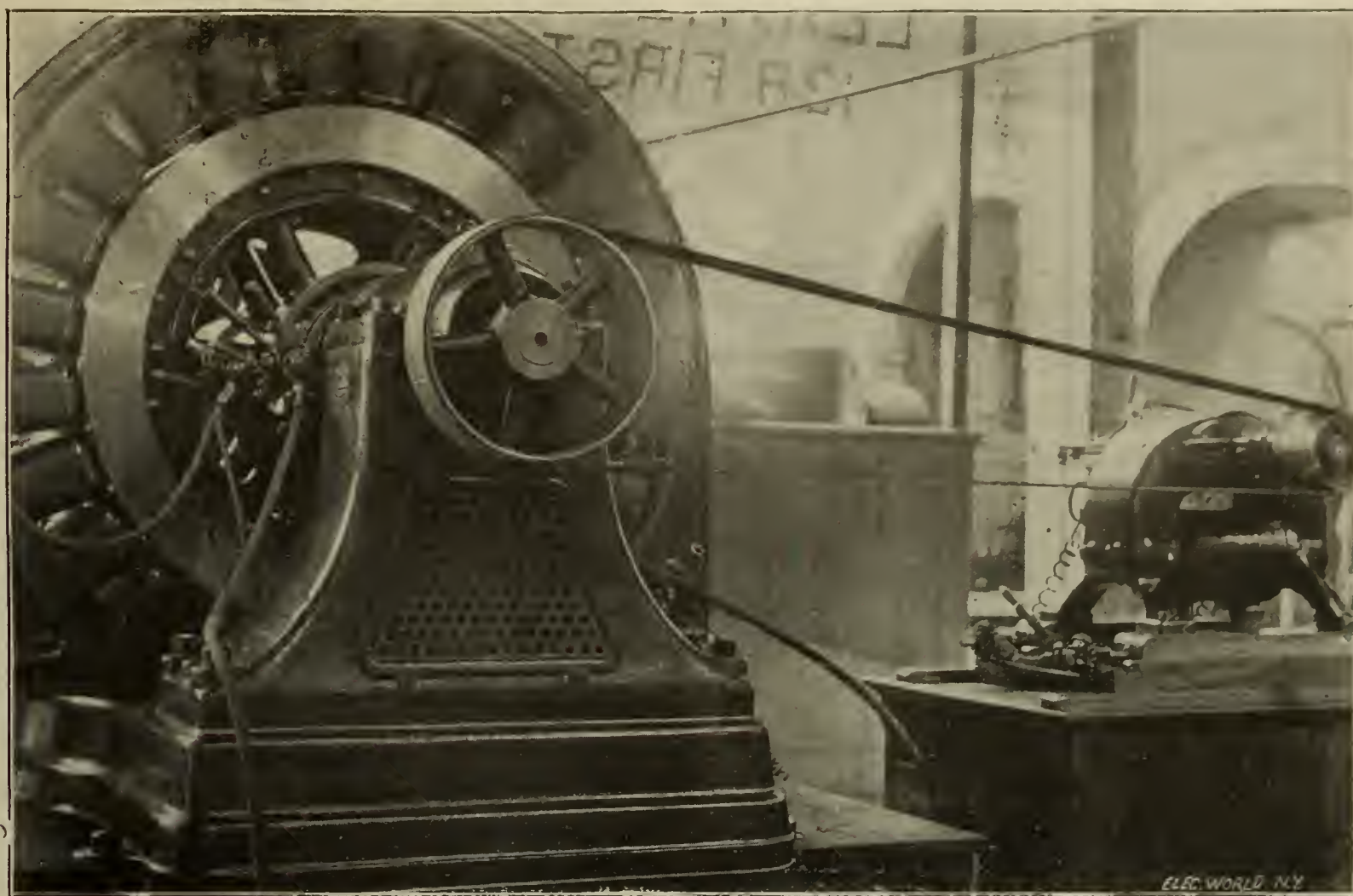
The lighting of the grounds, exteriors of buildings, etc., was a problem requiring considerable ingenuity, to produce the best results with the least possible expense. The number of lamps allowable was much less than was desirable, as is evident from the fact that the Western Electric Company estimated that 8,000 lamps would be required to light the tower effectively, while but 3,213 were placed upon it, and the number on other structures had to be similarly limited. Nevertheless the result is very effective. All lighting of buildings and grounds was under the charge of Chief Elec-

The system was accepted only on account of the economic wiring it presented, and grave doubts existed concerning its success. Salt spray had ruined lamps and corroded sockets. The first test was a dismal failure. Simple but effective measures were adopted to remedy the numerous troubles thus caused, and these lights now stand permanently successful.

When Assistant Electrical Engineers Sprout and Meredith started with three laborers, about the middle of December, to plant poles around the central court, the prospect of getting the lighting plant installed looked very dim. Not a single engine or dynamo had been received on the grounds, no foundation had been built, the buildings offered little protection from the weather, work was barely started on the boilers and the annex to Machinery Hall was still a matter of conjecture. Jan. 13 it was finally decided to officially open the Exposition on the 27th. The boilers were not yet installed, not a single engine was ready

for test, no line wire was strung. . . . Jan. 21 a single arc light was offered as a harbinger of the future. . . . and pressure was not again obtained until Jan. 25, when 12

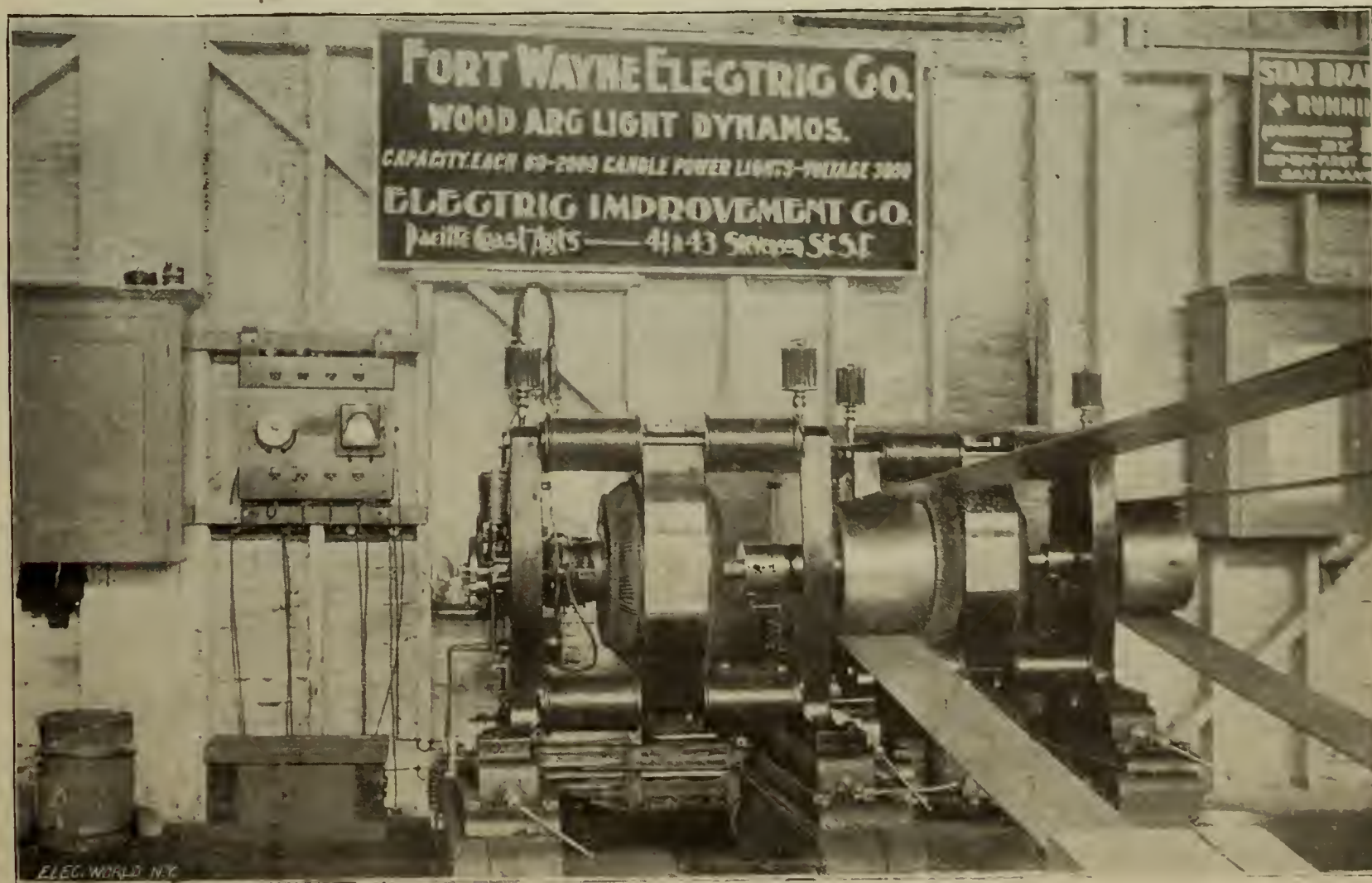
ing this period never exceeded 35. . . . The lighting of the Exposition is in no sense a great engineering undertaking. It is notable only that in



3,500-LIGHT WOOD ALTERNATOR.

arc lights were put in operation. Three arc dynamos broke down under test. On the evening of Jan. 26 200 lights were in circuit, and on Saturday, Jan. 27, poles had been erected,

a very short space of time a hastily constructed steam plant and an ill assorted set of untried engines and water soaked dynamos were put in successful operation without a single



A CORNER OF THE ARC LIGHT EXHIBIT.

over 120,000 feet of wire strung and 600 arc lamps hung and put in successful operation. The number of men employed in the Electrical Department dur-

serious accident. Up to the day of opening not a single skilled employe of the Electrical Department received anything but laborer's wages. These men worked with intelli-

gence and enthusiasm; no work was too hard, no hours too long. To them belongs the credit of the successful lighting of the Exposition.

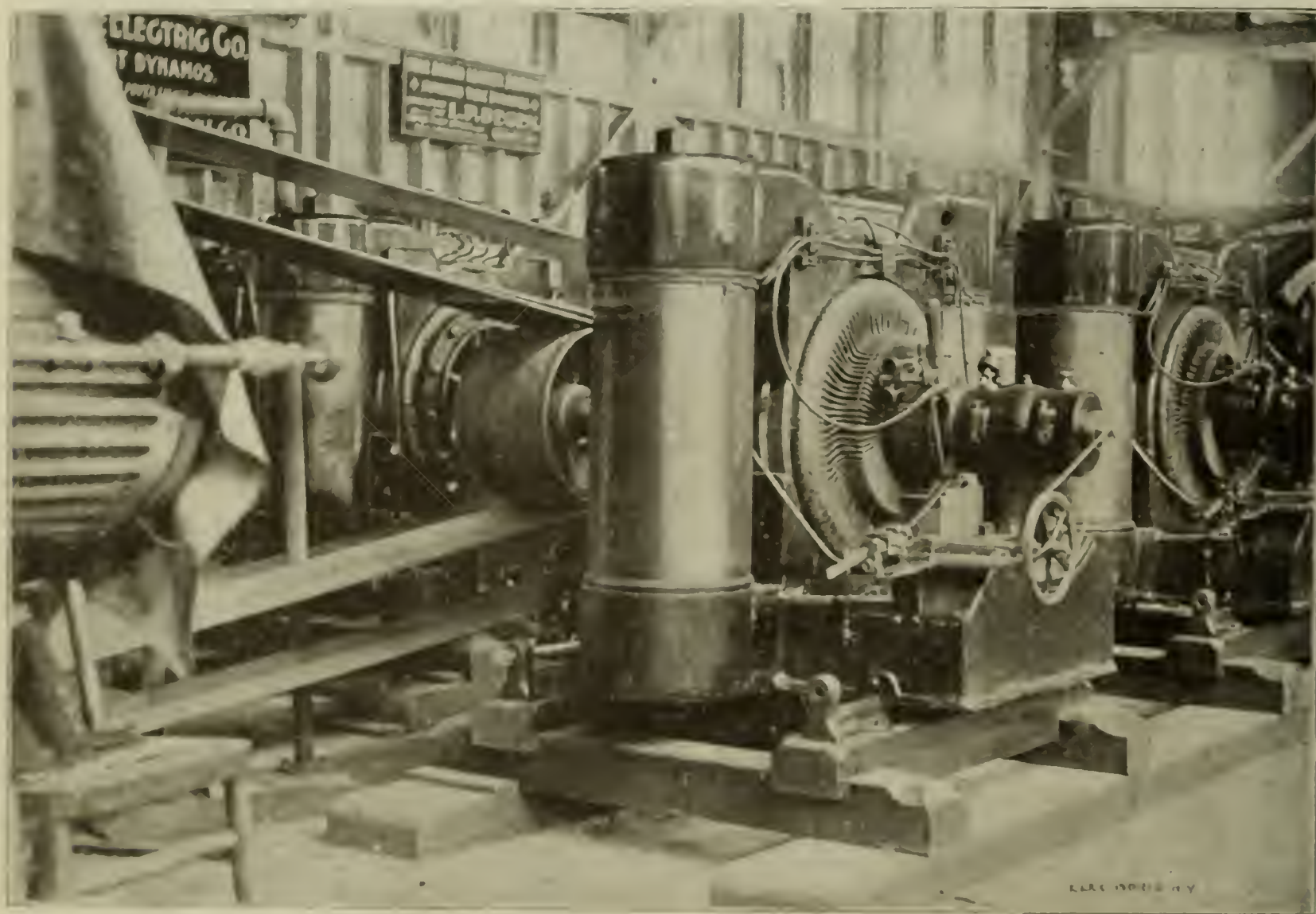
Mr. Hassen is enthusiastic in praise of his subordinates, but it is the consensus of expressed opinion that a large part of the success is due to the personal hard work of Mr. Hassen himself.

Although the electric fountain is the same one used in Chicago, the effect here produced is far more beautiful, no doubt owing to the more favorable surroundings. In Chicago everything was on such a large scale that the effect of the fountain was much dwarfed. The brilliant illumination of the Administration, Electrical and other buildings, the constant play of the great searchlights, made a flood of light in which the effect of the fountain was much lessened. Here, however, the beauty is much more pronounced, because, while the illumination of the grounds and buildings is really very fine, yet the much less magnitude causes the fountain to appear large in proportion. The effect is still

over the mountains than for the use of the villagers. Just under the bridge a waterfall gives movement and sound to the otherwise restful and silent scene.

The curtain rises at that hour, darkest before the dawn, when all life is at its lowest ebb. All is silent, and darkness reigns supreme except for the twinkling lights of the village streets and of the bridge. Soon the first flush of dawn appears, the sky reddens and brightens (going through its accustomed shades in a very natural manner), and the clear sunlight floods the scene. The sun itself cannot be seen at this stage, as it is supposed to be hidden from the audience by a great spur of the mountain.

Shortly after sunrise the sky darkens with a great black cloud, which shuts out the light until almost the darkness of night prevails in the deep and narrow canyon, and lightning flashes and thunder rolls. With the passing of the cloud the scene brightens and the sharp zigzag lightning flashes are replaced by the glow that denotes lightning in the distance. Soon the sun comes out again in a clear sky, runs



STANDARD ARC LIGHT DYNAMOS.

further enhanced by extinguishing the tower lights, the decorative cornice lights on the main buildings and all arcs in the neighborhood of the fountain while it is playing.

It is not the intention of the exposition to conduct any tests as to efficiency of dynamos, or economy of lamps, engines or boilers. This would be desirable, but the conditions are not such as to make it possible.

In addition to its exhibit, the Western Electric Company has a scenic theatre in which very pretty and realistic effects are produced by an ingenious arrangement of electric lamps and methods of controlling them.

The scene represents a canyon, high up on a mountain side, through which flows the small stream which has eroded it. The rocks overhang the sides in great spurs, and on the rocky shelves under these overhanging crags is built a mountain village divided into two parts by the bed of the stream. A little higher up the canyon a great bridge has been thrown across, apparently more for the purpose of a highway

its accustomed course and evening falls. The sunset glows appear, and as the last reds become dim, the stars begin to appear in the strip of sky at the head of the canyon, and the lights of the bridge and street lamps twinkle in a familiar manner, while the soft glow from the open doors and windows of the houses tells of quiet home life, far from the turmoil and strife of the great world.

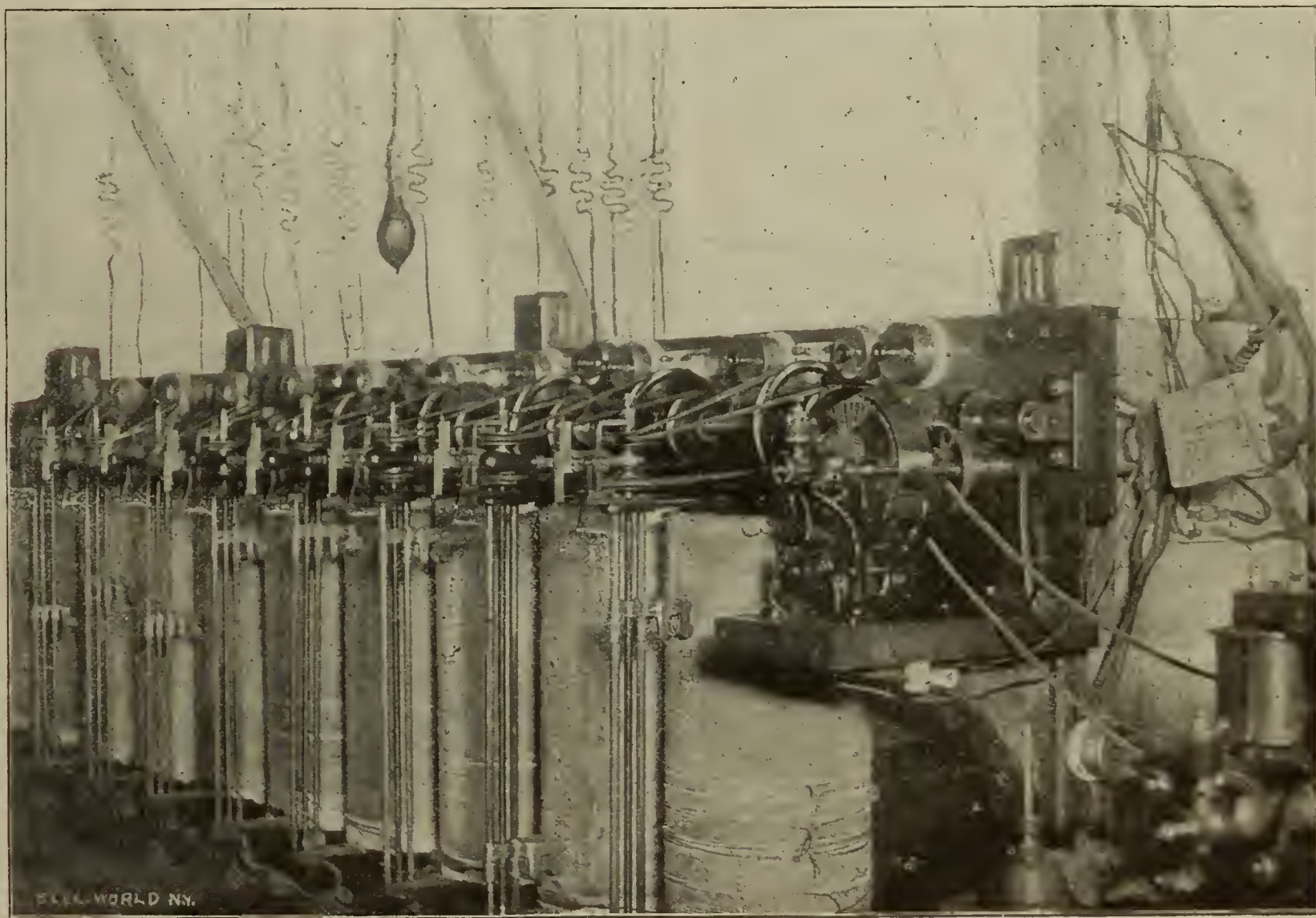
This is the course the scene is supposed to follow, does follow sometimes, and would always but for the fact that man is not without his little failings. Sometimes during the thunderstorm the cloud is allowed to become too thick and the darkness in the canyon becomes fully as dense as during that "darkest hour before the dawn" with which the scene opens; at other times the lightning is turned on and not noticed until the audience has been for some time edified by the sight of stationary and permanent lightning flashes, during the continuance of which the thunder forgets to roll. Again at other times the thunder rolls without any reference

to the lightning, and continues to roll with undiminished volume during the soft glow that denotes lightning at a great distance. Sometimes as evening comes on the stars forget to come out, and when finally they remember that they are not up they come out with a snap that is really startling. As the thunderstorm clears away a very realistic rainbow appears, but sometimes it gets in a hurry and shows as a brilliant band of color while the lightning is still flashing, the thunder rolling and the canyon is still clothed in that "darkest hour" darkness. These little mishaps are, however, the exception rather than the rule, and one can really pass a pleasant few minutes looking at a very pretty scene.

To produce the various color effects, groups of colored lamps are suitably placed and connected in series with rheostats, by means of which the degree of illumination can be controlled. The grouping of the lamps is as follows: Set at the back of the stage and close against the curtain representing the sky at the head of the canyon, are two groups of red lamps and two similar groups of blue ones, one group

In the ceiling flies and on the sides there are altogether 125 32-c. p. blue lamps and 150 16-c. p. red lamps. In addition to these red lamps the sun, when the lamps first begin to brighten, is behind a red screen on one side of the stage, and is drawn behind a similar one on the other side as the lamps darken, thus adding to the red glow at dawn and sunset. As looked at from the audience seats, east is on the left of the stage.

The rheostats being in series with the various groups of lamps, the sun lamps and the red lamps in the east and in the ceiling flies are thrown into circuit. The motor controlling the rheostats is started, and as the resistance is gradually cut out of circuit, the lamps brighten and produce the red glow at dawn; at the same time a motor is started that slowly draws the sun from east to west. As the sun begins to emerge from behind its red screen, the groups of red lamps in the east and overhead are gradually dimmed by throwing a clutch lever, by means of which the direction of motion of a traveler on the rheostat is reversed, and resistance grad-



SCENIC THEATRE CONTROLLING APPARATUS.

of each being placed on each side of the stage, representing the east and west. Higher up and considerably more to the front are similar groups of red and blue lamps, and four more such groups are found in the flies directly over the curtain of the stage.

The sun is located directly over the front of the stage, and consists of a group of 15 32-c. p., 80-volt lamps run on a 110-volt circuit. The lamps are set as close together as possible and produce a very bright light, having considerable diffusive power.

The moon, of course, follows the same course as the sun, and is composed of a group of five 32-c. p. green lamps, run at normal candle power (probably a more nearly perfect moonlight effect would be produced if the lamps were indigo instead of green). Behind the screen at the back of the stage is a narrow space lighted by 35 16-c. p. lamps, and the light from this space, shining through holes in the screen, forms the stars.

ually cut in. At the same time the various groups of blue lamps are thrown in circuit, and gradually brighten as the red lamps fade. By the time the sun is fully clear of its screen, the reds are extinguished and the blues burning full power. The sun continues its motion, and passes from east to west until it reaches the red screen at the west. As it begins to disappear behind this, the resistance is gradually thrown in circuit with the blue lamps, while the reds overhead and in the west begin to light up, producing the evening glow. Finally these western reds and the sun lamps begin to fade, and as they disappear the stars light up and the moon rises. The object of the blue lights with the bright sunlight is to produce clear daylight effects, and if they are not thrown in at the proper time a hazy, muddy effect is produced, like a sky covered with leaden clouds. When the thunderstorm is coming on these lamps are first cut out through the rheostats, and then the sun is darkened.

Lightning is produced by making some scratches on a

piece of japanned glass, several such being used to produce flashes of different shapes. The glass is slipped along until a scratch comes before a stereopticon lens in the company's well-known theatre focusing lamp. Light is flashed through it by means of a pneumatic shutter, similar to that on a camera.

The rainbow is produced by using a small semi-circular prism in front of an ordinary focusing lamp. The gradual brightening is produced by slowly shoving forward a cloth screen, which is made with a decreasing number of thicknesses, so as to permit the passage of more and more light, thus producing the same effect as a rheostat used in connection with an incandescent lamp.

Heat or glow lightning is produced by breaking a 5-ampere current with a file, the current being regulated by having five 32-c. p. in parallel in the circuit. The first time it was attempted to produce the effect no lamps were used, and a dead short circuit was produced, which made a fine lightning effect, but blew a 100-ampere fuse. A piece of sheet zinc, well shaken, produces a very good thunder.

The village and bridge lamps are 1-4 c. p., and are placed on models of the regular arc lamp poles made by the company. They are 3-volt lamps and run nine in series, with three 32-c. p., 80-volt lamps in parallel on a 110-volt circuit. They take three amperes, which is regulated by the three 32-c. p. lamps.

The houses are lighted by a 16-c. p. lamp, placed behind a screen, which covers the lamp, but has an opening in the back so as to produce a different light in the houses.

A view is given of the rheostats controlling the various groups of lamps. Eleven rheostats, made of German silver wire, bedded in asbestos, are placed in a row, and each controls a group of lamps. A board is shown, firmly secured to uprights behind these rheostats, to which is secured a shaft, which runs the entire length. This shaft is driven continually in one direction by the motor shown, and carries a series of grooved pulleys, each having beside it a smaller loose pulley, which turns freely on the shaft. A continuous belt passes over each such pair of pulleys and over two small ones set on a vertical shaft in a frame just in front and over a rheostat, as shown, thus giving these two pulleys motion in opposite directions. The handles shown connect with clutches, by means of which the vertical screws shown in front of each rheostat can be connected with either of the two pulleys, and thus be made to revolve in either direction. These screws carry travelers, as shown, which, as the screws revolve slowly, move contacts over the bared portion of the rheostats. The switches on the board above the shaft connect with the various circuits.

(To be continued.)

Magnetic Separator Patents.

Judge Cox at the April term of the United States Circuit Court, held in New York, entered an interlocutory decree on final hearing in favor of the complainants in the suit of the Magnetic Separator Company against William D. Hoffman. It was declared that the defendant infringed patents, the property of the Magnetic Separator Company, and granted to Clinton M. Ball and others, by making, using and selling systems or plants for the concentration of iron ores, as exhibited and operated at the Clover Hill mines and Croton magnetic mines, Westchester County, New York, at the mines of Wetherbee, Sherman & Co., near Port Henry, New York, and at the mines of the Chateaugay Ore and Iron Company, Clinton County, New York. The Court decreed the payment of profits derived from such infringement by the defendant, any damage sustained thereby and the costs of the suit, and also enjoined the defendant from further infringement.

The Practical Importance of Resonance in the Transmission of Electrical Power.—II.

BY F. W. DUNBAR.



THE fundamental equations required having now been deduced, we may discuss the problem of the construction of a circuit of a given length which is to transmit power at a certain alternating voltage, so that for a given weight of copper the power delivered at the distant end shall be a maximum and the percentage loss upon the line a minimum.

As the power transmitted is equal to $\frac{I V}{2} \cos \theta$, where I and V are the maxi-

mum values of the current and voltage, respectively, during one cycle, and θ is the angle of lag between the current and voltage, we must not only consider the current itself, but its displacement from the phase of the E. M. F.

First, however, we will determine the values which C and L must have in order to bring into resonance a circuit of given length, l , and of given resistance per mile, R , which is to transmit an alternating current of N cycles per second. Then we will consider the phase of the current with respect to the E. M. F., and also the percentage loss during transmission.

If the conditions, that the current at the distant end shall be a maximum for a certain value of L and also for a certain value of C , are imposed upon equation (11), then the values of C and L which satisfy the conditions $\frac{dI}{dC} = 0$ and $\frac{dI}{dL} = 0$, must be determined in terms of the other constants of the equation—i. e., the length, resistance and rate of alternation.

We will first make $\frac{dI}{dL} = 0$ and solve for L

$$I = \frac{E}{\left(\frac{\sqrt{R^2 + L^2 \omega^2}}{C \omega} \right)^2} \sqrt{\frac{2}{\cosh p l - \cos a l}}$$

I will be a maximum with respect to L when $\sqrt{(R^2 + L^2 \omega^2)^{1/2} (\cosh p l - \cos a l)}$, or $1/2 \log (R^2 + L^2 \omega^2) + \log (\cosh p l - \cos a l)$ is a maximum. Hence

$$\frac{dI}{dL} = 0 = \frac{L \omega^2}{R^2 + L^2 \omega^2} - \frac{l p \omega}{2 \sqrt{R^2 + L^2 \omega^2}} \sinh p l - \frac{l a \omega}{2 \sqrt{R^2 + L^2 \omega^2}} \sin a l$$

$$\cosh p l - \cos a l$$

$$\text{or } \frac{L \omega}{(R^2 + L^2 \omega^2)^{1/2}} = \frac{a l}{2} \left\{ \frac{\sinh \frac{a l}{\tan \mu}}{\tan \mu} - \sin a l \right\} \quad (12)$$

$$\cosh \frac{a l}{\tan \mu} - \cos a l$$

Also equating $\frac{dI}{dC}$ to zero, we have that

$\sqrt{\frac{C \omega}{\cosh p l - \cos a l}}$ or $\log C \omega - \log (\cosh p l - \cos a l)$ will be a maximum when I is a maximum.

$$\text{Hence } \frac{dI}{dC} = 0 = \frac{1}{C} -$$

$$\frac{l \omega \sqrt{(R^2 + L^2 \omega^2)^{1/2}} - L \omega \sinh p l}{(\cosh p l - \cos a l)^2} + \frac{L \omega \sqrt{(R^2 + L^2 \omega^2)^{1/2}} + L \omega \sin a l}{(\cosh p l - \cos a l)^2} \sqrt{\frac{C \omega}{2}}$$

$$\text{or } \frac{a l}{2} = \frac{\cosh \frac{a l}{\tan \mu} - \cos a l}{\frac{\sinh \frac{a l}{\tan \mu}}{\tan \mu} + \sin a l} \quad (13)$$

Combining (12) and (13), we have

$$\frac{L \omega}{(R^2 + L^2 \omega^2)^{1/2}} = 1 - \frac{2 \sin a l}{\sinh \frac{a l}{\tan \mu} + \sin a l} \quad (14)$$

which is the condition which will yield a maximum current at the distant end of a circuit of length l , resistance R and period ω — that is, it is the condition of "resonance" of the circuit.

This equation may be solved as follows:

If $\frac{x}{y}$ be any small angle, then $(\cosh \frac{x}{y} - 1) = \frac{x^2}{2 y^2}$, and as the angle increases $(\cosh \frac{x}{y} - 1) > \frac{x^2}{2 y^2}$.

Also if $\frac{x}{y}$ be any small angle, then $\sin \frac{x}{y} = \frac{x}{y}$, and as the angle increases $\sinh \frac{x}{y} > \frac{x}{y}$ and increases more rapidly than does $(\cosh \frac{x}{y} - 1)$. Therefore

$$\frac{\cosh \frac{x}{y} - 1}{\frac{x}{2 y} \sinh \frac{x}{y}} < 1, \text{ and equals } 1 \text{ when } y \text{ is large.} \quad (15)$$

$$\text{Hence } \frac{\cosh \frac{x}{y} - 1}{\frac{x}{y} \sinh \frac{x}{y}} < \frac{x}{2}, \text{ or } \frac{\cosh \left(\frac{a l}{\tan \mu} \right) - 1}{\sinh \left(\frac{a l}{\tan \mu} \right)} < \frac{a l}{2}.$$

If the numerator of the left-hand member be increased by $(1 - \cos a l)$ and the denominator increased by $\sin a l$, both members become identical with equation (13). But as $(1 - \cos a l)$ is always less than $\sin a l$ for all positive values of $a l$ less than 45° , it is evident that

$$\frac{\cosh \frac{a l}{\tan \mu} - \cos a l}{\frac{\sinh \frac{a l}{\tan \mu}}{\tan \mu} + \sin a l}$$

can never equal $\frac{a l}{2}$ if $\sin a l$ is positive. But $\sin a l$ cannot be negative; otherwise the second member of equation (14) would become greater than unity, which is impossible, as $(R^2 + L^2 \omega^2)^{1/2}$ is always greater than $L \omega$.

Hence the only values which $\sin a l$ and $\cos a l$ can have and satisfy equations (12), (13) and (14) are $\sin a l = 0$ and $\cos a l = +1$.

The conditions then which will bring a circuit of any length and any resistance into resonance and thus yield a maximum current for a given rate of alternation are

1. $a l$ shall equal 2π or some multiple of 2π .

2. $\frac{a l}{\tan \mu}$ shall be equal to .2 or less.

This latter condition is imposed directly by equation (13), which, as stated, is only true when not only $\sin a l = 0$,

but when $\frac{a l}{\tan \mu}$ is so small that the quantity

$$\frac{\cosh \left(\frac{a l}{\tan \mu} \right) - 1}{\frac{a l}{2 \tan \mu} \sinh \left(\frac{a l}{\tan \mu} \right)}$$

is practically equal to unity.

When $\frac{a l}{\tan \mu} = .1$ this quantity is equal to .999 and when $\frac{a l}{\tan \mu} = .2$ it has decreased only to .988.

The difference becomes rapidly more marked above this value of $\frac{a l}{\tan \mu} = .2$, and the value .2 has been chosen as the maximum value which will yield practically perfect resonance, although, as we shall see, it may have a considerably greater value and still not throw the line completely out of resonance.

By the second condition then $\tan \mu$ must exceed five times the value of $a l$ or must exceed 10π , 20π , $30 \pi \dots n 10 \pi$, depending upon whether the circuit has 1, 2, $\dots n$ complete wave lengths.

$$\begin{aligned} \text{But } \tan \mu &= \frac{a}{p} = \sqrt{\frac{(R^2 + L^2 \omega^2)^{1/2} + L \omega}{(R^2 + L^2 \omega^2)^{1/2} - L \omega}} \\ &= \cot \cos^{-1} \frac{L \omega}{(R^2 + L^2 \omega^2)^{1/2}} = \tan \left(90^\circ + \tan^{-1} \frac{L \omega}{R} \right) \\ \text{or } \mu &= \frac{\left(90^\circ + \tan^{-1} \frac{L \omega}{R} \right)}{2} \end{aligned} \quad (16)$$

This may be written

$$90^\circ - \omega = \frac{90^\circ - \tan^{-1} \frac{L \omega}{R}}{2}$$

and μ is a large angle, as its tan is large. But we know that the tangents of large angles vary as $(90^\circ - \text{these angles})$, hence

$$\tan \mu = \frac{2 L \omega}{R} \text{ or } L \omega = \frac{R \tan \mu}{2}. \quad (17)$$

Therefore, the second condition may be written $L \omega$ must exceed $(5 \pi, 10 \pi \dots n 5 \pi) R$ depending on whether there be 1, 2, $\dots n$ wave lengths in the circuit.

The corresponding values of $C \omega$ may be found directly from the relation

$$\begin{aligned} a &= \sqrt{\frac{C \omega}{2}} \sqrt{(R^2 + L^2 \omega^2)^{1/2} + L \omega} \\ &= \sqrt{C \omega} \sqrt{R^2 + L^2 \omega^2} \sin \mu. \end{aligned}$$

But as $\tan \mu$ always exceeds 10π , $\sin \mu$ is never less than .999, or is practically unity. Again, as $L \omega$ must exceed $5 \pi R$ the value $\sqrt{R^2 + L^2 \omega^2}$ differs from $L \omega$ by less than two-tenths per cent., and we may write

$$\sqrt{C \omega} = \frac{a}{\sqrt{L \omega}} \text{ and } a = \frac{2 \pi, 4 \pi, \dots}{l}$$

hence

$$C \omega = \frac{4 \pi^2 n^2}{l^2 L \omega}. \quad (18)$$

where n = number of wave lengths.

The three equations then for perfect resonance in any circuit are

$$a l = 2 \pi n, \quad (A)$$

$$L \omega > 5 \pi R n, \quad (B)$$

$$C \omega = \frac{4 \pi^2}{l^2 L \omega} n^2, \quad (C)$$

where n is the number of complete wave lengths which the circuit is divided into.

Equation (A) is the fundamental equation of resonance.

Equation (B) expresses the proportion which must exist between the inductance, or weight or inertia of the circuit to the resistance or friction of the circuit in order that the resonance may be possible.

And equation (C) is simply equation (A) expressed with the condition of (B) included.

If now we were right in our supposition that by giving C and L certain definite values it should be possible to "tune" any circuit to any period of alternation, that is to make it resonant to that rate, then equation (C) should be identical with the equation expressing the law of the vi-

bration of any mechanical body, as an organ pipe or piano string.

(C) may be written $\omega = \frac{2 \pi n}{\sqrt{C L}}$, but $\omega = 2 \pi N$, where N is the number of alternation per second, hence

$$N = \frac{n}{\sqrt{\frac{1}{C L}}}$$

But the law of the vibration of a mechanical body, as a piano string or our wire rope, is

$$N = \frac{n}{\sqrt{\frac{P}{M}}}$$

where P is the elasticity and M is the inertia of the vibrating string.

Similarly $\frac{1}{C}$ is the electrical elasticity of the electrical circuit and L its inertia, and the two equations are identical in all respects.

We are thus justified in assuming that all the phenomena accompanying the vibration of a mechanical string in a medium, as the air, in which the frictional resistance is small compared with the inertia of the string, can be reproduced electrically upon an electrical circuit where the inertia or inductance of the circuit is made large in comparison with the friction or resistance, or as equation (B) states, when $L \omega > 5 \pi R n$, or when $L > \frac{5 R n}{2 \omega}$.

The process then of designing a line to be resonant to a certain period of alternation is, assume: $n = 1$, then L must be greater than $\frac{5 R}{2}$ divided by the number of alternations per second. And $C = \frac{1}{N^2 L}$.

If this should yield a value of C smaller than it is possible or practicable to obtain, say less than $\frac{.016}{10^9}$ farads for a No. 5 B. W. G. wire, then make $n = 2$, in which case the inductance and capacity will each be twice as great as before. If still too small make $n = 3$, in which case the inductance and capacity will each be three times as great as when $n = 1$, etc.

If, however, the value of C becomes so large that it would be expensive to secure it, then it is evident that L may be increased with advantage for as long as it is at least equal to $\frac{5 R}{2 \omega}$ it may have any value such that

$C L = \frac{1}{N^2 L}$. Of course it is of advantage, to maintain $n = 1$ on short lines as the values of L and C may each then be small.

The methods by which L and C may be cheaply varied and the limits of these variations will be discussed later.

(To be continued.)

The Buckeye Electric Company Again Successful

Judge Ricks, of the United States Circuit Court, for the Northern District of Ohio, on May 4 refused to grant a preliminary injunction against the Buckeye Electric Company, of Cleveland, Ohio, for infringement of the Edison incandescent lamp patent. The motion was made by counsel for the General Electric Company on the grounds that it now possessed valuable evidence which had not been presented when the court dissolved the injunction previously in force against the defendant.

The new facts disclosed by the affidavits are that at the time the owner of the patent and the assignee thereof made

their application to the Patent Office, in October, 1883, asking for a limitation of the life of the patent, and at the time of the proceedings taken under said application, a contract was in force by which the owner of the patent had given the exclusive right to manufacture lamps under the patent to Edison, the patentee, and to certain persons whom the contract stipulated might be associated with him in that undertaking. The contract was made on the 8th day of March, 1881. On the 12th day of January, 1884, Edison and his associates named in the contract of March, 1881, assigned and transferred to the Edison Lamp Company, a corporation organized under the laws of New Jersey, all their title and interest in the said contract, and also all their interest in a second contract between the Edison Electric Light Company and the Edison Lamp Company, made October 11, 1883.

This right to exclusively manufacture lamps, thus vested in Edison and his associates, was in force when the owner of the patent and Edison joined in the Patent Office application of October, 1883. The associates of Edison in that exclusive right, it is claimed, were not advised of what Edison and the owner of the patent did with reference to the said proceedings in the Patent Office, were not bound thereby, and that, so far as their rights in that contract are concerned, they are not now estopped from claiming a preliminary injunction by any acts of the owner of the patent or the patentee.

The case is practically, therefore, the application of the holders of this equitable interest in the contract of March, 1881, for a preliminary injunction against the defendants. It has already been decided that the assignee of the patent and the patentee are not entitled to such relief. Those who now ask for the injunction upon the new facts disclosed must show their right to this remedy and relief by the same rules and upon the same principles governing any other applicant for such an order. Judge Jenkins finally concludes that the relations of those associated with Edison under the contract of March, 1881, were so close, and their interests so bound up in the success of the patent, that, accepting their denial of not having authorized the act limiting the life of the patent, yet such denial is not inconsistent with the contention of the plaintiff that they must soon after the act have obtained knowledge of it. Between October, 1883, and March, 1893, the indorsement in question appeared on every copy of the patent, and with their natural interest in that patent the court concludes they must have had knowledge of it.

While Edison estopped himself from claiming an injunction by his acts and conduct between October, 1883, and March, 1893, as found in the decision hereinbefore referred to, it does not follow that his associates were likewise estopped. But in this hearing it ought affirmatively to appear that those parties who claim a prior equity to the defendant were ignorant of, and did not participate in, or authorize, the several acts and the line of conduct which it has been held estopped the other plaintiffs from claiming relief against these defendants. This should appear so satisfactory as to justify the court in granting this unusual relief. The burden of proof is not on the defendant but on the plaintiffs, and the court concludes that the latter have not established their claim to a prior and superior equity not affected by the estoppel heretofore found.

In regard to the suggestion made by counsel for the General Electric Company that an injunction be allowed, and its operation then suspended, thus allowing the complainants to appeal the case, the court stated that while fully appreciating the disadvantage under which the complainants stand in being unable otherwise to appeal, yet the court has no right to thus impose on the defendants the burden and expense of prosecuting an appeal from an order allowing an injunction to which the plaintiff is not entitled. The motion for a preliminary injunction is therefore refused.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

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BY CARL HEDING

ELECTRO-PHYSICS.

Discharge Through Gases.—A Royal Institute paper by Prof. J. J. Thomson is abstracted briefly in the Lond. "Elec. Rev.," April 20. He observed the discharges by means of a rapidly rotating mirror in a discharge tube of 50 feet in length, in which the velocity at the positive electrode was said to be more than 100,000 miles per second, its progress being checked near the negative electrode, where there appeared to be a reluctance to enter the electrode; in one experiment the bulb contained two electrodes projecting some distance into the tube with the ends close together, showing that the spark did not pass from end to end, but started from the end and followed the gas in preference to the electrode, to the sealed-in end, an example of which is given; he deduced the conclusion "that the conductivity of gases at a certain degree of rarefaction was greater than that of any metal and almost infinitely greater molecule for molecule." At a higher degree of rarefaction, however, conductivity is diminished and in a perfect vacuum it is probable that the discharge would not pass at all; in another experiment he showed that electrical currents crossed a high vacuum quite freely, although they produce no glow to indicate the fact.

Electric Discharges.—In a French Academy paper by Mr. Piltchikoff, abstracted in the Lond. "Elec.," April 13, and more fully in "L'Ind. Elec.," April 10, he shows a new method for studying the electric discharge, in which one pole of an influence machine is attached to a metallic point, which is held over a layer of castor oil in a copper dish connected with the other pole, in which case the surface of the oil will be deformed differently under different circumstances.

Dielectric Hysteresis.—According to "L'Elec.," April 7, Mr. Kleiner has recently published the comparative researches concerning the heating of various dielectrics used in condensers; representing the energy dissipated in ebonite (hard rubber) by 1, that for paraffine was 0, mica 0.28, glass 0.74, rubber 1.41, colophane 0, wax 0.6, gutta-percha 0.76; no values for the electrostatic forces nor the frequency are given.

Peltier Effect.—According to an abstract in "L'Elec.," April 14, Mr. Houllevigue, in an Academy paper, gives a formula to find at a given temperature the difference of potential between the metal and the same metal in a given magnetic field.

Radiophone.—"La Lum. Elec.," March 31, abstracts an article by Mr. Semmola from the Italian, in which he describes some experiments with radiophones; the experiments of others were with gases and vapors, which were submitted to a thermic-radiation, transforming it into sound; in the present paper he shows that a solid can act in the same way, a fact which he claims is not generally known; in his

experiment with a Hunning microphone, he shows that it is without doubt the simplest and most direct method.

Hydraulic Analogies.—In "La Lum. Elec.," March 17, Mr. Claude concludes at some length his paper on the subject mentioned in these columns before. A simple alternating current is represented by a vessel containing water connected with a flexible tube, the vessel being alternately raised and lowered; resistance and self-induction are shown by using a small and a large tube respectively; the effect of a capacity is shown by inserting a reservoir between the two vessels, containing an elastic diaphragm in its centre, which will yield to pressure but will transmit no liquid; a self-induction and capacity in parallel are shown by a combination of the two latter; resonance is shown in an apparatus like that for capacity, there being a stopcock in the thick tube, which is suddenly opened, thus producing an oscillatory current.

Conductivity of Discontinuous Conductors.—In "La Lum. Elec.," March 17, Mr. Branly discusses the recent article in the "Phil. Mag.," giving a resume of some prior similar researches made by himself.

Pressure in the Interior of Magnets and Dielectrics.—"La Lum. Elec.," April 7 and 14, contains a mathematical article by Mr. Lienard.

Propagation of Electricity.—An article by Mr. Poincare is given in "La Lum. Elec.," April 7.

Rapidity of Photo-Electric Phenomena.—The paper of Mr. Majorana is given in "La Lum. Elec.," April 7.

Synchronization and Resonance.—A theorem connecting the theory of synchronism with that of resonance by Mr. Cornu, is given in "La Lum. Elec.," March 31.

Work of Electromagnetic Forces.—A correction of an error in the paper of Mr. Pellat is given in "L'Ind. Elec.," April 10.

MAGNETISM.

Variation of Hysteresis with Temperature.—In a long article by Dr. Kunz in the "Elek. Zeit.," April 5, he describes in detail a long series of tests to determine the nature of the relation between the hysteresis loss and the temperature, having in a previous article two years ago shown that hysteresis varied with the temperature. Wires of different qualities were used and were magnetized in the form of a straight open circuit magnet, the iron being heated by means of an insulated coil of platinum wire, through which a current was passed, the temperatures being measured by a thermopile, which had previously been carefully calibrated by comparison with a thermometer; a complete diagram of the connections for the test is given, as also one set of hysteresis curves for different temperatures and several series of data (as the weight or volume of the iron does not appear to be given, the results are only of value relatively). For annealed charcoal iron wire some of the results were as follows: At 20 degrees C. the loss was 2,350 ergs per cycle, at

290 degrees it was 1,600, and at 836 degrees, 316 ergs; for Swedish iron the results for 20, 270 and 812 degrees were 2,690, 2,080 and 712 ergs; at about 744 degrees the results were irregular. For soft wrought iron he found the law was as follows: $L = a - b t$, in which L is the loss in ergs per cycle, t the temperature in centigrade degrees, and a and b constants for the material, which, however, depend on the maximum induction, which in this case was 3,590; for steel this law did not apply, as the rate of variation changed. He found, furthermore, that for greater inductions than the one given above, the straight line law in the case of soft iron expresses the relation with sufficient accuracy. For steel, it was found that there was a bend in the curve at about 300 degrees C., from where, up to 600 degrees, it approached that for soft iron. A series of experiments was made, in which these tests were repeated with the same iron, and it was found that for soft wrought iron there was a continual regular decrease in the hysteresis loss in each cycle (corresponding to the same temperature) up to the fourth, after which no further change could be noticed; for "patenttiegelgussstahldraht" (meaning a patented crucible steel wire) it was found that the hysteresis loss diminished in each of the corresponding cycles up to about the fifth, after which no further change could be noticed; the relation of the loss in the fifth cycle, as compared with that in the first, was as 1 to 8.3; the curve for the hysteresis as a function of the temperature had the broken characteristics of steel curves for the first cycle, but for the second and subsequent cycles it approached the curve for soft iron; this shows that after several cycles the steel takes the properties of soft iron, as far as temperature and hysteresis are concerned (it appears that the single cycle was taken at each value of the increasing temperatures, the series being repeated after the iron had gotten cold again, as distinguished from a repetition of the same cycle at each temperature). In another experiment with soft iron the first cycle was taken at the normal temperature, the second at the highest temperature, 750 degrees, and the third at normal temperature again; the area of the hysteresis curve in the second test was only one-quarter that at normal temperature, while that in the third test was two-thirds of that of the first. Some figures are also given for nickel, the curve for which is a broken line. In conclusion, he states that by means of repeated cycles, while the iron is hot, the hysteresis loss for the iron when cold may be greatly reduced; he also believes that the same can be accomplished with a single cycle at a very high temperature.

Magnetism of the Planets.—"La Lum. Elec.," March 31, contains a note showing that Mr. Leyst, of a Russian observatory, claims to prove scientifically that the other planets possess magnetism like the earth.

Magnetic Screening. Mr. Foeppel, in the "Elek. Zeit.," April 12, suggests that in recently published articles it does not appear to have been noticed that hard iron will make a much better magnetic screen than soft iron for screening delicate magnetic instruments from magnetism, citing as an illustration that magnetic flux cannot be made to penetrate to the interior of a large steel magnet.

UNITS, MEASUREMENTS AND INSTRUMENTS

Transparent Conducting Screens for Measuring Instruments.—In an Institution paper by Prof. Ayrton and Mr. Mather, reprinted in the Lond. "Elec. Eng.," April 13, they describe a varnish for coating the glass of electrostatic instruments, which varnish conducts sufficiently well to screen the needle from electrification from the outside, such as that due to rubbing off the glass. After describing a number of different unsuccessful attempts, they give the following receipts, which are claimed to give perfectly satisfactory results: it is somewhat difficult to apply the coating so that it is neither cloudy nor a comparatively poor electrostatic screen. No. 1. "Dissolve one-fourth ounce of transparent

gelatine in one ounce of glacial acetic acid by heating them together in a water bath at 100 degrees C. To this solution add half the volume of dilute sulphuric acid, which has been prepared by mixing one part of strong acid with eight of distilled water by volume, and apply the mixture while still warm to the glass shade, which should be previously polished and be warm. When this film has become very nearly hard, apply over it a coating of Griffith's anti-sulphuric enamel." Method No. 2. "Thin the gelatine solution, prepared in the manner previously described, by the addition of acetic acid (say two volumes of acid to one of solution), and after polishing the glass, float this thin solution over the glass cold. Drive off the excess of acetic acid by warming, allow the glass to cool, and repeat the floating process, say, twice. Thin the anti-sulphuric enamel by the addition of ether, and float it over the gelatine layer applied as just described. Expel the ether by heating, and apply a second layer of this thinned anti-sulphuric enamel."

The Lond. "Elec.," April 20, criticises this paper editorially and intimates that the effect of the electrostatic charge of instruments in stations has been exaggerated, being by no means a serious matter. The same issue contains a communication by Prof. Ayrton, in which he gives the results of experience with the electrostatic effect on the needle of station instruments, showing what a great error can be produced by slightly rubbing the glass; he also calls attention to the fact that the error is an unknown quantity, therefore making the readings uncertain; he also shows that the idea that a layer of oil prevents the glass from being electrified when rubbed is a common mistake (presumably he refers to a certain class of instruments not described, as the effect is undoubtedly different with different instruments).

Universal Shunt Box.—In an addition to the discussion of the recent paper on this subject published in the Lond. "Elec.," April 20, Prof. Ayrton gives some numerical examples to compare his method with the ordinary one, showing the advantages of the former, especially in connection with the discharge of condensers, in which case the controlling magnet in the ordinary galvanometer requires different correction to be made every time it is moved; the paper is discussed editorially, and while some of the claims are admitted as beyond dispute, the claim that the resistance of the circuit is less altered cannot be maintained, as the change is sometimes greater and sometimes less; the increase of resistance by using the shunt may be many times that of the galvanometer.

Astatic Station Voltmeter.—The paper of Prof. Ayrton and Mr. Mather, abstracted in the Digest last week, is published, together with the illustrations, in the Lond. "Elec. Rev.," April 20. (We call attention to the fact that the "full-sized" cut showing the scale has been reduced by about one inch, although no mention is made of it in that reprint, where it is spoken of as full-sized.)

Modified Lippmann Electrometer.—The Limb modification is illustrated in "La Lum. Elec.," April 7, the object being to adjust the level of the mercury to any desired point, which is accomplished by connecting a vessel of mercury with the tube by means of a flexible connection and raising or lowering this vessel.

Photometry.—Captain Abney's second lecture is abstracted in the Lond. "Elec. Rev.," April 13, but gives little or nothing that is new; in his opinion the Rumford method, popularly called a comparison of shadows, is as accurate, if not more so, than the Bunsen method, in which the grease spot is used; regarding the latter, he says that it is very important that the disc should be clean and perfectly free from scratchings; the Harcourt modification of the Rumford method is described, though not very clearly; he claims that errors can arise when using an illuminated opening in front of a light as a standard, as in the Methven screen; it is often

stated that the eye could appreciate one-sixtieth part of light, but this figure, he says, is not a constant, depending on the illumination; with the best light, for instance, one two-hundredth could be distinguished; he thinks that the oscillation principle is a good one in photometry, as the eye does not become so fatigued. It is quite illusory to speak of a fixed degree of accuracy of a photometer, for with a feeble light a difference of 2 per cent. is not appreciable, but with strong lights 1-2 per cent. or less can be detected.

In his third lecture, abstracted in the Lond. "Elec. Rev.," April 20, he stated that the law of inverse squares, although true in reality, was not true to the eye, because the eye had a limit; with red, green and blue lights thrown on screens it was found on cutting down the luminosity of each equally that red disappeared considerably before the green, the law of inverse squares was therefore not true when dealing with faint lights. A one-candle ether-Argand is described; air is passed over ether, forming a combustible gas, which is burned in a very small Argand burner, the top of the flame being cut off by a screen, the portion of the flame below the screen yielding a constant light, even though the height of the flame may be varied considerably; in a 10-candle pentane-Argand standard the height of the flame was varied as much as 2 inches without affecting the intensity of the light below the screen.

Photometer.—The modified Foucault photometer is described and illustrated in "La Lum. Elec.," April 7; it is a photometer for contrasting two surfaces without the employment of prisms like those in the Lummel & Brodhun.

Carcel.—According to "La Lum. Elec.," April 7, determinations of the equivalent of the carcel by different authors are as follows: Schilling, 9.6 English candles or 9.826 German candles; Le Blanc, 9.30 English candles; Monnier, 8.3 English candles or 7.5 normal German candles; Violle, 8.91 English, 7.89 German candles, 9.62 bougies decimales, 9.08 Heffner standard or 0.48 Violle units.

Measuring the Magnetic Qualities of Iron.—In a paper reprinted in the "Elek. Zeit.," April 12, Dr. Koepsel describes in detail, with the aid of a large number of curves, an instrument made by Siemens & Halske and devised by himself for making such determinations in absolute measurements by direct reading. The instrument is identical with that shown by Mr. Robinson in The Electrical World Feb. 24, page 236, but Dr. Koepsel claims to have invented it long ago.

Measuring the Difference of Phase.—In "La Lum. Elec.," March 17, Mr. Hess describes the principle of various forms of apparatus, including the theory of one of his own, for measuring the difference of phase between two currents; most of the forms have been described before.

Measurement of the Resistance of Earth Contacts.—The "Zeit. fuer Elek.," April 1, contains an article by Dr. Hiecke, in which he discusses mathematically the measurement of such resistance by means of potentials.

Cadmium Standard Cell.—The E. M. Fs. of the Muirhead & Deerlove cells for percentages of cadmium are given in "La Lum. Elec.," April 7; an amalgam of one of cadmium with seven of mercury, giving an E. M. F. of 1.0192, is preferred.

Clark Standard Cell.—A paper by Mr. Kahle is abstracted in the Lond. "Elec. Rev.," April 20; he criticises severely the Board of Trade standard and urges its replacement by the H form of cell.

Symbols.—The "Rev. de l'Electricite," March 31, reprints from a French physical journal a set of abbreviations for all the units of measurement of the metric and electric systems, by Mr. Guillaume, consisting chiefly in the use of the initial letter of the unit preceded by the letters *M*, *k*, *m* and μ for the prefixes mega, kilo, milli and micro respectively.

Electrostatic and Electromagnetic Dimensions.—"La Lum. Elec.," March 17, reprints from "Nature" a reply of Mr. Ruecker to an article by Mr. Mercadier on the relative values of the two systems.

Mirror Galvanometer.—In the "Elek. Zeit.," April 12, a description is given of a new galvanometer of Siemens & Halske with liquid damping.

Meter.—The Dejardin meter is illustrated and very briefly described in "L'Ind. Elec.," April 7; it appears to be quite complicated.

Meter.—The latest form of the Meylan-Rechniewski meter, mentioned in the Digest, Nov. 11, 1893, under the heading of the Eclair meter, is described and illustrated in "L'Ind. Elec.," April 10.

Influence Machine.—The improved machine of Mr. Bonetti, mentioned quite frequently in the foreign journals lately, is described in "L'Ind. Elec.," April 10.

Radiant Heat.—An article by Mr. Kurlbaum on a method for the quantitative determination, is abstracted in "La Lum. Elec.," March 17.

Demonstration Apparatus.—The lecture apparatus of Mr. Grimsehl to demonstrate the laws of electromagnetic induction, is fully illustrated in "L'Ind. Elec.," April 7.

Discharge Key.—An improved form of the Sabine key is briefly described in "L'Ind. Elec.," April 10.

DYNAMOS AND MOTORS.

Designing Dynamo Magnets.—In an interesting article by Mr. Marcher in the "Elek. Zeit.," April 5, he discusses in a practical manner several disputed questions; one is the statement that the outside or longer windings have the same action as the shorter inner ones; this statement, so often made, is true only for a magnetic circuit of given dimensions; if in a new construction of the magnetic circuit the lengths of the windings are shortened there will be more lines of force for the same amount of copper; he describes an experiment in which two magnet frames were wound so as to fill the whole coil space, in one case with a 2-millimetre wire and in the other with a 0.8-millimetre wire, the number of windings and the current being the same in both, and consequently the magnetic circuit was larger in the first case; the number of lines in the two cases were as 1 to 1.44; the outside diameters of the coils were 41 and 30 millimetres, showing that the lines of force increased in a greater proportion than the lengths of the windings decreased, which is explained by the fact that the leakage is greater; the consumption of energy was, of course, much greater for the smaller wire, being in the proportion of 1 to 4.45; that the larger number of lines were not due to a greater amount of energy was shown by winding the fine wire on the large coil magnet with layers of insulating material, so as to make the size of the coil and the length of wire the same, in which case the same number of lines were generated. The second point had reference to short and long cores with the same volume of winding; the mean length of the magnetic circuit was about the same in both, but the mean length of the windings was about as 1 to 1.36, therefore requiring more copper in that proportion; the result of this test showed that the core should be as close as possible to the return magnetic path (including the armature) as is possible without increasing the leakage too much and that the space between them should be fully filled with the windings; from this the length of the core will be given. The third point had reference to hollow magnets; he shows by means of a very rational set of experiments, that the statements which have been made to the effect that hollow magnets are better than solid ones are entirely wrong and misleading when applied to dynamo construction; these tests are fully described and illustrated and would seem to settle this question beyond dispute in favor of solid magnet cores, the conclusion being that the smallest amount of wire will be required when solid, round,

massive cores are used. A rather odd shaped ironclad dynamo, constructed according to the above principles, is shown in the article.

Alternating Current Motor.—The results of the test of the Joel motor (described in the Digest July 1, 1893) are given in the Lond. "Elec. Eng.," April 20; it yielded somewhat less than 1-2 per cent. with an efficiency of about 35 to 40 per cent.; the starting torque with the armature at rest as compared with that when running was about as 4 to 2.3.

Substitute for Brushes.—The Roberts collector is described and illustrated in "La Lum. Elec.," March 31; in place of commutator brushes, two flexible metallic belts or cords, guided by pulleys so as to touch the commutator only in a few sections, are used to replace the brushes.

ARC AND INCANDESCENT LIGHTS.

Lamp Filaments.—According to "La Lum. Elec.," April 7, the oxides of the rare earths utilized in the Auer incandescent gas burner, may be incorporated in the filaments by immersion for 48 hours in a warm solution of 20 parts of nitrate of magnesium, 10 zircon, 10 oxide of lanthenum and 50 of water; if treated before carbonization they should be treated again afterward; the object is to increase the light and the life.

Gas vs. Electric Lights.—According to the "Zeit. fuer Elek.," April 1, the relative costs are as follows: In Berlin 1.25 to 1, Hanover 1.46 to 1 and Cologne 1.88 to 1 (presumably incandescent lights are referred to).

Small Current Arc Lamp.—The Buchet lamp for 2 to 4 amperes, is described and illustrated in "L'Ind. Elec.," April 10; it is very highly spoken of.

Cance Lamp.—The new type of this lamp, which is largely used in France, is described and illustrated in "L'Elec.," April 14.

Alternating Current Arc Lamps in Parallel.—In Mr. Carter's serial in the Lond. "Elec. Rev.," on arc lighting, he discusses this subject.

Workshop Lighting.—According to a description in the Lond. "Elec. Rev.," April 20, a large machine shop in Bolton is lighted successfully with the inverted arc lamp, the light being reflected by a white enamelled reflector.

ELECTRIC RAILWAYS.

Underground Sectional Railway System.—The Rast system is described in the "Elek. Anz.," April 8; it is claimed to be no more expensive than the usual overhead arrangement and is spoken of very highly by a well known German expert; there is no conduit, the current being taken from insulated sections on the surface which are connected to the line when the car passes over them, by means of a magnet on the car and a switch operated by the same, inclosed in underground boxes.

Underground Line in Berlin.—According to the "Elek. Tech.," March 15, a concession has at last been granted for the first part of a system of electric underground lines in that city.

Paris Accumulator Lines.—In a lecture by Mr. Deri, reprinted in the "Elek. Tech.," March 31, he gives some data regarding these lines.

Electric Traction in England.—The Lond. "Elec. Ind.," April 1, contains the first part of an article by Mr. Wilkinson, in which he deals with the past of electric traction and its future in England; frequent references and comparisons are made with this industry in the United States.

Electric Vehicle.—The conditions for the prize competition offered by a French daily journal for small vehicles containing their own propelling power are published in "La Lum. Elec.," March 31.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Rotary Field Installation.—According to Mr. Dahlander, in an article in the "Elek. Zeit.," April 5, the late Mr. Wenstroem was an independent inventor of the rotary field; the company in Sweden operating his inventions has been build-

ing such motors since 1890. Their first installation, which is described and illustrated in that article, has lately been completed; a water power is transmitted to the villages of Hellsjoen and Graengesberg in Sweden. A short abstract of this article is given in the Lond. "Elec. Eng.," April 13.

Rotary Field Currents.—In his serial in the "Elek. Anz.," March 29, on a universal physical fundamental law, Mr. Schwartz discusses the subject of the rotary field currents and shows mathematically that it is absurd to talk of a saving of 25 per cent. in the line wire when the system requires 30 per cent. more coal.

The Central Station Question in France.—In an article in "La Lum. Elec.," April 14, Mr. Claude discusses the causes of the somewhat unsatisfactory condition of the central stations (presumably in France), and suggests remedies.

Country House Electric Lighting.—In a paper by Mr. Acourt reprinted in full in the Lond. "Elec. Rev.," April 13, he discusses the various sources of power, the apparatus and the estimated costs for private plants in mansions outside of the cities.

Three-wire System with a Single Dynamo.—The system described and illustrated in the Digest Feb. 3, is described more in detail, together with some calculations and a number of illustrations, in "L'Elec.," April 7. An abstract is published also in the Lond. "Elec. Eng.," April 13.

Best Frequency.—An abstract of a translation of the article by Mr. Kolben (see Digest, March 10), together with the curves, is given in the Lond. "Elec. Rev.," April 20.

Cost of Energy in Stations.—The Lond. "Elec. Rev.," April 20, publishes a translation, including a large table, of the data regarding six large stations in Germany, mentioned in the Digest Jan. 27.

Interruptioners.—In "L'Elec.," March 31, Mr. Leroy calls attention to the difficulties in making a minimum current interrupter (such as is used for accumulators, for instance), and describes a means of overcoming the difficulty by the automatic insertion of shunts, the apparatus being thereby made much more sensitive and sure; a diagrammatic illustration accompanies the article.

Windlass for Suspended Arc Lamp.—A novel form is described and illustrated in "L'Elec.," April 14; it can be turned only one way by means of a removable crank and cannot be lowered by any one except with this crank; to lower it a friction brake is released by means of the same crank.

Elevator.—The Tylan elevator is described briefly in "L'Elec.," March 31; it provides for starting and stopping the machinery gradually.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Best Resistance for Receiver on Leaky Telegraph Lines.—In the Lond. "Elec.," April 20, Dr. Sumpner gives a simple proof of the statement made by Prof. Ayrton and Mr. Whitehead in their recent paper (see Digest April 28); it is also discussed editorially. In commenting on this paper editorially the Lond. "Elec. Rev.," April 20, calls attention to what it terms a great omission in not pointing out that while that resistance may be the best to give to an instrument, it ought also to have been stated that a very considerable departure from that value could be made without any material effect being produced upon the efficiency of the apparatus; as an example is cited the well known law about the maximum sensitiveness of a galvanometer being arrived at when its resistance is equal to that of the external circuit, and that it has been shown that this maximum law may be very largely departed from without very greatly affecting the sensitiveness of the instrument.

Telephone Meters.—In "La Lum. Elec.," March 31, Mr. Hess discusses the subject and describes several meters for different purposes.

Rewinding Mechanism.—The system of Denezet for electrically rewinding telegraphic mechanism requiring mo-

tive power in the form of a weight, is described in "La Lum. Elec.," April 7.

Submarine Cables.—An article on the Pacific cable is contained in the Lond. "Elec. Rev." and "Elec. Eng.," April 20. The Lond. "Elec.," April 20, gives some data regarding the new Atlantic cables to be laid this year. The Lond. "Elec.," April 20, gives a short account of the cable steamer Duplex.

Block System.—The Fletcher system is described and illustrated in "La Lum. Elec.," March 31.

Clocks.—A new contact device for standard clocks is described and illustrated in the "Elek. Anz.," March 15.

ELECTRO-CHEMISTRY.

Accumulators.—The Roe & Surtro accumulator is described and illustrated in "La Lum. Elec.," March 17. The Pet-schel accumulator is described and illustrated in "La Lum. Elec.," April 7.

A New Depolarizer.—The "Elek. Tech.," March 31, mentions but does not give the composition of a new depolarizer of Dr. Oppermann; it is said to give double the current strength of a Bunsen cell at 1.9 volts, it gives off no fumes, and has less powerful action on the materials than nitric acid has; the consumption of zinc is said to be very much reduced; as exciting liquid he uses a concentrated solution of kitchen salt in place of the sulphuric acid; the cost of his depolarizer is not more than that of strong nitric acid, although it is said to have three times the output.

Lighting from Primary Batteries.—A system in which primary batteries are used to charge accumulators, is described in "La Lum. Elec.," April 7.

Electrolysis on Organic Substances.—The Lond. "Elec. Rev.," April 20, summarizes some recent work in this branch, among which are the reduction of nitro-benzene, for which it gives the formula; the production of aniline, the oxidation of glycerine and the reduction of aromatic nitro-compounds.

Electrolyzer.—The Blockmore and the Cutin apparatus are described and illustrated in "La Lum. Elec.," March 17.

Aluminium.—The serial of Mr. Richard, in which a number of furnaces are described and illustrated, is continued in "La Lum. Elec.," April 7.

Elmore Process.—The "Elek. Anz.," April 5, reprints a lecture by Dr. Feldmann on this method of copper deposition.

Chlorate of Potash.—In Savoy, France, an installation is being erected for the electrolytic production of chlorate of potassium.

Velocity of Ions.—The Lond. "Elec. Rev.," April 20, abstracts briefly a paper on this subject.

MISCELLANEOUS.

Cooking.—According to a note in the Lond. "Elec.," April 20, Mr. Crompton claimed that the English were far ahead of the Americans in electric cooking apparatus. He uses three kinds of enamel, the hardest is first laid on the plate, the conducting wire is then spread upon it, a second coat a little less hard is laid over it, and, finally, a coat of white enamel is spread over all; he uses nickel-steel wire in place of copper or other metal; he claims that his success is due to a method for crimping and laying the fine wire by machinery on to a dummy plate and then transferring it bodily to the enamel.

Welding.—In an installation at Bolton, mentioned in the Lond. "Elec. Rev.," April 20, a current of about 25,000 amperes at about two volts is required to weld a shaft 2 1/8 inches in diameter, representing 67 h. p. for two minutes.

Electricity in the Navy.—It is reported that every gun on future warships of the English Navy will be equipped with electrical appliances.

The Johnson-Lundell Electric Railway System.

For some time it has been known among electrical engineers that a novel system of electric railway traction was under experiment on a track installed on private grounds in the upper part of New York City. Considerable curiosity has been manifested as to the details, particularly as it was reported that the practical tests carried out on the experimental road have given results entirely satisfactory to those pecuniarily interested. The system is the invention of Messrs. E. H. Johnson and Robert Lundell, the former so well known as one of the pioneers in the introduction of the electric light, the trolley railway and the interior conduit system of wiring, while the name of the latter is familiar in connection with the Lundell dynamos and motors, which have been so favorably received by the engineering profession.

The track of the experimental road referred to runs around a whole city block, with stiffish grades and with difficult curves of necessarily short radius. The power house is at the foot of the hill and at the centre of that section of the track or circuit. The generating plant comprises a vertical engine driving directly a pair of Lundell dynamos, the unit being such that it could be enlarged on exactly the same proportions up to any size for any road. By means of the interior conduit telescopic iron tube, current is carried to the



CAR AND TRACK OF JOHNSON-LUNDELL SYSTEM.

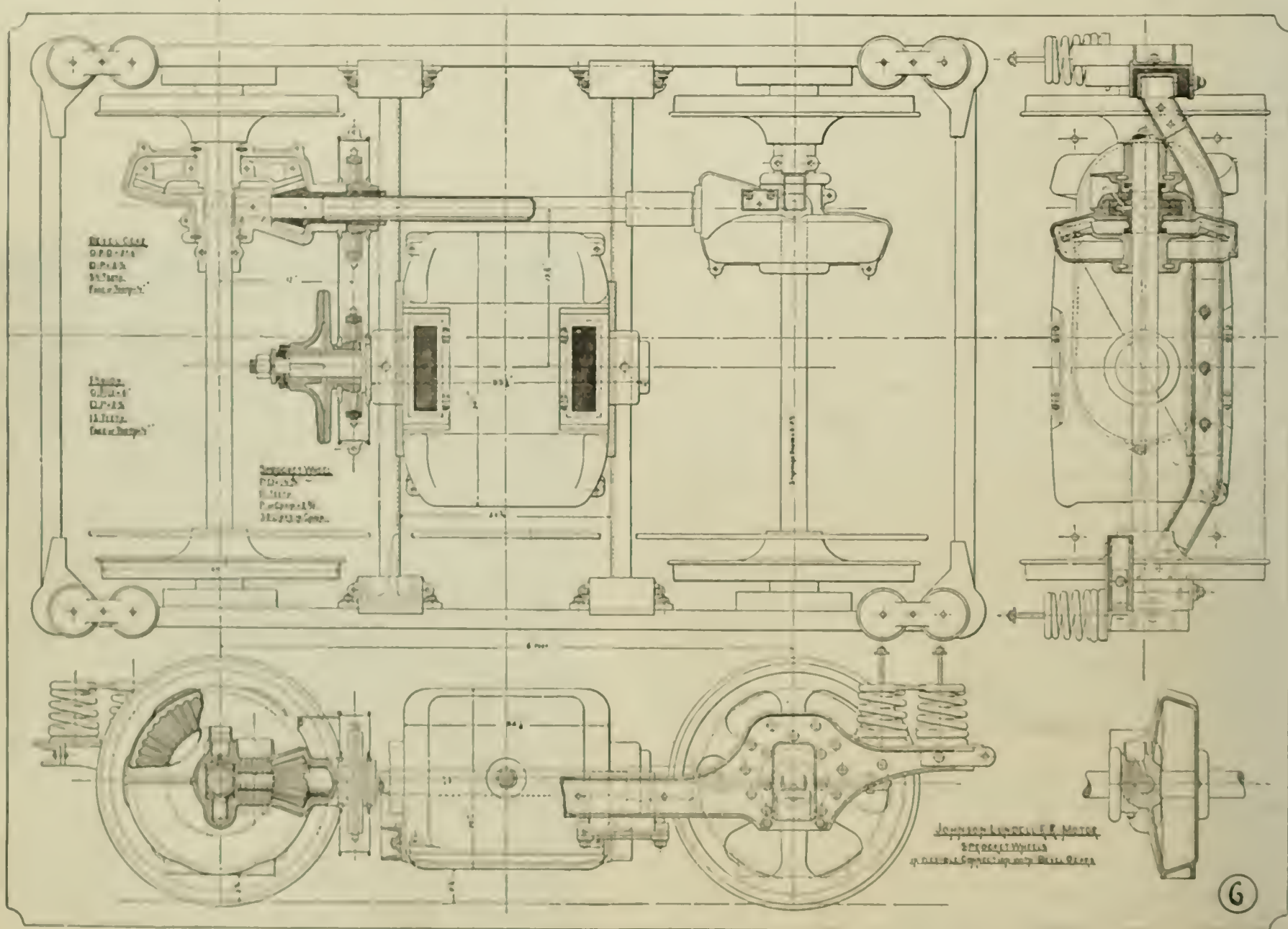
track at the proper points of feeding, and is distributed without any loss due to leakage or conduction, owing to the high insulation of the ducts. The track itself is of ordinary construction as to the rails. Between the rails it is asphalted or paved and parallel with the rails lies a conducting bar or strip of metal embedded in the asphalt. This bar is level with the surface, and is divided up into sections with insulating blocks of stone or other material between them. Just outside the single track, or midway between the double tracks, are plain, watertight boxes with iron covers flush with the street surface. In these boxes are substantial electromagnetic devices which deliver current to the section of the track it governs, as the car comes along, and then lie quiet until the succeeding car rolls up. The car carries a pick-up rubbing brush, which leads the current into the motor and takes the place, or fulfills the function, of the trolley pole wheel. The road is not alive anywhere except

at the point over which the car is passing. Moreover, the difference of potential between the two sides of the circuit between which the car moves is practically and actually nil; hence there is no danger to horse or passer-by.

The car has but one motor, a feature toward which all the first-class electrical inventors have been directing their energies for years. This motor is central under the car and drives on each axle by means of bevel gear, and with sprocket wheels and link chain in flexible connection with the same. Its suspension is flexible, the bevels are boxed, the sprocket wheels and links mesh noiselessly; and by means of a bipartite screw coil in close relation to the armature shaft, the motor, though capable of instantaneous arrest or sudden starting, never moves off or stops with a jerk. It sustains no jar, no sudden rush of current, no heavy short circuiting, no swift reversing and consequent breakdown. The spring coils are an efficient buffer between it and any

plicated and troublesome wiring at crossings, switches, steam railway tracks, etc. If the car has not sufficient headway to run over a crossing, the battery will do that, just as it will keep the car going should it be deprived of central station current or even put on a line that is without electricity.

One of the claims for the system is the absolute and immediate control of the car which it gives. The apparatus is so combined that when the motorman wants to use his brake, the propelling power at once becomes his ally. To-day, on the ordinary trolley car, no motorman dare reverse his car, because if he does he will have neither motor nor position left. What is needed is that the motor shall first stop, and then reverse its direction of rotation while the car may be traveling onward. To do this there must be an interval of free elasticity, however brief, so that while there is a sequence of effect it is so gradual that nobody could tell



PLAN AND ELEVATION OF MOTOR TRUCK.

danger. The motor is, moreover, iron-cased and protected against dirt, stones, moisture, etc.

Underneath the car is a steel brush which gathers up the current and passes it up into the motor, the return being as usual through the rails, which are obviously harmless, as the conducting strip between them is only alive when a car is right over it. But the car is not dependent merely upon the supply of live current. Under the seats are frames holding a very simple elementary form of lead storage battery, enough to furnish the voltage at which the motor runs—300 volts—and though with very few plates in each cell, giving considerable capacity, which can be called upon to carry the car through emergencies. The batteries perform several functions; the battery "picks up the circuit" for an instant when starting, lights the car, and, above all, renders it at once self-contained and dispenses with the usual costly, com-

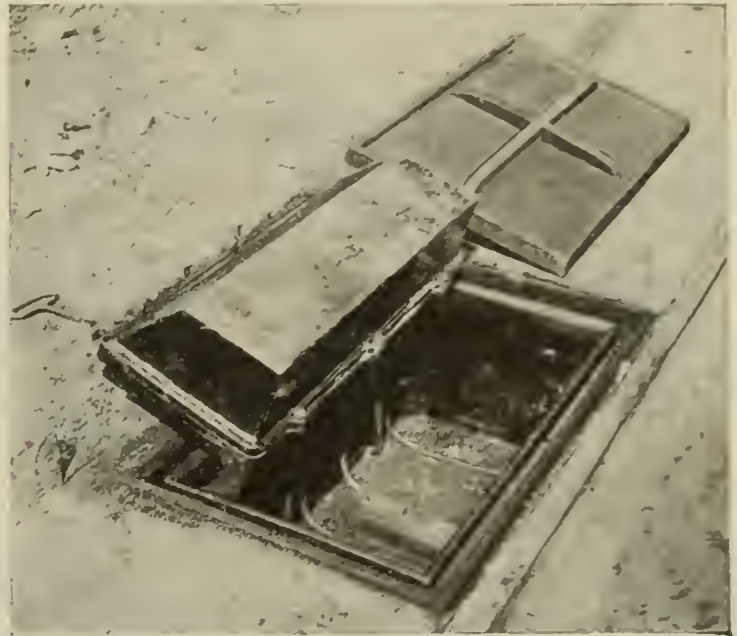
when the moment of reversal began and nobody would know that the car had smoothly followed suit until it had come to a halt or gone backward. This is done in the Johnson-Lundell system, not by any auxiliary apparatus, but by the motor itself, so that all the motorman has to do is to pay attention to the one handle of the switch stand in front of him on the platform. At sight of anybody on the track before him, the driver turns the crank handle, when the motive power at once begins to head the car the other way—although its momentum may apparently be urging it onward. Such a form of equipment is superior, in securing safety for the public, to any brake or car fender that could possibly be imagined.

As to the first cost it is claimed that the Johnson-Lundell system compares more than favorably with anything that has gone before. To install it well involves a liberal expendi-

ture, but the outlay is small compared to that for the cable system, and on practically equal terms with that of a well built trolley road. There is no deep excavation, there are no poles to set, no overhead wires to maintain, no trolley poles and wheels to renew. The conducting strip along the track does not scrape away in any perceptible degree, and the steel brush will perhaps wear to a stub after a great many months' use. The magnet boxes have nothing to wear out except strong little contact jaws, and the iron tubes are a solid protection to the feeders. On the cars the gears are liable only to the usual wear, and to less than that, as the elastic connection prevents any grinding or stripping action. The battery is under the most favorable conditions that could well be conceived. It gets no strain, and little work, but when the opportunity presents itself, it is always fresh and ready. Besides, the use of but a few plates in the batteries on these cars greatly simplifies the conditions of their care. Another feature is that each car has its single set of batteries and does not have two or three other relay sets lying around a large central power house to be charged, occupying time and space and attention. What charging these batteries get is given on the road while the car is at work.

The rapid depreciation of cables and grips in the cable system, and of poles and overhead wiring in the trolley system, is a fact very familiar to all street railway men. In the trolley system, the item of depreciation has been very often abnormally large on account of the racking of the motors and their burning out. The line renewal, however, in the Johnson-Lundell system becomes, it is claimed, as insignificant as it does in underground conduits generally, where to-day the rental and not the renewal is the only item that is thought of. As for the motors, they are no longer subject to rapid depreciation, having between them and the evils they have been liable to a method of resilient gearing that

The independence of weather considerations of this system was illustrated by its trial during the past winter. The winter was a wet one with rapid fluctuations. Mere snow or ice in cold weather is little test of a system, as dry snow and ice are good insulators and are easy also to clean out of

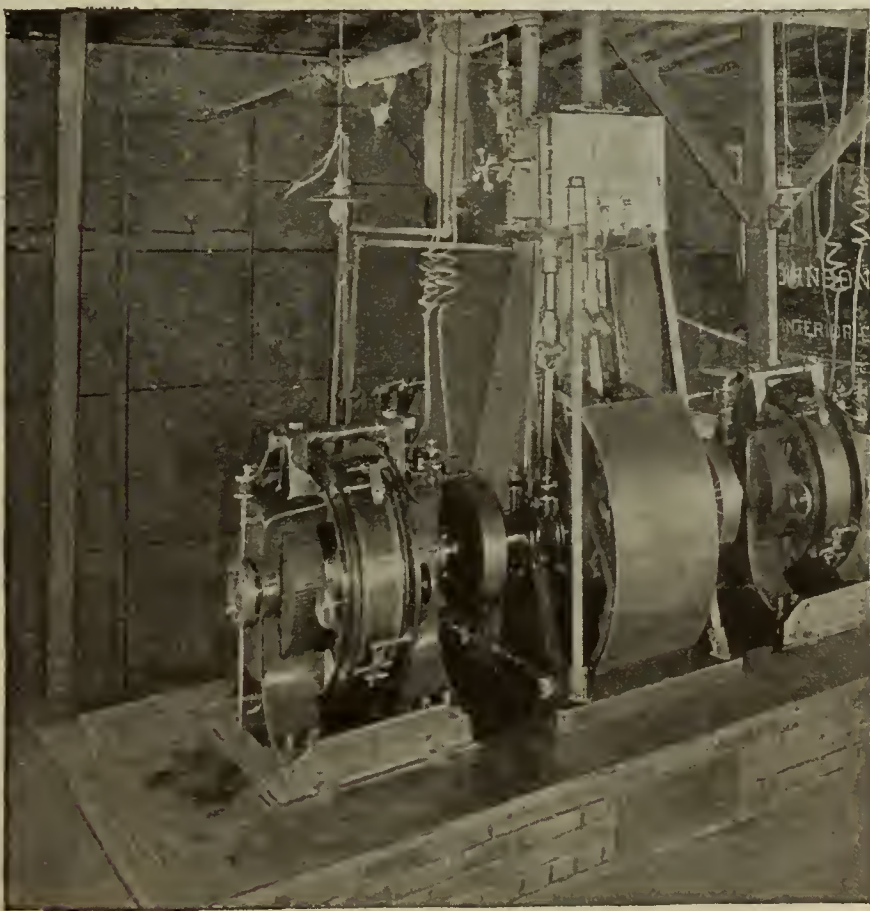


SWITCHBOX IN POSITION FOR INSPECTION.

the way. But wet snow and soft ice, such as the last winter saw so frequently, are the bugbear of the electrician. Yet the Johnson-Lundell car ran through it all, day in and day out, and apparently the better when the days were wettest. All the track views here shown have been made from photographs taken in winter time; yet, as will be seen, the car ran through thick snow, the switch boxes were opened up and exposed, and all manner of severe tests made with the utmost ease and success. If the car went on running for years the demonstration of practicability could not be more effective or conclusive.

It is claimed that the cost of operation is moderate. The storage batteries are reduced to their simplest form, given their lightest work and put where the least attention is required. No construction or repair gangs are needed to patrol and repair an overhead line, and the single motor reduces this item of expense. Another point is that the motor starts the car with but a normal supply of current, and hence its power and weight, as well as the generating plant and attendance, are less. It is claimed that the special winding of the motor under this car gives it all the flexibility of two motors, as its coils when thrown into series and into parallel by means of a new form of series parallel controller accomplish all that has been aimed at in that device through its various modifications, although it is only now that the drawbacks are avoided of having to consider and deal with two mechanisms. It is obviously also more economical to vary the conditions of speed and current in one motor than in two. In the Johnson-Lundell system of car control, all the mechanisms and operations have centred in the one handle. Hence the strain on the nerve and intelligence of the motor-man is less, with less liability to accident.

Other advantages enumerated for the system are that as every car has a reserve of power each becomes an independent unit, thus securing a gain in flexibility, freedom from blockade, etc., unlike a trolley car when cut off from its supply; the motor is a very quiet one and the pick-up brush and magnets in the switch boxes give forth no audible noise; the only evidence on the street that the system is an electric one is the little strip central between the ordinary car rails. Other points of superiority over the trolley and over other conduit systems are claimed, and supported by very thorough tests under the most unfavorable conditions during the past winter.

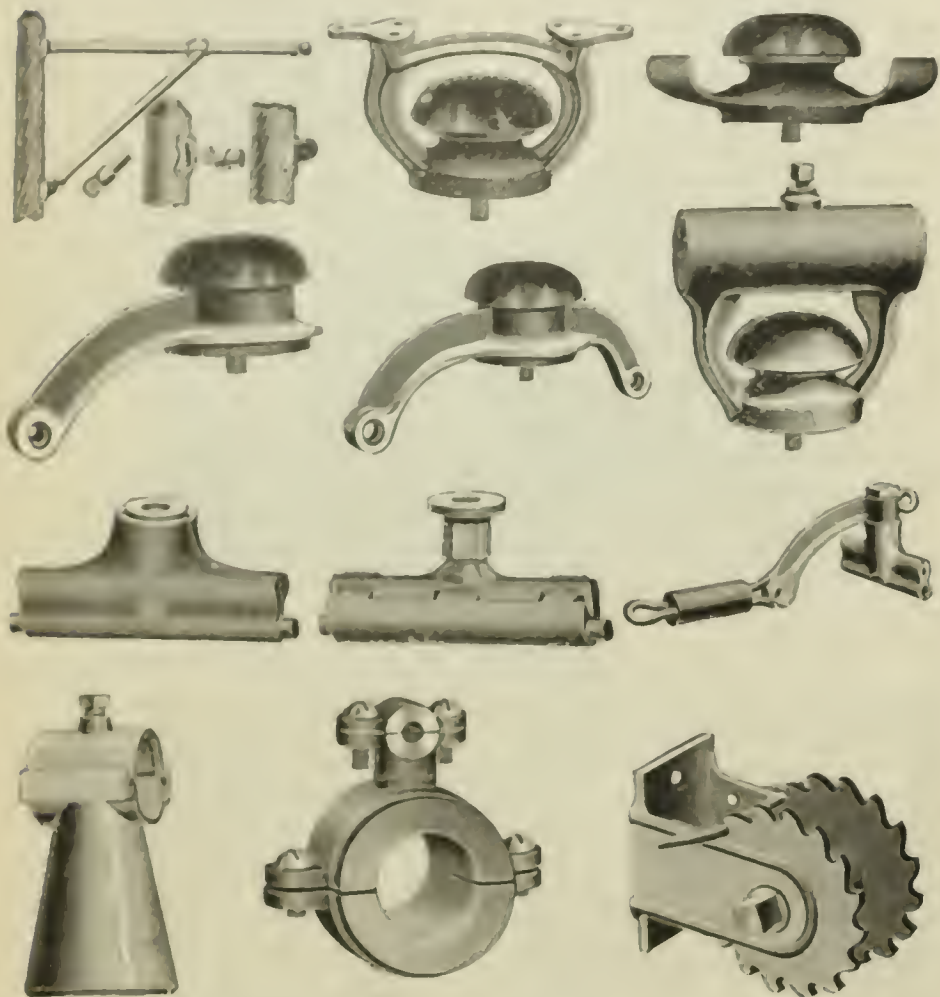


GENERATING PLANT.

cushions them against any abrupt action or onslaught, and whose presence at once absolves from the readjustment of mechanical parts the use of levers, the renewal of brake shoes, etc. The central conducting rail or strip should undoubtedly have a very long life. It is by no means as liable to the hammering of traffic as a cable slot, for the reason that being a thin edge, so to speak, no horse or wheel is likely to occupy itself long in the effort to balance upon it.

Street Railway Fittings.

We illustrate herewith some of the street railway line fittings manufactured by the Ohio Brass Company, Mansfield, Ohio, whose use will be apparent, as well as their efficient design. This company is noted for the character of



STREET RAILWAY FITTINGS.

its fittings, not only as to material, but also as to design, and it manufactures an unusually complete line, including numerous forms of trolley hangers, switches, and cross-overs.

A New Arc Light Dynamo.

Arc lighting machinery has not received of late years the attention it formerly did, owing, no doubt, to the great developments in other branches of electricity; but more recently renewed interest in the subject seems to have been awakened, and we illustrate herewith a new constant current arc light dynamo and regulator, the invention of Mr. Force Bain, and manufactured by the Great Western Manufacturing Company, Chicago.

The regulator is said to be sensitive and at the same time positive in operation, and will maintain a constant current independent of the number of lamps in circuit. The machine may be run indefinitely on an absolute short circuit without injurious results. The field is of the salient pole, horseshoe type, cast in one piece. The armature is large in diameter and strongly built, it is of the Gramme type having independent coils, and a large number of them, by means of which a very steady current is produced. The brushes, or collectors, are made of carbon and are so placed as to produce a constant lap on the commutator.

The automatic regulation is performed by the movement of the brushes around the commutator. The motor device, to accomplish this movement, is operated by means of a small belt connected from the armature shaft to a larger pulley, as shown in the illustration. In the rotation of this larger pulley a ratchet bar is reciprocated, the small ratchet of which is held out of engagement with the ratchet wheel by means of two elliptical springs on either side of the armature, placed between two pairs of electromagnets. The

ratchet wheel is connected by means of a shaft, not shown in the engraving, to a small pinion which engages in gearing cut on the rocker arm which carries the brushes.

The directing device, shown under the connecting board, which is mounted on top of the dynamo, consists of a small iron bar suspended immediately over the armature; this director controls two contact devices, shown on the top of the connecting board, which operate to short circuit both electromagnets when the machine is working under normal conditions.

The thumb nut, on the right hand side of the engraving, and just below the connecting board, illustrates a means of adjusting the value of the current while the machine is in operation. This thumb nut is connected by means of a bar and a spiral spring to the director bar and tends to hold it in a position opposite to the position that the bar would assume by an increase of current in the armature.

The operation of the device is as follows: When the machine is first started the spring connected to the controller pulls the controller bar into a position approximately parallel with the path of the current circulating in the wires of the armature. When the current in the armature has assumed a given value, which is predetermined by the tension of the spring, the deflecting bar is deflected from a line parallel with the current in the armature to a line slightly at angle therewith; before it has been deflected, however, to the position described, the contact above the deflecting bar has been opened by the deflecting bar being out of the position it assumes when the machine is operating under normal conditions. An open contact above allows the current to pass through a pair of electromagnets, on the right hand side of the armature, situated between the two pairs of electromagnets. The current circulating in this pair of electromagnets attracts the armature toward them and engages the ratchet device in the ratchet wheel and quickly gigs the latter, in this case, in clockwise direction, which moves the brushes to a point on the commutator corresponding to the highest potential. If the external resistance is such that the current may be maintained with a lower voltage than the maximum of the dynamo, the current tends to rise above its normal value and the director is deflected to a still greater angle, which causes the contact controlling the electromagnets on the



BAIN ARC LIGHT DYNAMO.

left hand side of the electromagnetic armature to be closed, and at the same time, or possibly a period later, the contacts controlling the electromagnets, on the left hand side of the armature, are opened, allowing the current to pass through them. They then attract the armature, which causes the double ratchet to engage in the ratchet wheel in such a way as to cause the wheel to move in an opposite direction from that just described, by means of which the brushes are

moved forward on the commutator to a point where the E. M. F. is just sufficient to maintain a constant current through the resistance contained in the circuit. When the machine is operating through a circuit which is substantially unchanged, the brushes remain quiet and the only moving device is the crank wheel and the reciprocating bar which holds the ratchet, as the ratchet is held out of engagement until one or other pair of the electromagnets are energized.

The director device may be adjusted at any time while the machine is operating so that it will maintain a constant current within a range of 20 per cent. of its rated capacity.

Cutter's Arc Insulator.

Most arc lamp users have felt the need of a good device for insulating the frame of the arc lamps from the hoisting rope or the supporting arm, so as to reduce the chances for grounds in wet weather. The arc insulators now in the market and the substitutes known as break insulators are readily covered with a film of moisture on rainy days, so that at such times they are very inefficient. George Cutter, of "The Rookery," Chicago, has devised a new form, which, it is claimed, avoids this source of trouble. Our illustration shows the new type, which is only twice the size of the cut. The insulator proper is made of hard rubber, which is less likely than glass to have a film of moisture form on its sur-



ARC INSULATOR.

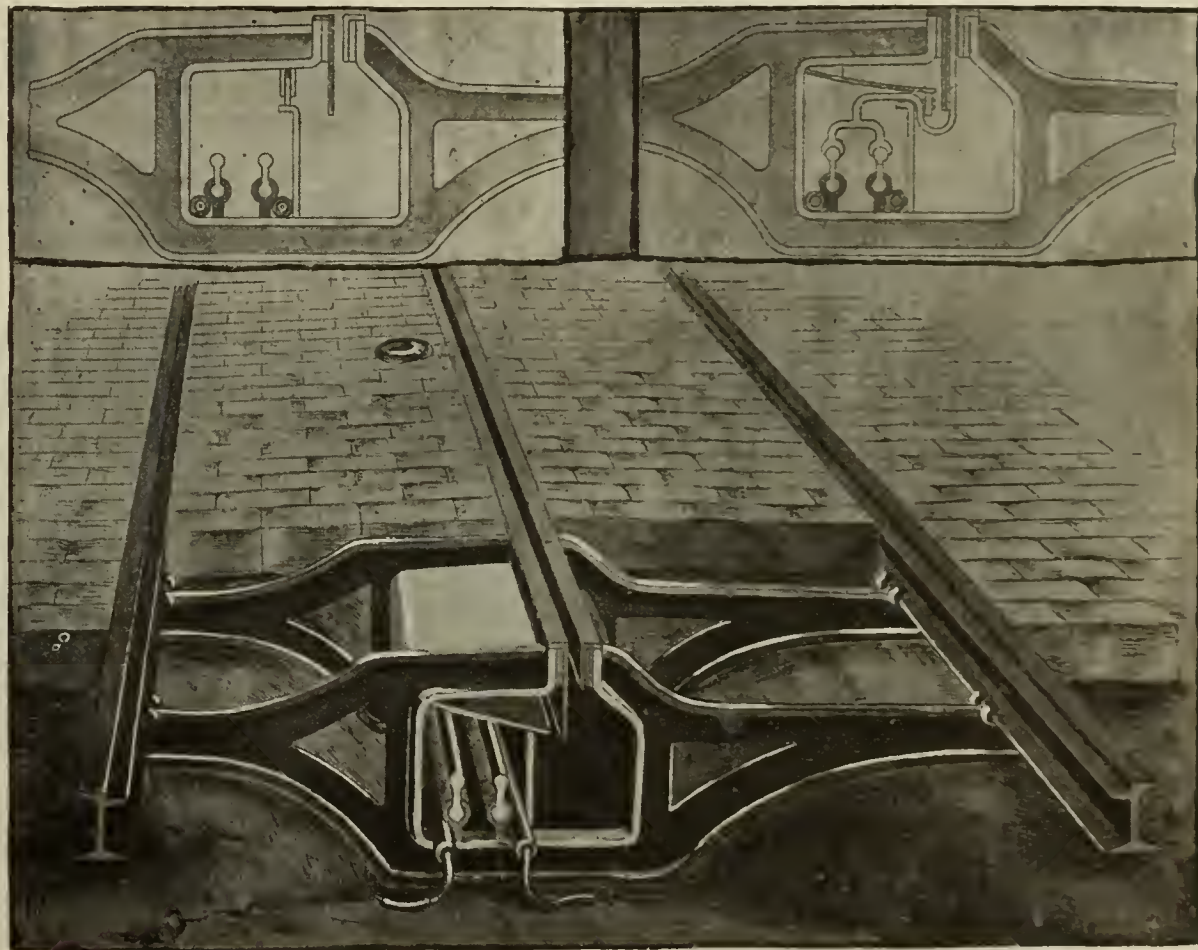
face. The double petticoat gives a good water drip, so that the moisture cannot creep across the lower surface. All parts are planned for ample strength, the eye at the top and the snap hook at the bottom being threaded into bushings, which are moulded directly into the rubber, and the whole device seems well suited to the needs of the case.

Street Railway Conduit System.

The chief objection to underground railway systems has been the leakage resulting from the accumulation of moisture and dirt in the conduit and the consequent difficulties of insulation, and this trouble has been so serious that it has prevented the introduction of conduit systems for traction work. Mr. H. Petersen, proprietor of the Petersen Electrical Works, Milwaukee, Wis., has invented a system, which, it is claimed, successfully obviates this difficulty. The chief

aim of the inventor has been to guard against the effects of moisture and dirt, and it will be seen from the accompanying illustration that the principal feature of the system is its construction in two longitudinal compartments, one of which is arranged to contain the electrical conductors and the other to carry off the water. The latter conduit is connected at frequent intervals with the sewers and a steel broom attached to the car is arranged to sweep any accumulations of dirt into this compartment and deposit it in the sewer. The second compartment is out of line with the slot in the conduit, so that water cannot fall upon the conductors.

The partition between the two compartments is closed, being automatically opened by the trolley arm upon the car when it passes along. This is accomplished in the conduit shown in the lower portion of the illustration by vertical strips of metal of a suitable length joined and adapted to be raised between guides. This effectually prevents the water from entering the compartment where the conductors are placed. As the temperature is practically the same as that of the wall of the conduit, it is not thought that condensation will take place to any noticeable extent. Under very bad conditions it could easily be arranged to circulate air through this compartment, but it is not thought that this will be necessary. In the upper right-hand corner of the illustration a slightly different device for separating the two



PETERSEN CONDUIT.

compartments is shown, consisting of a flexible cover, which normally rests on the division wall, but is raised on the roller carried by the trolley arm as the latter passes along.

It will be seen that iron or steel contact rails are used instead of copper wires for the conductors. These are divided into sections of 100 feet or any convenient length, and each section is tapped on to two main feeders and provided with a switch and safety cut-outs placed in manholes, so that in case of any trouble one section can be cut out without delaying traffic on the whole line. There are a number of different ways in which the contact rails can be held in position. In the illustration two brackets are supported on two yokes and held in position by insulating material. The whole compartment is finally coated with waterproof insulating paint and the main feeders are laid in pipes. The depth of the conduit is considerably less than that required for a cable road.

The trolley arm, as shown in the illustration, is provided with two contact arms, which nearly surround the upper part of the contact rail, so that they will not jump the conductor. They are also provided with a swivel arrangement to take up any unevenness in the track and springs are provided to keep them in proper contact with the conductors. The shape of the trolley arm will be seen from the illustration. From each contact shoe wire is carried through the hollow arm to the motor and at each end the arm is hermetically sealed. The motorman can, by moving a lever on his platform, lift the contact carrier out of the conduit at the man-hole without delaying the car more than a few moments.

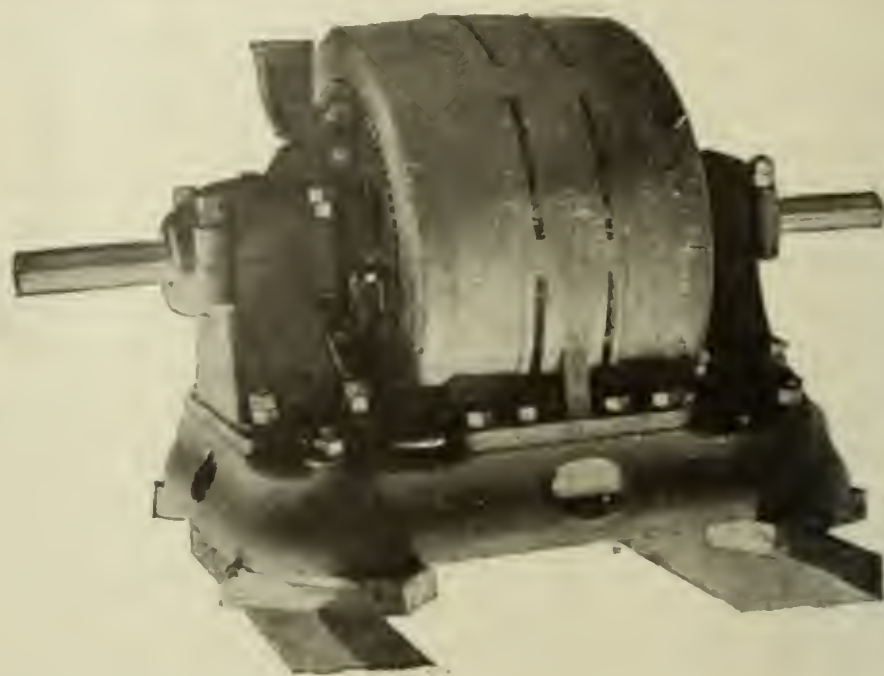
Electrical Power Transmission at Columbia, S. C.

In our last issue we referred to the important electrical transmission plant being installed for the Columbia Mills at Columbia, S. C., and illustrated the turbines. We now add some further details, including illustrations of one of the generators and one of the 65-h. p. motors.

The total amount of power to be transmitted is over 1,000 h. p., and it was decided to divide this into two units at the generating station. Consequently, two special slow-speed triphase generators were designed to meet the requirements of the case by the General Electric Company. One of these colossal machines, of 500-kw. capacity, is shown in Fig. 1. It has forty poles and operates at a normal speed of 108 revolutions per minute, giving 36 cycles upon the line, at a voltage of about 575 at the dynamo terminals.

The armature is 10 feet in diameter and is of singular and massive construction. It is of the ironclad type and is wound with a single bar per slot, heavily insulated, a con-

huge machines were a matter of no small difficulty. A wrecking car lent by the railroad company enabled them to be unshipped from the cars, and they were then slowly moved, as one would move a house, along a somewhat circuitous route to their final position, where huge temporary shears were erected to place them upon their foundations. Fig. 3 shows one of the generators just placed in position.



65-H. P. MOTOR.

the power house proper not yet having been placed over them. The power plant consists of two pairs of 48-inch cylinder gate Victor turbines, made by the Stilwell-Bierce & Smith-Vaile Co., which are directly connected with the generators. The generating station is connected with the



500-KW. GENERATOR.

struction which gives practical freedom from burn-outs and other electrical difficulties. The total weight of the machine is about 100,000 pounds.

Two of these huge machines were completed in the early part of the present year and shipped to Columbia, where the turbines (shown in position in Fig. 2) were nearly ready to receive them. The transportation and erection of these

mill by an underground conduit of planking, protected by pitch and asphalt, the bare wires being placed in position in a bedding of asphalt. The conduit thus constructed rests on a blind drain, and is carried across the canal to the power house under a bridge, which is there erected.

In the mill there are 17 65-h. p. motors hung overhead and driving sections of line shafting with direct belting. The

speed of the motors is 535 revolutions per minute, and varies less than 2 per cent. from full load to friction load. These machines have neither commutators nor collecting rings, and even the armature rheostat requires almost no attention, inasmuch as it is operated from the floor by means of a lever thrust into the switch socket.

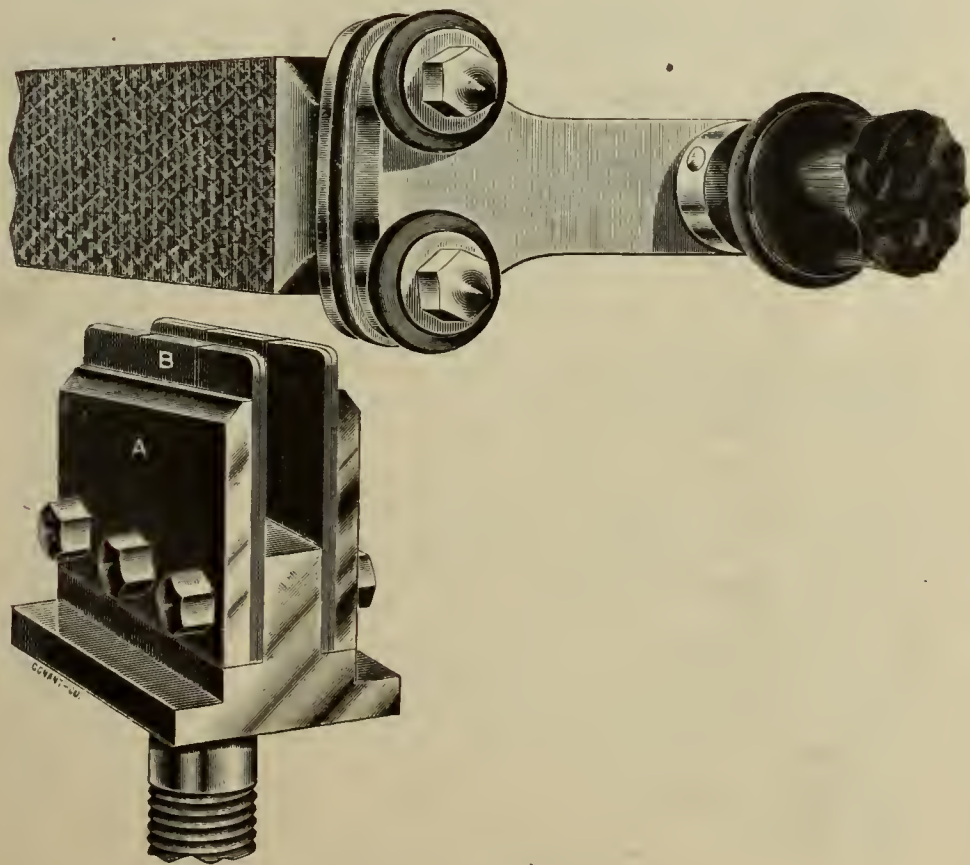
All interior wiring is in conduit tubing, and the switches are boxed in. In addition to the motors, several hundred lights are wired in the mill, and can be operated either from the main circuit or in part from either of the two 25-h. p. exciters, purposely provided with surplus capacity.

The mill is not yet all in place, but on the 24th of April the big generators were started and the motors given a preliminary spin.

An Improved Switch.

We herewith illustrate one of the latest improvements in the line of switches by the W. S. Hill Electric Company, letters patent for which have just been issued bearing the date of April 24, 1894.

The first feature in the invention is the manner in which the two or more blades are secured to the yoke so as to obtain rigidity, and keep all the blades in proper alignment while the switch is being operated. By the old method of securing the blades to the yoke (to which the handle is attached) by a single bolt or screw in each blade, there was nothing to prevent the twisting of the blades, thus allowing one to move in advance of the other, and as the two or more poles would not break in unison, excessive flashing would result. To overcome this defect and produce a more mechanical device, the outer ends of the blades and yoke have been broadened and two screws or bolts inserted, thus securing the parts so rigidly that the blades must at all times move in unison, and all the blades leave the contacts at the same instant.



A NEW SWITCH.

The second feature consists in backing up the regular flexible contacts, *B*, by what they term "reinforcing plates," *A*. It has heretofore been the custom to use nothing but the copper strips, *B*, and these of a necessity being flexible were liable to spring apart by constant usage, thus impairing the contact and causing the parts to heat.

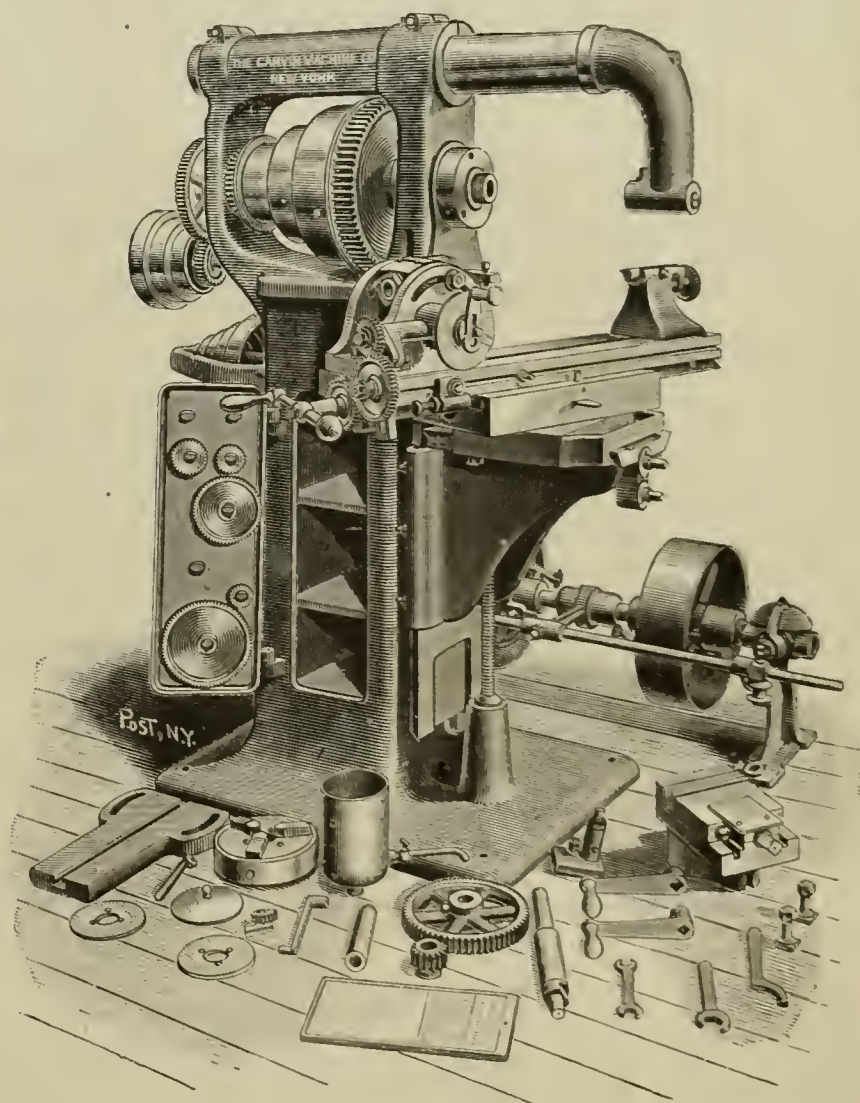
By the method shown the flexibility is maintained and on account of the reinforcing plates the flexible contacts are always held in proper position, consequently the electrical

connection between blade and contact is always kept perfect.

It will also be seen that the carrying capacity of the flexible copper plates, *B*, is increased by the reinforcing plate, *A*, to the maximum of any other part of the circuit, preventing loss of current in the switch and heating and destruction of its contacts.

Eight Spindle Automatic Drill.

The accompanying cut illustrates an eight spindle automatic drill press, manufactured by the Garvin Machine Company, Laight and Canal streets, New York City, adaptable to drilling or counterboring a large variety of small articles where two or more holes are desired to be drilled close together on opposite sides or ends of the piece. The spindle heads are mounted in opposite pairs on the planed surface of an inclined frame, on which they are adjustable as to their centre distances. Thus the several pairs of spindles may be set so as to drill two holes in exact line from opposite sides of the work, or parallel holes in each end of a link at one operation. The spindles have an automatic feed trip and reverse motion, and can be made to feed up to the work one at a time, in pairs, all simultaneously or in other combinations as the work may require. They are driven by pulleys, having a feather in the outer end of the bulb engaging a spline in the spindle, and running on independent hollow studs which take the belt pull, thus leaving the spindles free and sensitive. For each of the two sets of spindles on opposite sides of the machine there is an endless driving belt, passing over idler pulleys, one of which is adjustable



AUTOMATIC DRILL.

to provide for taking up the slack in the belt. The fixtures for holding the work are mounted between the spindle heads on a rail, beneath which is a cast iron trough for conducting the oil and chips to a tank beneath the machine, where the oil is strained and returned to the drills by an automatic pump. The weight of the machine complete is about 850 lbs., and with 3-16-inch drills it will produce about 5,000 pieces per day, only requiring the attention of a boy to drop in and remove the work and throw the starting lever.

stock \$3,000, has been incorporated by John Flanning and others.

THE ELECTROLYTIC REDUCTION COMPANY, San Francisco, Cal., capital stock \$1,000,000, has been formed to mine and reduce ores.

THE ELECTRO-METALLIC BRICK COMPANY, Chicago, Ill., capital stock \$300,000, has been incorporated by J. E. Robinson and others.

THE JERSEYVILLE TELEPHONE COMPANY, Jerseyville, Ill., has been incorporated by J. G. Swartz and others. The capital stock is \$5,000.

THE IMPERIAL ELECTRIC LAMP COMPANY, New York, has been incorporated with a capital stock of \$250,000 by J. F. Wood and others.

THE TELEPHONE EXCHANGE COMPANY, of Seneca, Kan., has been incorporated by J. A. Gilchrist and others. The capital stock is \$25,000.

THE NEMAHA TELEPHONE EXCHANGE COMPANY, Seneca, Kan., capital stock \$25,000, has been incorporated by J. D. Kennard and others.

THE SPECIAL FIRE ALARM SIGNAL COMPANY, New York, has been incorporated by Frederick Pearce and others. The capital stock is \$50,000.

THE CHICAGO AND MORGAN PARK ELECTRIC STREET RAILWAY COMPANY, Chicago, Ill., capital stock \$500,000, has been formed by F. Dean.

THE HILLSBORO INVESTMENT AND ELECTRIC COMPANY, Hillsboro, Tex., capital stock \$50,000, has been organized to supply electric power, gas, etc.

THE INTERSTATE CONSTRUCTION COMPANY, Des Moines, Iowa, capital stock \$500,000, has been incorporated by E. I. Rosenfeld and others to construct and operate railway and telegraph lines.

BAKER CITY, ORE.—The Baker City Electric Light Company has been incorporated with a capital of \$60,000, to erect and maintain an electric light plant. Jos. A. West and C. W. Nibley, Jr., are interested.

THE ROSE ELECTRIC COMPANY, St. Louis, Mo., capital stock \$40,000, has been formed to manufacture and deal in electrical machinery, etc. P. L. Rose, A. E. Rose and Matilda Rose, of St. Louis, are the incorporators.

THE INTER-COUNTY STREET RAILWAY COMPANY, Tamaqua, Pa., capital stock \$200,000, has been incorporated to construct and operate a street railway. C. E. Hogue, S. Friedberger, J. C. Dedier, Philadelphia, Pa., are the incorporators.

THE DOBBS FERRY LIGHTING COMPANY, Dobbs Ferry, N. Y., capital stock \$40,000, has been incorporated to supply electric light, heat and power. G. C. Todd, G. F. Cameron and Oliver Snow, Tarrytown, N. Y., are the organizers.

THE IMPERIAL ELECTRIC LAMP COMPANY, New York, capital stock \$250,000, has been formed to manufacture electric lamps and appliances. H. F. Rogers, J. F. Wood, Huntington, and R. I. Murray, Chappaqua, N. Y., are interested.

THE PORTLAND ELECTRIC WORKS, Portland, Me., capital stock \$50,000, has been formed to make and sell all kinds of electrical supplies. The promoters are Nathan E. Redlon, Chas. O. Files, Howard Gould and H. G. Bennett, Portland, Me.

THE GENEVA CONSTRUCTION COMPANY, Trenton, N. J., capital stock \$25,000, has been formed to take contracts for the construction of railroads, electric light plants, etc. J. B. Reilly, Thos. Craig, Trenton, N. J., and J. F. Dolan, New York, are the promoters.

THE LIVGRO INCANDESCENT LAMP COMPANY, Harrison, N. J., capital stock \$1,000,000, has been formed to manufacture and sell incandescent electric lamps. W. E. Forest, A. H. Gross, Jos. Livingston, New York City, and C. M. Myers, Newark, N. J., are interested.

THE LORAIN MACHINE COMPANY, New York, capital stock \$1,800, has been incorporated to manufacture electrical and mechanical machines. Jerome Bradley, 5 Dey street; W. M. Earl, 32 West 128th street, and H. H. Gevel, 5 Ridge place, New York, are the promoters.

THE STATE BELT ELECTRIC STREET RAILWAY COMPANY, Bangor, Me., capital stock \$200,000, has been formed to construct and operate an electric street railway. The organizers are C. A. Oakes, Brooklyn, N. Y.; C. Shuman, Bath, and G. W. Mackey, Bangor, Me.

THE MARION STREET RAILWAY COMPANY, Marion, Ohio, capital stock \$100,000, has been formed to construct and operate street railways and to furnish light, heat, power, etc. E. Durfee, C. E. Turner, G. Liffier, E. Huber, H. Strelitz and G. E. Burlow are the incorporators.

THE GEO. L. COLGATE COMPANY, New York, capital stock \$20,000, has been formed to manufacture electrical machinery. The interested parties are G. L. Colgate, Fanwood, N. J.; G. O. Van Voast, Jr., 543 Herkimer street, and I. A. Stevenson, 394 Shepard avenue, Brooklyn, N. Y.

THE MASON ELECTRIC COMPANY, Chicago, Ill., capital stock \$10,000, has been organized to manufacture, buy and sell machinery used in equipping or constructing electric railways, mining plants or kindred interests, and also to construct electric

railways. The promoters are Norman Totten, F. A. Moore and Manton Maverick.

THE DEWEY ELECTRIC SIGNAL COMPANY, Jersey City, N. J., capital stock \$60,000, has been formed to manufacture, buy and sell machinery, lamps, motors, etc., appertaining to, or connected with, the production, distribution, etc., of electricity for signaling power. A. M. Dodge, J. F. Tams, New York; F. G. Ingersoll, New Haven, Conn.; E. B. Wyman, Highwood, and G. B. Hollister, Rutherford, N. J., are the promoters.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD, }
253 Broadway, New York, May 7, 1894.

MR. FRANK FULLER, of Seth W. Fuller, manufacturer of electric apparatus, 27 Arch street, Boston, Mass., was in town last week.

MR. EDWARD J. DALTON, manager of M. T. Davidson's New York office, 77 Liberty street, reports having sold a number of steam pumps to electrical plants during the past week.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD, }
Room 91, Hathaway Building, 620 Atlantic Ave., }
BOSTON, Mass., May 5, 1894.

BURTON E. BAKER, formerly of the Thomson-Houston company, with offices in the Whittlesey Block, New Britain, Conn., is forming the Improved Electrical Machine Company, to manufacture electrical appliances.

THE WATERHOUSE ARC LAMP for incandescent and arc circuits has been adopted by the Boston and Maine Railroad Company for the Union Station in Boston. The order was obtained by Mr. F. G. Waterhouse personally.

THE PETTINGELL-ANDREWS COMPANY, Boston, has just been awarded a nice contract by the Union Street Railway Company, Providence, R. I., for the overhead construction of its Pawtuxet Valley and Pawtucket Street Railway divisions.

THE BILL to permit cities and towns to construct, maintain and lease conduits for electric wires, cables and conductors has been rejected by the House of the Massachusetts Legislature by a vote of 73 to 61, but its author, it is said, will endeavor to get a reconsideration.

MR. E. W. LITTLE, vice president of the Interior Conduit and Insulation Company, and Mr. Jean A. Wetmore, of the Okonite Company, were Boston visitors this week. Their headquarters were, of course, at the offices of the Pettingell-Andrews Company, their New England agency.

THE DAY-MOBERG ELECTRIC COMPANY, Boston, has removed its office and factory to 185 Franklin street, where it has greater convenience for the manufacture of its storage battery—the "Jupiter"—and other specialties, and the general conduct of its rapidly growing business.

MR. LINTON, of Linton & Southwick, Worcester, Mass., favored this office with a call this week, and reports the demand for his switches as constantly on the increase. This firm makes a specialty of the manufacture of switches of superior grade and at extremely low prices, and will very soon place on the market another and improved switch.

MR. ALEXANDER JAY WURTZ, of the Westinghouse Electric Company, delivered an interesting lecture Monday evening, April 30, on "Non-Arcing Lightning Arresters," before the Society of Arts, Boston. The students of the Institute of Technology were out in good numbers and gave the lecturer a hearty reception, and the able address of Mr. Wurtz on this very important subject commanded the closest attention of all present.

THE MEIGS ELEVATED RAILWAY MEASURE is commented upon by the Boston "Transcript" as follows: "The transit committee's report is the beginning rather than the end of the matter, for the Meigs bill will have a thorough overhauling by the finance committee in its monetary provisions; and as to its physical features, there are on the Senate table the petitions of White and Boynton and Mack, each with a bill ready to be brought forward at the fitting moment to supplant and succeed the bill reported by the transit committee."

Pittsburg Notes.

PITTSBURG, May 4, 1894.

THE EDISON GENERAL ELECTRIC COMPANY has filed a suit in the United States Court in this city against the Uniontown Street Railway Company, to recover \$5,000. The amount is claimed to be due on a promissory note, for which payment was refused when it fell due.

DIRECTOR McAFEE, of the Department of Public Works, Allegheny, is particularly interested in a device for supporting electric light wires. His plan is to place the electric light wires in an arch in the middle of the street, and thus do away with the mast-arm system. Mr. McAfee expects that his method will greatly add to the improvement of the streets. In giving an explanation of the system, he said that he intended to erect an arch 40 feet above the street. This arch is to be constructed of structural iron or steel, and will be anchored under the street on stone foundations. The weight of the wires will act as a brace, and as a result no guy wires will be necessary. They may be placed a much greater distance apart than the mast arms are now. At a height of about 30 feet the crossbars and pendant will be placed and on these will be a place from which the arc lamps are to be suspended. At a certain distance below there will be room made for the trolley wires. Resting on the crossbar and braced by the rising curve of the arch is to be an immense frame on which to string the wires. Below and above the street railway feed wires are to be attached, and then the city and other electric light wires. Again, some distance above these is the place for the telegraph wires, and, at last, even higher than these, the city fire and police wires. While speaking about this proposed system Mr. McAfee remarked: "My idea to adopt this method is, because it is cheaper than the underground plan, has some advantages over that method, and also because I think it would be easier to induce the street railway and electric light companies to adopt this system than the underground plan. Underground currents of electricity have a bad effect upon the water lines. My system will not interfere with the firemen in case of fire, and I also think these arches will, to some extent, enhance the appearance of streets; at all events it will be a manifest improvement upon the unsightly poles of the present." The director has had an ordinance drawn up upon this matter, which will be presented before councils in a few days, and, owing to the influential position of Mr. McAfee, it is very likely that the matter will be approved of.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD, }
336 Monadnock Building Chicago, May 4, 1894. }

THE GREAT WESTERN MANUFACTURING COMPANY, finding its old quarters in South Canal street inadequate for the enormous business which it is doing at present, has decided to move to new and commodious apartments at 116, 118, 120 Market street. Here it will have one of the best equipped houses in Chicago, and is to be congratulated on this important move. The manager, H. K. Gillman, is winning a great many compliments because of his able management of this firm. It seems to have gone steadily forward from its incorporation, until it is now recognized as one of the leading houses of the West. The works at Duluth are crowded more than ever with orders, and every one connected with the company cannot but feel the spirit of progress which is at present so manifest.

Canadian Notes.

OTTAWA, Ont., May 4, 1894.

OTTAWA, ONT.—The Bell Telephone Company has a bill before the Dominion Parliament, which takes authority to issue bonds or debentures to the amount of 75 per cent. of its paid up capital stock. As this is \$2,500,000, the new issue amounts to over \$1,700,000.

TORONTO, ONT.—E. N. Cooke, representing the Western Electrical Manufacturing Company, of Chicago, has been in the city, where he is anxious to establish a branch of the company's business. He also had a conference with the city engineer with reference to putting in an electric lighting plant for the city. He will look over the ground and then submit an estimate for the work. The city engineer has sent a circular to several different electric companies, asking for a similar estimate.

ST. JOHN, N. B.—Mr. Van Horne and James Ross on their return from Ottawa will proceed at once to St. John for the purpose of maturing the plans for the extension of their newly acquired electrical and street railway plant. This comprises the charters of three different companies, which were bought for \$92,000. The new owners intend double-tracking the road, and extending both it and the electric light to the adjoining suburbs, for which purpose they expect to expend the sum of \$400,000.

HAMILTON, ONT.—Mayor Stewart had a conference with the directors of the Hamilton Electric Light and Power Company this week, in reference to the renewal of contract for lighting the city. The electric light company say they will renew the contract for five years at the old figure, but if the contract is to be for only one year the figure will be higher. Frank R. Rae, the electrical expert of Detroit, will meet the Board of Works, when it is probable he will be engaged to prepare a report on the proposed plan to establish municipal electric light works.

WINNIPEG, MAN.—For some time nothing has been heard of the proposed electrical railway from Winnipeg to Selkirk, but negotiations have been going on, and, as a result, operations will commence this spring. F. W. Colclough, who holds the charter, has been in communication with A. W. Austin, of the Winnipeg Street Railway, to construct the road while he (Mr. Austin) has been away in England, and the reply was that nothing could be

done until the return of Mr. Austin to the city, and that in the meantime the company make no arrangements with other parties to go on with the work. Upon Mr. Austin's return the matter will be discussed with him, and it is understood that he is willing to make a contract with the company. Besides this, Duluth capital will be forthcoming to build the road, should it be wanted, and if Mr. Austin will not take hold the American money will be utilized. In either event work will be proceeded with this spring.

English Notes.

(From Our Own English Correspondent.)

LONDON, England, April 18, 1894.

MUNICIPAL ELECTRIC LIGHTING.—The Town Council of the well known south coast seaside resort of Folkestone has decided to spend £35,000 on a municipal electric lighting scheme.

ELECTRIC PUMPING.—The Worcester City Council, whose municipal electric supply station, driven by water power, will shortly be opened, propose to give their station a day load by employing electric motors geared to three-throw pumps to perform the necessary pumping work at the municipal water works.

ELECTRIC MINING MACHINES.—Considering the trouble which the coal owners have had in the past, and are likely to have in the immediate future, with their workmen, it seems somewhat strange that more attention has not been paid by colliery owners to the introduction of mechanical appliances for the winning of coal. This question was raised recently in a paper read before the Manchester Geological Society, and in the discussion that followed a government inspector of mining remarked that the "Hurd" pneumatic electrical cutting machine, which had been exhibited at that meeting, seemed to be more adapted for a long wall, whilst in Lancashire the system of working was mostly "pillar and stall." Another member remarked that the reason that coal cutting machines had not been adopted in Lancashire was not that there was any prejudice against them or unwillingness on the part of the coal owners to adopt mechanical appliances, but simply because machines had not been produced capable of working successfully with the bad roofs they had in most of the mines.

UNDERGROUND MAINS.—Some interesting information was given to the public at a recent meeting of the Northern Society of Electrical Engineers upon various points connected with underground mains. Mr. Crompton, the founder of the bare-copper strip system, has always maintained that the cost of maintenance of mains laid in this way would turn out to be "next to nothing." The following figures for the South Kensington mains, it must be admitted, substantiate this claim. The total cost for laying mains in Kensington amounts to £56,000, of which by far the greater part was spent in the years 1891 and 1892. The cost of maintenance, including all repairs to surface boxes, caused by wearing away of cement, modifications in paving, resetting of boxes caused by reflagging, etc., comes out at considerably under 5 per cent. per annum on the capital outlay. In the matter of insulation also, about which there has been considerable doubt, it is found that at Hove, in wet weather, the average insulation resistance runs from .35 to .5 megohm per mile, and in dry weather from 2 to 3 megohms. Mr. Callender, of Callender's Bitumen Telegraph and Waterproof Company, pointed out that of the 82 stations at present at work in the United Kingdom, only 19 used throughout rubber insulated cables, whilst 39 used throughout cables insulated by materials other than rubber. Several members of the society expressed decidedly favorable opinions as regards paper insulated lead covered cables. Mr. Nisbett, of the City of London Electric Lighting Company, gave the following example of the flexibility of a paper insulated cable, the cable being a treble concentric cable of 1½ inch diameter. The cable was bent to a 20-foot radius and straightened, and a pressure of 4,500 volts was then applied, and successfully withstood, the cable being designed to work at 200 volts only. There was also a consensus of opinion in favor of keeping the various sections of network separate, so as to avoid the possibility of a single fault on the big system jeopardizing the entire network.

ELECTRICAL MISCELLANEA AT THE INSTITUTION OF ELECTRICAL ENGINEERS.—In the programme of the Institution of Electrical Engineers there was recently a gap, and Professor Ayrton obligingly came forward to fill it with a miscellaneous sheaf of short papers dealing with a universal shunt for galvanometers, devised by himself and Mr. Mather, the best resistance for the receiving instrument on a leaky telegraph circuit, a transparent conducting screen for electrical and other instruments and an astatic station voltmeter. The transparent conducting screen devised by Professor Ayrton and Mr. Mather for use with electric and other instruments is considered by them to be necessitated by the occasional powerful electrostatic effects which arise from the glass of such instrument being accidentally or intentionally rubbed. As an example of what might possibly take place in a warmed up and possibly dry engine room, Professor Ayrton showed that after one or two vigorous rubs with a pocket-handkerchief the glass face of a Schuckert voltmeter was so charged that the aluminum pointer was deflected to the position of 40 volts, a 16-c. p. glow lamp having been warming up the face for some 20 minutes beforehand. To make sure that this cause of error shall not have any effect, Professor Ayrton and Mr. Mather have devised their transparent conducting coating, which is

to be applied on the inner side of instrument faces. The recipe is to dissolve one-quarter of an ounce of transparent gelatine with one ounce of glacial acetic acid by heating them together in a water bath at 100 degrees Centigrade, and to add to this solution half the volume of dilute sulphuric acid, prepared by mixing one part of strong acid with eight of distilled water by volume, the mixture being applied while still warm to the glass shade, which should be previously polished and be warm. When this film has become nearly dry, a coating of Griffith's anti-sulphuric enamel should be applied. Several voltmeters were shown treated in this manner. It is interesting to observe that this transparent conducting screen, if we are to assume that it conducts as an ordinary conductor, and not as an electrolyte, is a flagrant contradiction of Maxwell's law that an optically transparent body must be an insulator, and that every electrical conductor must be optically opaque.

ELECTRICAL COMMUNICATION WITH LIGHTHOUSES AND LIGHTSHIPS.—The first report of the Royal Commission appointed to consider the question of electrical communication with lighthouses and lightships appeared in the beginning of last year, and the second report has just been published. The first report recommended that communication should be effected by means of a telephone cable with five lightships, one pile lighthouse and three rock lighthouses; the Fastnet light of the south of Ireland, to be electrically connected with the shore by means of a non-continuous cable. These recommendations were in addition to those relating to the connection of some 18 lighthouses with the general telegraphic system of the country. The total cost of carrying out the recommendations of the committee were estimated at £25,000. At the time of wiring all the shore lighthouses referred to in the first report have been connected, and two out of the five lightships have just been telephonically connected with the shore. In the second report now issued some 19 more lighthouses are scheduled for electric connection with life saving stations, at an estimated cost of £1,800. The Royal Commission state that they received and considered particulars of a number of inventions for effecting electrical communication between light vessels and the shore, but none of these are, in their opinion, preferable to the method adopted on the Goodwin and Kentish Knock lightships, to which I referred in a recent letter. The report concludes as follows: "It is with regret that we have decided to confine our recommendations in this report to shore lighthouses, but until more has been done towards effecting the connection of those light vessels, which we selected in our first report as having the strongest claims to immediate attention, we hesitate to add to the list of light vessels, island and rock lighthouses with which we consider that electrical communication should be established." There is a valuable appendix prepared by Sir Edward Birbeck, relating to the system of coast communication in vogue in Canada and the United States. Sir Edward Birbeck was much struck by what he saw on the coast of the Gulf of St. Lawrence and along the coast of New Jersey, and he states his opinion that the maximum efficiency would be secured if the American system of running the telegraph lines along the coast were adopted in England, instead of the zigzag system of communication through inland post-offices. He points out that neither in Canada nor the United States is there a single instance of a rock light house or light vessel being placed in electric communication with the shore.

News of the Week.

Telegraph and Telephone.

WHARTON, TEX.—The Sorrell Brothers Company will put in a telephone line $4\frac{1}{2}$ miles long.

BROOKVILLE, IND., is anxious to have the telephone, and has recently granted a franchise to M. H. Irwin, publisher of the "Franklin Democrat," and John G. Goudie.

WASHINGTON, D. C.—The Chesapeake and Potomac Telephone Company has declared a dividend of 50 cents per share, and announces that from May 1, 1894, its charges for each set of telephone instruments will be \$10, instead of \$15 per annum, as heretofore.

Electric Light and Power.

YUMA, ARIZ.—A franchise has been granted to G. A. Allen to build an electric light plant.

AURORA, ILL.—The Brush Electric Light and Power Company has surrendered its charter.

SHORT CREEK, ALA.—W. T. McCoy and W. M. McKnight are to establish an electric light plant.

TALMAGE, NEB.—A company is being organized to put in electric lights. Henry Renkin is interested.

JACKSON, TENN.—Bids will be received to June 1 for 40 to 50 arc lights for five years. S. C. Lancaster is city engineer.

HAMBURG, IOWA.—J. P. Smith, of Weeping Water, Neb., is seeking a franchise to establish an electric lighting plant in Hamburg.

BLAINE, WASH.—The Blaine Electric Light and Power Company is recorded as having appointed Frank W. Hawkins receiver.

KALAMAZOO, MICH.—It is stated that the Kalamazoo authorities will lease the Buchanan water power for their electric light plant.

MINNEAPOLIS, MINN.—An electric light plant is to be established by W. D. Packard, of Warren, Ohio; the capacity will be 1,000 lamps.

SYCAMORE, ILL.—The Sycamore Electric Light Company is talking of erecting a new plant, the capacity of the present one being insufficient.

MONTREAL, CAN.—The plant of the Royal Electric Light Company, at Prince and William streets, has been burned; the loss is very heavy.

DETROIT, MICH.—The Palmer Log Cabin Park Syndicate will erect an electric lighting plant. John W. Lincock, 21 State street, Detroit, is interested.

MANISTEE, MICH.—The Sands Electric Lighting Company has installed a 4,000-h. p. Reynolds-Corliss engine, thus increasing the steam plant to 700 h. p.

FORSYTH, GA.—An election will be held May 18 to vote on the matter of issuing \$7,000 in bonds for an electric lighting plant. R. G. Anderson is city clerk.

MONTCLAIR, N. J.—The Baker ordinance, covering the matter of an electric lighting plant for Montclair, was read and laid over indefinitely. There is strong objection to the cost.

GENESEIO, N. Y.—Taxpayers have approved at the polls the intended award of contract for electric lighting to the Geneseo Gas Company. Lights to be ready Oct. 1 next.

ITHACA, MICH.—The Ithaca Electric Light Company has offered to furnish lights at \$70 per annum apiece, which was referred to a committee consisting of Trustees Lewis and Franker.

PHILADELPHIA, PA.—The suggestion of the Roxborough Improvement Company for using the power of Wissahickon Creek for an electric plant was discussed and referred to a sub-committee.

COLUMBUS, OHIO.—The committee in the matter of establishing an electric light plant has recommended that a power house be established near the penitentiary, with room for additions in the future; the estimated cost is \$25,000.

FOSTORIA, OHIO.—The creditors of the Fostoria Light and Power Company have taken possession of the plant, and it is stated that they will enlarge same and put in additional dynamos. They may also add dynamos for incandescent lights.

The Electric Railway.

ALTON, ILL.—The Alton Electric Street Railway Company is about to construct 10 miles of electric railway.

PEEKSKILL, N. Y.—The scheme to build an electric railway in Peekskill has been abandoned for the present.

CONCORD, N. H.—A hearing will be given May 31 on the petition of the Concord Street Railway for right to extend its tracks.

WASHINGTON, D. C.—A company is being organized to construct an electric railway between Washington and Manassas, Va.

PORTSMOUTH, VA.—L. R. Watts is president of the re-organized street railway company, and the railway will be improved.

CANANDAIGUA, N. Y.—The village trustees have given permission to an electric railway company to lay tracks through the streets.

LAWRENCE, MASS.—The petition of the Lowell, Lawrence and Haverhill Street Railway for right to extend its tracks will be heard May 7.

CINCINNATI, OHIO.—The Cincinnati Street Railway Company has secured a building permit to erect a power house at Depot and Smith streets.

DEARBORN, MICH.—The City and Suburban Traction Company has been granted a franchise to construct and operate an electric street railway on Michigan avenue.

NEWARK, N. J.—The Consolidated Traction Company has begun work on a large car house on Blanchard street, from plans of the Penn Steel Company, to cost \$30,000.

TONAWANDA, N. Y.—The Tonawanda trustees have granted an extension of time to the Niagara Falls and Buffalo Street Railway Company for the completion of its line.

LANSFORD, PA.—Chas. H. Hague is president of the recently incorporated Inter-County Electric Railway, which will build and operate an electric road from Lansford to Tamaqua.

TROY, N. Y.—The Troy and New England Company, which holds a charter for an electric line from Troy to Sandlake and Albia, has virtually decided to begin work at once on a plant.

HARRISBURG, PA.—A charter has been granted to the State Belt Electric Street Railway Company to run from Bangor to Pen Argyl and Wing Gap, in Northampton county, to cost \$200,000.

BROOKLYN, N. Y.—The Brooklyn Suburban and Queens County Railroad has given a contract to J. D. Murray, of New

Brunswick, N. J., to lay 25 miles of track, which it recently purchased.

OPELIKA, ALA.—The Opelika and Auburn Electric Railway Company is being organized by C. J. Daughtry and others. The road is to run from Opelika to Auburn. The capital stock will be \$40,000.

CHICAGO, ILL.—An ordinance has been passed granting a franchise to the North Chicago Street Railway Company and the West Chicago Street Railway Company to equip their lines with the trolley system.

KANSAS CITY, KAN.—The county commissioners have granted a franchise to the Rosedale and Merriam Park Railway to extend its line from Rosedale south to the boundary of Johnson County. A. A. Pearson is president.

BUFFALO, N. Y.—A hearing will be given by the Common Council at 2:30 p. m., May 14, upon the petition of the Crosstown Street Railway Company for right to operate an electric street railway on certain streets.

CHICAGO, ILL.—The Metropolitan L. road, which runs westward in the neighborhood of Harrison street, will be run by electricity. This decision was arrived at during a meeting held by the directors in New York.

HOOSICK, N. Y.—The highway commissioners have granted a franchise to the Hoosick Railway Company to build a street railway to North Hoosick and Wallamsue. C. B. Story, manager, states that work will be begun at once.

NIAGARA FALLS, N. Y.—Among those interested in the proposed Niagara River Tramway Company, to build a cable tramway across the Niagara River, are R. N. Campbell, of Niagara Falls, and G. W. Pound, of Lockport, N. Y.

ELKHART, IND.—The new power house of the Home Electric Company will be built on the north side of the St. Joe River, between the Big Four Railway and the Globe Tissue Paper Works. The dimensions of the building will be 25 by 100 feet.

BROOKLYN, N. Y.—Opponents of the scheme of John W. Ambrose and the South Brooklyn Terminal Company to build a railroad from 39th street to the 26th ward have asked Mayor Schieren to veto the franchise granted by the Board of Aldermen.

PORT HURON, MICH.—The City Electric Railway will build the Lapeer avenue line as soon as the order for the repaving of Water street is issued. Their charter calls for the completion of the line this summer. Many improvements will be made.

MANCHESTER, N. H.—General Williams, of Manchester, N. H., writes to the secretary of the Board of Trade, stating that he is now figuring on an electric railway for the city, and that he will issue information from time to time as plans mature.

Tiffin, OHIO.—The Electric Railway and Power Company, which owns several miles of street railway, thoroughly equipped, has become a part of the Tiffin Consolidated Interurban Railway Company. All the horse car lines in the city will now be equipped with electricity.

BUFFALO, N. Y.—An item in the Buffalo "Times" states that Capt. John M. Brinker is president of a company which will, in all probability, run an electric road at the bottom of the Niagara Gorge, between Lewiston and the Falls, close to the water's edge, to be opened for traffic in 1895. Majority consent for right of way has been secured.

CHICAGO, ILL.—The Chicago Construction Company has the contract for the construction of 10 miles of road for the Englewood and Chicago Electric Company, work of construction to be begun April 23. For the present the company will lease the power for its trolley lines, though eventually it is intended to build a power house by the track of the Indiana Street Railway Company. W. H. Cumstock is president, and the capital is \$1,000,000.

MARION, OHIO.—The projectors of the City Street Railway have secured a franchise entirely acceptable under the existing general ordinance, which was reasonably amended. The board of seven directors, consisting of prominent business men, have elected Mr. Edward Durfee president, Mr. Godfrey Jeffer vice president and Mr. G. E. Turner secretary. Mr. Turner will also serve as superintendent. The work of construction will commence at once, and four miles of road must be finished and in operation within five months. With the building of this road the Marion Electric Light and Power Company will add a large incandescent and power circuit complete.

Miscellaneous Notes.

HONORS TO FRENCH ELECTRICIANS.—As a recognition of their services, at the Chicago Exposition, the French Government has named M. J. Carpentier an officer and MM. Ch. Milde, J. Richard and Werleim, chevaliers, of the Legion of Honor.

THE NEW TRANSATLANTIC CABLE.—The London "Daily Graphic" contains a detailed description of the new transatlantic cable now being laid by the Commercial Cable Company, illustrated by a map, and views showing the construction of the cable itself.

COLUMBIA COLLEGE SCHOOL OF MINES.—Mr. Alexander Jay Wurts, of the Westinghouse Electric and Manufacturing Company, read a paper on non-arcing lightning arresters, with special

reference to the protection of street railway circuits. Experiments were made with some new forms of apparatus.

RIGHT OF MUNICIPAL CORPORATIONS TO SUPPLY ELECTRICITY.—An act authorizing municipal corporations to manufacture and supply electricity at reasonable rates to the inhabitants violates no constitutional provision, this being a public service.—(Linn v. Borough of Chambersburg. Supreme Court of Pennsylvania, 28 At. Rep., 842.)

THE NEW YORK-WASHINGTON TROLLEY LINE.—The Elkins-Widener syndicate, of Philadelphia, is reported to be interested in a trolley line from New York to Washington. It is stated that it has procured a charter for an electric line from Washington and Baltimore to the Pennsylvania State line. It is also reported that the syndicate has had surveys made from Jersey City to Newark, N. J., for an electric road, and from Newark the road will certainly be extended to Philadelphia, and down through the southern suburban towns of that city. A further extension from Wilmington to Baltimore will follow.

ELECTRIC COOKING AND HEATING.—Mr. R. E. Crompton, in a recent interview in the "Pall Mall Gazette," gives some facts and figures in regard to electric cooking and heating. On a 100-volt circuit, he says it took 25 amperes to heat up a small family oven, which would then cook for nearly an hour. A frying pan requires $2\frac{1}{2}$ amperes, and it costs one-third of a cent (with electricity at 8 cents per kilowatt) to heat an ordinary tea kettle. A flat iron takes from $2\frac{1}{2}$ to 3 amperes of current, and a soldering iron $1\frac{1}{2}$ amperes. The reporter was assured that mutton and pastry could be cooked simultaneously in the same oven with no risk of tainting the latter, the reason given being that the oven is practically hermetically sealed.

A NATIONAL SCHOOL OF ELECTRICITY.—We learn from the daily press that Prof. J. P. Barrett, of Chicago, has organized a National School of Electricity, the following officers and instructors being named: President, J. P. Barrett; vice president, J. L. Little; treasurer, E. L. Powers; secretary, J. Allan Hornsby. The faculty, in addition to specially selected local instructors, is stated to be as follows: Thomas A. Edison, dean; Nikola Tesla, Prof. Henry S. Carhart, Dr. Elisha Gray, A. M., Ph. D., LL. D.; Prof. Harris J. Ryan, M. E.; Dr. F. A. C. Perrine, Prof. William A. Anthony, Ph. B.; Prof. George D. Shepardson, Prof. Michael T. O'Dea, M. S. E. E.; Prof. Brown Ayres, Prof. Dugald C. Jackson, C. E.; Prof. Benjamin F. Thomas, Prof. J. P. Barrett. It is the intention to organize a class in electricity in every city and town the population of which is large enough to justify it. This class will meet weekly and be provided with a study leaf, which will take the place of text books. There will be one lesson a week for 40 weeks, the course to cover one year.

THE NORTHWESTERN ELEVATED RAILROAD COMPANY, of Chicago, proposes to construct a line passing through some of the Chicago buildings. This is rendered possible by the use of electricity as a motive power, so that smoke and cinders and much of the noise are avoided. The structure is to be arranged so that it rests on its own foundation entirely independent of the buildings, leaving the side spaces on each side of the track for small structures or booths. In one instance, in New York City, where an elevated railroad station is located in a building, it has been found that the value of the building for rental purposes has increased over 150 per cent. It is understood that the management of the road has decided to recommend electricity as a motive power, and that it is its purpose to build a two-track structure south of the Chicago River, and have the trains stop at every street crossing in the central portion of the city. North of the river there will be four tracks, the two inner tracks being for express trains and the two outer tracks for general business.

NEWS FROM A UNIVERSITY.—The "University Courier," of the University of Kansas, has the following item of news: "There are to be several important additions in the electrical engineering and physical departments in the way of apparatus. This is a most important step, and has long been looked forward to by everybody connected with these departments. The equipment consists of one large 100-h. p. Rustle engine, which will drive a large iron-clad direct alternating dynamo, having a capacity of 750 lights for the library building. There are to be also two high pressure boilers for the engines. The boilers are of 100-kw. capacity, and are designed to work perfectly synchronous with a large transformer, used to pump water for the boiler house. The following apparatus has been purchased for the physical laboratory: One highly finished coulomb arrester, to measure one-millionth of a "Board of Trade unit," or Joule's equivalent, by Hyche, of Berlin; a large galvanometer, wound with stadia wires, and one small Westinghouse ohm sifter. More is expected in the near future."

THE WEST VIRGINIA UNIVERSITY is building a mechanical laboratory adjacent to its mechanical shops, in which the light, heat and power plant of the university will be installed. Having this plant all under the same roof, in the department of mechanical engineering, greatly increases the facilities for instruction, as the whole plant will be available at any time for experimental work and special testing and investigation. The equipment will contain a storage battery plant, arc and incandescent dynamos and motors, electrical testing and measuring instruments, simple and compound engines installed so as to work as a triple expansion engine of 100 h. p., exhaust steam and independent jet and surface condensers, compound pumping engines for reservoir service and duty tests, high pressure sectional

boilers set for coal and natural gas firing, and the present equipment of standard engineering testing and measuring instruments and accessories will be materially increased. The university is located at Morgantown, W. Va., on the Monongahela River, and on the new link of the Baltimore and Ohio Railroad, connecting its Pittsburgh and Wheeling lines.

THE PERMANENT COMMERCIAL EXHIBIT of New York, conducted by the Pan-American Company, is a development of the foreign commercial museum, such as those of Brussels and Liverpool. This company has secured the Industrial Building, at 43d and 44th streets and Lexington avenue, New York City, and proposes to carry samples there, and at the same time offers the assistance of an organization especially valuable to conserve the interests of American manufacturers abroad in a capacity similar to that of a traveling salesman, and to collect all information through its foreign correspondents and traveling representatives that may be of interest and value that the manufacturer represents. Officers and agents of the company having a knowledge of the Spanish language will make trips through the various portions of Spanish America solely in the interests of American manufacturers who are subscribers to the enterprise, introducing their goods and collecting information for them. The company has resident agents in each of the larger cities of Spanish America, South Africa and Australia, with whom the subscribers are at liberty to correspond at all times. The company lets to various subscribers floor space in its building, which the subscribers may use as an exhibit space or a New York office, as may be desired. The objects of the company are novel, and it will no doubt meet with success.

Trade and Industrial Notes.

THE WALLACE ELECTRIC COMPANY reports a steady and rapidly increasing sale of the Wirt brush. This brush is adapted to all incandescent dynamos.

CHARLES A. SCHIEREN & CO., 47 Ferry street, New York City, have secured an order from the Brooklyn City Railroad Company for an extra belt, 91 feet long and 60 inches wide.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, of Pittsfield, Mass., will erect a new building on Renne avenue, near the station of the Pittsfield Electric Company. The building will be three stories high, 200 by 70 feet, and work will be begun as soon as plans can be prepared and contracts given out.

PALMER BROS., of Mianus, Conn., are putting an addition on their factory. The firm has just booked one order for 6,000 telephone receivers, 5,000 of them being their standard compound magnet receiver, with rubber shell, and 1,000 of a cheaper grade. The same customer has also ordered 500 complete telephones.

THE H. M. LOUD & SONS LUMBER COMPANY, of 39 Cortlandt street New York, and Au Sable, Mich., is sending to its many friends and customers samples of its superior make and finish octagonal poles, both carboline and painted, for use on electric roads, lighting, etc. The samples are neatly mounted on cardboard.

THE FRISBIE ELEVATOR AND MANUFACTURING COMPANY, New Haven, Conn., states that its sales for the month of March far exceeded that of any one month since the existence of the company, and equal to any four ordinary months in the year. Among the many contracts secured within the past few weeks are mentioned a large order for Frisbie clutch pulleys and cut-off couplings, patent pillow blocks, hangers, shafting, etc., for the New Haven Electric Light Company's new station; a 2,000-pound Champion safety freight elevator, of its new friction pulley pattern, for The E. S. Greeley & Co.'s new warerooms, at 5 and 7 Dey street, New York; a 5-ton freight elevator, of the same pattern, for the Safety Insulated Wire and Cable Company, West 28th street, New York. Judging from the large business now coming from electric light plants throughout the country, from Maine to California, the company thinks it evident that the many points of superiority that the Frisbie clutch pulleys and cut-off couplings possess are being appreciated.

THOMAS H. FEAREY, manager of the Buffalo office of the General Electric Company, reports a large spring business. The Buffalo Railway has ordered two 800-h. p. direct coupled genera-

tors, which will be placed in its present power station and coupled to Lake Erie upright engines. These will be duplicates of the couple which did such fine work at the Intramural station at Chicago. They have also ordered G. E.-800 motors for 84 new cars. The West Side Railroad, of Elmira, has purchased two W. P.-50 equipments. The Kingston City Railway Company has bought two G. E.-800 equipments, the Seneca and Waterloo Railway one, and the Buffalo and Williamsville Railway two. The Grand View Beach Railway will install a new switchboard of the General Electric Company's make, to take the place of the one destroyed by fire. The Buffalo, Bellevue and Lancaster Railway has purchased a 150-kw. Edison generator and two W. P.-50 equipments; 2,000 h. p. of motor generators have been sold to the Cataract Construction Company, at Niagara Falls. A 150-h. p. power plant has been installed by the Niagara Falls Hydraulic Power and Manufacturing Company, and is in successful operation. The Niagara Silver Company has changed from steam to electric power, using a 75-h. p. General Electric motor. The palace car which has been used by the General Electric Company for exhibition purposes has been purchased by the Buffalo, Bellevue and Lancaster Railway. Lighting plants have been installed at the Barber Asphalt Paving Works and the Atlas Works, of the Standard Oil Company. A large trade has also been done in railway and lighting supplies and incandescent lamps.

QUEEN & CO., Philadelphia, are offering to the trade a number of instruments, excellent in design and construction, but not conforming to their regular stock, some of which were imported for exhibition purposes or for experiment, others whose place in the catalogues has been taken by later designed instruments, while others have become much shop worn by remaining on the shelves. Among the pieces which they now have on hand are a standard ohm, described in the London "Electrician," April, 1892; ammeters and voltmeters of the magnetic vane and Desprez-Carpentier types, and some manufactured by Hartmann & Braun and Schuckert; Kohlrausch spring ammeters, Siemens dynamometers and wattmeters; a Swinburn static voltmeter and non-inductive wattmeter. This last instrument consists of a small, movable, fine wire coil in series, with a high non-inductive resistance and a coarse wire stationary coil. The fine wire is placed as a shunt across the circuit whose power is to be measured while the coarse coil is placed in series with it. A torsion screw and spring attached to the fine coil allow the needle to be fastened to it to be brought back to zero. The watts are proportionable to the torsion of the spring necessary to accomplish this. Another instrument is a balance galvanometer, devised by the General Electric Company, to show when a voltage of a dynamo is equal to the voltage of bus bars, so that when it is thrown in circuit it may take a proper part of the load. There are also several types of galvanometers with shunt boxes, lamp stands and scales. Space in their new show rooms being imperatively necessary, Queen & Co. have decided to offer these instruments without regard to their original cost.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MFG. CO., 2140 DeKalb St., St. Louis, Mo.

THE ALLGEMEINE ELEKTRICITAETS-GESELLSCHAFT, Berlin, Germany, announce herewith that, owing to the general appreciation which their exhibition has met at the World's Fair, it is their intention to appoint selling agents in New York, Chicago, Cincinnati, Atlanta, San Francisco, Boston, Philadelphia, St. Paul, Washington, Denver, etc., for the sale of their manufacture. Trustworthy electrical firms inclined to handle their goods are requested to forward offers to the head offices, 22 Schiffbauerdamm, N. W. Berlin.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED APRIL 24, 1894.

518,604. ELECTRICAL CALCULATING SYSTEM; H. Hollerith,

Washington, D. C. Application filed Dec. 9, 1892. This comprises an integrator, registers, switch mechanism intermediate the registers and integrator, record card, master circuit controlling the integrator, gauge contacts and circuit closer for the master circuit.

518,613. PROTECTOR FOR ELECTRIC OR OTHER BELLS; L. R. Lecellier, Villedieu, France. Application filed July 31, 1893. A cover for electric bells having lock tumblers adapted to be brought into position to operate the bell by the action of a key.

518,654. ELECTRIC ARC LAMP; R. Segerdahl, Chicago, Ill. Application filed Sept. 29, 1893. A lamp having its controlling lever movable with the shunt magnet electrode and a tension spring adapted to establish the arc between the respective elec-

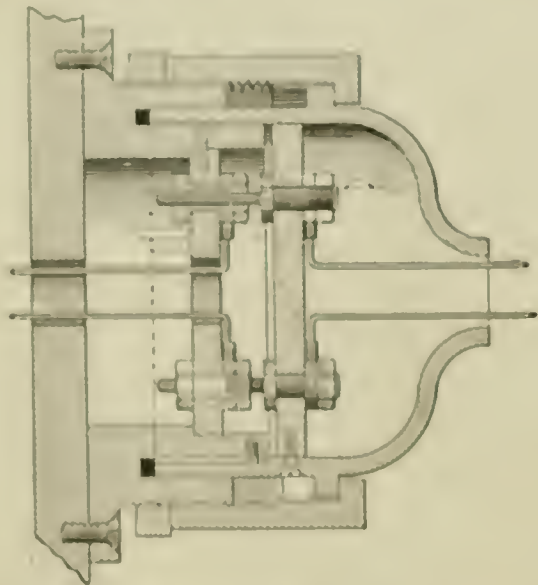
trodes of the lamp and means to regulate the tension on the spring.

518,667. ELECTRIC LOCK; J. Eldon, Lockhaven, Pa. Application filed Oct. 31, 1893. A lock having its bolt operated by the rotation of the shaft of an electric motor.

518,673. ELECTRICAL DEVICE FOR TOWING VEHICLES; T. P. Milligan, South Orange, N. J. Application filed June 3, 1893. This comprises a fixed rail, a carriage sustaining an electric motor and geared to the rail, a drag rope attached to the carriage for directing current to the motor, and a pull rope for actuating the switch lever.

518,693. CONTROLLING SWITCH FOR ELECTRIC RAILWAYS; P. Lange, Newark, N. J., and B. G. Lamme, Pittsburgh, Pa. Application filed Feb. 25, 1893. In an electrically propelled vehicle, two motors for driving the same, permanently connected in series and having their armatures next each other in the series.

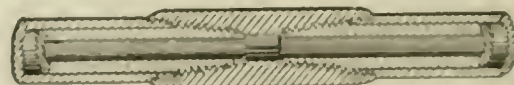
- 518,695. CONDUIT ELECTRIC RAILWAY; C. A. Maynard, Springfield, Mass. Application filed Feb. 9, 1894. The combination with the return wire removed from the conduit and with removable covers, of auxiliary wires to connect the two.
- 518,712. SUPPORT FOR ELECTRIC LIGHTS; W. H. Connell, Wilmington, Del. Application filed March 28, 1893. The combination with a desk having pigeon holes, of an electric light mounted on a carriage adapted to be moved in and out of the pigeon holes, an electric circuit, and means for opening and closing the circuit.
- 518,719. ELECTRIC ARC LAMP; C. Hoffmann, Berlin, Germany. Application filed Sept. 28, 1893. The combination of a weighted carbon carrier, a flexible support therefor, means for feeding the carbon, an electromagnet for bringing the carbons into apposition, and auxiliary means in shunt with the magnet for maintaining their juxtapositions.
- 518,722. FIRE ALARM BOX; W. H. Kirnan, Bayonne, N. J. Application filed Jan. 31, 1894. The combination of a signal box, lever engaging the disabled device, and a lever for operating the pull of the box, both levers being operated by a key.
- 518,728. APPARATUS FOR NEUTRALIZING THE EFFECTS OF SELF INDUCTION IN ALTERNATING CURRENT CIRCUITS; J. F. Kelly and C. C. Chesney, Pittsfield, Mass. Application filed Nov. 18, 1893. This comprises a transformer having its primary in derivation to an alternating working circuit, and a condenser in the circuit of its secondary, the transformer and condenser being proportioned to produce in the current in the primary of the transformer a negative lag for neutralizing the effects of the self induction of the working circuit.
- 518,740. ALTERNATE CURRENT DYNAMO; J. F. Kelly, Pittsfield, Mass. Application filed Dec. 22, 1893. This comprises polar projections in combination with induced coils thereon, and a yoke bridging the projections, the reluctance of the body being high relatively to that of the projections.
- 518,742. TELEPHONY; W. C. Lockwood, New York, N. Y. Application filed June 27, 1892. An electrode for telephone transmitters consisting of chloride of silver.
- 518,756. ARMATURE FOR DYNAMO ELECTRIC MACHINES OR ELECTRIC MOTORS; T. H. Hicks, Detroit, Mich. Application filed Jan. 9, 1893. An armature having a magnetizable cylinder supported to rotate with the shaft by flanges and non-conducting material.
- 518,768. DYNAMO ELECTRIC MACHINE OR MOTOR; A. L. Riker, New York, N. Y. Application filed Jan. 29, 1894. A gas and watertight terminal block comprising a base and a cover adapted to fit over the base, packing interposed in the joint between the parts, and means for clamping the parts together.
- 518,773. TELEPHONE SYSTEM; U. H. Batsley, Philadelphia, Pa. Application filed April 29, 1889. This comprises two guides, contacts guided thereby and respectively connected therewith, a two-contact switch plug, connecting flexible conductors connecting the two contacts of the plug respectively with those guided by the guides, and line wires from the subscriber connecting with the insulated guides.



NO. 518,768 DYNAMO OR MOTOR.

- 518,781. ELECTRIC OPERATING MECHANISM FOR VEHICLES; L. E. Freely, Boston, Mass. Application filed Dec. 29, 1893. The combination of a vehicle body, running gear therefor, a brake mechanism, an electric motor for setting the brake mechanism, an electric circuit passing through the motor and automatic mechanism for breaking the circuit when the brake becomes set.
- 518,782. DISTRIBUTION SYSTEM FOR ELECTRIC RAILWAYS; J. E. Goodhand, Baltimore, Md. Application filed Jan. 20, 1894. The combination of the feeder and working conduits, branch conduits arranged transversely to and connecting the feeder and working conduits; feeder wires in the feeder conduit, electrical conductors arranged in sections in the working conduits, a connecting block at the intersection of the branch and feeder conduits, and branch wires connecting the feeder wire with the working conductor.

- 518,788. ELECTRICAL INSTRUMENT TABLE; J. F. Mehren, Chicago, Ill. Application filed Feb. 7, 1893. A table having in its top conducting terminals, in combination with a set of electrical instruments and withdrawable fasteners connecting the instrument wires with the terminals and engaging the instruments to fasten them to the table against separation therefrom.
- 518,792. LIGHTNING ROD AND COUPLING; J. W. Smith, Galesburg, Ill. Application filed Jan. 6, 1893. A rod comprising sections of metal having an enveloping tube of copper, the sections of rods having tapered ends, which extend well on to the copper envelope, and a sleeve of copper having socketed ends and a conformity of outline with the conical ends of the rod sections, and extending on to and over the tapered part of the enveloping tube, whereby there may be an extended surface contact of the copper of the sleeve and the rod section.
- 518,800. ELECTRIC SWITCH; E. Woltmann, Chicago, Ill. Application filed July 11, 1893. This comprises a rotary wheel having cams and a crown ratchet, a contact terminal, a second resilient contact terminal riding upon the cams and actuated thereby in successive partial rotations of the wheel alternately to engage and separate from the first terminal, a pawl engaging the ratchet, and means for actuating the pawl to rotate the wheel a partial revolution with each operation.



NO. 518,792.—LIGHTNING ROD AND COUPLING.

- 518,813. ELECTRIC SWITCH; W. S. Hill, Hyde Park, Mass. Application filed Oct. 31, 1893. The combination with the contact pieces, of blades adapted to connect therewith to close the electric circuit, the contact pieces having flexible plates between which the blades pass to close the circuit, and rigid reinforcing plates secured thereto to increase the carrying capacity of said contact pieces.
- 518,877. ELECTRIC RELEASING DEVICE FOR DOORS; S. H. Curwen, Salem, Mass. Application filed July 12, 1893. The combination of a series of automatically closing doors or windows, a main line, branch circuits each including an electromagnet, a circuit closer interposed between the main line and the branch circuits, a contact arm, a mechanical motor for rotating the same, and a pivoted lever normally holding the motor against rotation, but permitting, when released, one complete revolution of the contact arm.
- 518,885. TABULATING SYSTEM; H. Hollerith, Washington, D. C. Application filed Aug. 1, 1893. The combination of a switch mechanism controlled by a record card, a series of independent circuits, each containing a relay and connected with the switch mechanism and a normally open independent local circuit, including the circuit controlling devices of the relays arranged in series.
- 518,886. TABULATING SYSTEM; H. Hollerith, Washington, D. C. Application filed Nov. 17, 1893. The combination with the integrator, switch mechanism, registers, and a starting circuit controlled from the switch mechanism, of a series of circuit controllers located in a branch of the starting circuit and controlled through relays connected to the switch mechanism.
- 518,894. ELECTRIC BELT; P. E. Petterson, Minneapolis, Minn. Application filed July 26, 1892. This comprises a series of batteries connected by wire links, each battery being composed of a bent zinc plate, absorbing felt folded about the plate, the plate secured on one side of a connecting link and a long and single sheet of zinc copper having its end curled about the side of the next link and thence extending entirely around the felt and lapping around itself.
- 518,906. AUTOMATIC DEVICE FOR REMOVING RESISTANCE IN STARTING ELECTRIC MOTORS AND REPLACING SAME; G. H. Whittingham, Baltimore, Md. Application filed April 4, 1893. This comprises a motor, a resistance coil, a movable contact device in circuit therewith; a pawl and ratchet operated by the motor armature and adapted to impart to the contact device a limited movement in the direction which reduces the resistance of the armature circuit, and means for disengaging the pawl and ratchet when the supply of electricity is cut off.
- ELECTRIC CIRCUITS; H. B. Wyman, Slingerland, N. Y. Application filed Dec. 20, 1893. An insulating cleat having a central fastening screw and its ends curled to form a hook to receive the wire, the points of the hooks so formed being impinged against the support for the cleat.
- 518,913. COMMUTATOR BRUSH; G. W. Brown, Deering, Me. Application filed Nov. 15, 1893. A commutator brush composed of woven wire cloth folded together and the inner layers only of which are impregnated with a graphite compound left in a soft yielding condition and adapted to make contact at its end with a commutator.
- 518,916. TELEPHONE TRANSMITTER; H. Cottrell, Newark, N. J. Application filed March 15, 1894. This comprises a variable resistance piece, consisting of a conducting base having projections extending therefrom, a diaphragm susceptible of being vibrated by sound waves and means for varying the contact between the projections, in correspondence with the vibrations of the diaphragm, to produce variations in the current.

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1881 " 26 " "	1888 " 175 " "
1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 269 " "
1884 " 82 " "	1891 " 325 " "
1885 " 100 " "	1892 " 340 " "
1886 " 138 " "	1893 " 377 " "

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THE WESTINGHOUSE ANNUAL REPORT.

The annual report of the Westinghouse Electric and Manufacturing Company contains no surprises and indicates the wisdom of the present policy of conducting its affairs on a strictly business basis, devoid of all the extravagant features in organization and personnel which were so largely the cause of its former reverses. Were the company, however, not so secure in its present position one of the items in the report would probably excite comment, and that is the asset of \$4,379,831.69 for "charter, franchises, patents, etc." While the Tesla patents which it owns are of undoubted value, its alternating patents have not thus far had the effect of securing to it any monopoly in that field, and the cost of defending the suits relating to these and to the Tesla patent must be considered in estimating their real value. Other items whose real value it must be difficult to exactly estimate are bonds, stock, advances to leased companies and book accounts, which amount to more than six and a half millions. It seems certain, however, that with the gradual improvement of the business of the country these latter assets will finally become secure and some may even recover their normal value. A very favorable showing is the increase, even though it be small, in profits over the preceding year, for with the terrible business conditions of the last year a moderate decrease shown would not have had much effect on the otherwise favorable reception of the report. A comparison with last year's report shows that the company has \$300,000 more money, and bills receivable and matured on hand, and \$566,000 less floating debt and bonds, while the asset of stock and bonds has been decreased by \$200,000. With new works under construction that will enable the cost of manufacture to be largely reduced, with increasing business, and, above all, a comparatively moderate capitalization, the future of the Westinghouse company seems assured.

THE CHICAGO A. I. E. E. LOCAL MEETING.

The discussion at the Chicago meeting of the American Institute of Electrical Engineers on the paper of Mr. Farnham is a valuable contribution to the Transactions of the Institute, while to the friends of local meetings it is a gratifying vindication of their position. Notwithstanding the great disparity between the number of the members in the territory tributary to the New York and Chicago meetings, respectively, the latter has already demonstrated that it need not fear comparison with the former if the lively professional interest thus far manifested is continued. It is doubtful if the profession at large would have had the benefit of even a small part of the important information brought out at Chicago if local meetings had not been inaugurated there, and we trust, in view of the similar additions to the value of the Transactions which would result, that steps will soon be taken by members in Pittsburgh, Schenectady, Boston and San Francisco to establish local meetings in those cities. With all of the electrical journals of New York now unanimously—we think we can assert—in favor of local meetings, and all, we believe, gratified at the success of the Chicago experiment, it is singular to find a Chicago electrical journal bitterly opposing that innovation and sneering at the efforts of Western members of the Institute to make it a success. It was scarcely to be expected that the journal in question would recognize the disinterested action of the New York members of the Institute, whose advocacy of local meetings implied a willingness to curtail the importance of the New York meeting. It was not foreseen, however, that

its disappointment at the impossibility of making this Chicago electrical body a journalistic annex would go so far as to traduce an enterprise when every consideration of local pride should cause the reverse course to be eagerly followed. As the paper in question has never pretended, so far as we know, to represent the electrical engineering profession of the West, confining its claims solely to its advertising department, and has no member or its technical staff on the rolls of the Institute, its attacks on the Chicago local meeting are indefensible, and can only be construed as an acknowledgment of professional impotency, and an exhibition of chagrin at the establishment of an electrical body in Chicago of which it cannot hope to make ulterior use.

LONG DISTANCE AND SUBMARINE TELEPHONY AND RAPID TELEGRAPHY.

In another column we print an abstract of two important patents recently issued to Prof. M. I. Pupin, of Columbia College, which claim to offer a solution of perhaps the most important electrical problems which now confront us—submarine rapid telegraphy and telephony, and long distance land telephony and rapid telegraphy with conductors of moderate cost. The principle consists in dividing a line into a number of sections depending upon the periodicity of the current to be used, and then tuning these various sections to the proper frequency by interposing condensers in series with them. The method should not be confounded with that of Prof. S. P. Thompson, who proposed to counteract the distributed capacity of cables by means of inductance devices. It has been pointed out in reference to the latter method that while an inductance can be neutralized by a capacity, the reverse is not true, and Dr. Pupin does not employ inductance coils except as a detail having no relation to the principle involved in the method. The importance of these claims is evident from the facts that if practically established they not only furnish a solution of ocean telephony, but will enable 400 words per minute, instead of a present maximum of 30, to be sent through ocean cables; further, they admit of telephony between New York and Chicago over ordinary telegraph lines, and would put New York within reach of telephone communication with San Francisco. It will be seen that the solution only applies to the electrical problem and that mechanical difficulties of great proportions will be encountered in applying the method to submarine work, on account of the condensers for this purpose not only having to be large but numerous. For long land lines, however, there seems to be no practical difficulty, as the condensers can be installed in way offices in the same manner as telegraphic relays. Aside from the great saving in copper that would result on present long distance telephone lines is the more important point of extending by this method the range of these. At present the New York-Chicago line seems to have nearly reached the limit, as any further extension under the present method would require a still heavier wire than the No. 8 B. & S. now used, and when we consider that the cost of one of these lines is now said to be \$375,000, it is readily seen that further additions to both size and length would entail an expense that would render any such project commercially impossible.

COST OF ELECTRICITY.

That there exists considerable misconception in regard to the cost of generating electricity in central stations is frequently made manifest by the extremely low figures quoted, and the error is generally on the side of underestimation. In a paper on the "Cost of Electrical Energy," recently read by Mr. R. E. Crompton before the English Institution of Electrical Engineers, an estimate is made of the cost of electrical energy developed in an "ideal" station and distributing system, costing \$2,500,000 and designed for the most eco-

nomical production of 5,000,000 kilowatts annually with a load factor of .2. As the estimate is based upon 2.5 pounds of coal per kilowatt, or about 1.9 pounds per electrical horse power delivered, it will not be disputed that the case is indeed an ideal one, but the estimate may serve the purpose of indicating the range within which reductions may be made. In the same paper data of 23 central stations are given, and for the purpose of comparison with the ideal case and also to show the average and possible minimum cost of generating electricity in England at the present time, we have calculated the following table. The first column refers to the ideal station, and the second and third columns contain, respectively, the minimum and the average figures, as far as given in the paper, of the 23 stations quoted and now in practical operation; the data for the minimum cost do not refer to the same station, each item being the lowest under that head for all the stations:

	Ideal station.	Present stations.	
Operating expenses.		Minimum.	Average.
Fuel	.54	1.26	2.22
Stores and water	.06	.09	.30
Labor and superintendence	.40	.74	1.44
Maintenance	.80	(.80)	(.80)
Management	.84	(.84)	(.84)
Capital at 4 per cent	2.00	(2.00)	(2.00)
Cost per kw., in cents	4.64	5.73	7.60
Cost per electrical h. p., in cents	3.48	4.30	5.70

The figures for maintenance, management and for capital charges are not given in the paper for the present stations, and are assumed to be the same as for the ideal one, the estimate for these items being made on a more liberal basis than for operating expenses. The rate assumed for maintenance, Mr. Crompton states, is in accordance with experience, and should be sufficient to keep a plant in working order forever. The rate for management includes taxes and insurance. It will thus be seen that, under the conditions given and assuming the basis of this estimate to be correct, the very lowest figure we may hope to attain for the cost of generating electricity in central stations and distributing it is 3.48 cents per electrical horse power; that if one station should in England unite all of the minimum conditions of the stations quoted, the cost would be 4.30 cents per electrical horse power, while the average is 5.70 even with an ideal basis for the estimate of maintenance and management. The stations in England where the operating expenses are stated to be the least are those of Knightsbridge and Liverpool, this item being 2.1 and 2.2 cents per electrical horse power, respectively, corresponding to a total cost per electrical horse power of 4.85 and 4.95 cents, which figures represent the most economical practice in that country at the present time. How this compares with American practice we can only surmise in the absence of the necessary data. The load factor in a few of our stations is probably already in excess of .2, which would affect all of the items except fuel, water and stores, but, on the other hand, the relative cost of all items is doubtless greater in this country than in England. In the light of these figures it seems more reasonable to accept 6 cents per electrical horse power (exclusive of capital charges), as the cost of developing electrical energy in the average American central station, instead of 4 cents, the figure most usually quoted. This higher figure might apply to even large stations, while for the smaller ones it is probably considerably too small.

An Electro-Chemical Journal.

A new monthly journal has been started in Berlin specially intended as the organ of the electro-chemical and electro-metallurgical industries. The new journal, which is entitled the "Electrochemische Zeitschrift," is edited by Dr. Neuburger, and is published by Dr. N. von Klobukow through Fischer's Technologischer Verlag, Berlin. A long list of contributors has already been prepared.

Prof. J. J. Thomson.

The accompanying engraving is from an excellent photograph of Prof. J. J. Thomson, one of the most eminent living physicists. Prof. Thomson, who is the son of the late Mr. J. J. Thomson, of Manchester, England, was born at Cheetham, near Manchester, on the 18th of December, 1856, and is, therefore, in his 38th year. When 14 years of age he became a student at Owen's College at Manchester, receiving his training in physics under the well-known late Prof. Balfour Stewart, and mathematics under Prof. Barker.

Prof. Thomson's pre-eminent ability for mathematical analysis applied to the development of physics early manifested itself, for after entering Trinity College, Cambridge, in 1876, he obtained as an undergraduate the Foundation scholarship and the Sheepshank scholarship for astronomy. After four years at Cambridge University he graduated as Second Wrangler and Second Smith prizeman, and was elected to a fellowship at Trinity College the same year. Two years later he was appointed to a lectureship in mathematics. An essay that he wrote "On the Motion of Vortex Rings," and possessing marked merit on a most recondite subject, received the Adams prize in 1883. Prof. Thomson was made a fellow of the Royal Society in 1884, when only 27 years of age, and in the same year became professor of experimental physics at Cambridge, which chair he still retains.

Prof. Thomson's contributions to mathematical physics are numerous and important. He has written three books.

First, "A Treatise on the Motion of Vortex Rings," which is the standard mathematical text book on that subject at the present time.

Second, "Applications of Dynamics to Physics and Chemistry," a most interesting and important application of mathematics to a very obscure and difficult field. By purely dynamical reasoning Prof. Thomson succeeds in establishing throughout this book a series of conclusions concerning various relations between physics and chemistry, pointing out where in the absence of experimental knowledge various important reactions may be looked for, and where, on the other hand, they may be expected to fail. Lagrange, when he developed that magnificent theorem in dynamics which alone would immortalize his name, and by which the reactions of any material system can be predicted from a sufficient number of observations upon the mutual interdependent actions of that system, never could have anticipated a more complete and notable vindication of his methods than that Prof. Thomson's book propounds.

Third, "Recent Researches in Electricity and Magnetism." The rapid development of the principles laid down by the late Clerk-Maxwell in his celebrated treatise on electricity and magnetism has necessitated a revision, an extension of that great text book. By unanimous consent, the task of bringing this up to date was entrusted to Prof. J. J. Thomson, and his book carries the evidence that a worthy selection was made. Not only have numerous typographical errors in Maxwell's work been corrected by Prof. Thomson, but this new book is the best sequel to Maxwell's treatise in the English language to-day. It is true that some of the theories outlined in it are quite different from, although not in opposition to, those of Maxwell; but the development of the subject of electric waves, which so prominently engrosses modern thought, is dealt with in Maxwellian methods by a master hand. A long chapter is devoted to the passage of electric discharges through gases and is probably the clearest and most complete account of that difficult subject which has ever been published.

Most of Prof. Thomson's papers on scientific subjects have been published either in the "Transactions of the

Royal Society" or "The Philosophical Magazine," as is shown by the following list:

"Electric and Magnetic Effects Produced by the Motion of Electrified Bodies," Phil. Mag. 11, p. 229. 1881.

"Electromagnetic Experiments with Open Circuits," Phil. Mag. 12, p. 49. 1881.

"Dimensions of a Magnetic Pole," Phil. Mag. 13, p. 427; 14, p. 225.

"Maxwell's Theory of Light," Phil. Mag. 9, p. 285. 1880.

"Theory of Electric Discharge in Gases," Phil. Mag. 15, p. 427. 1883.

"On the Chemical Combination of Gases," Phil. Mag. 18, p. 233. 1884.

"Magnetic Effects Produced by Motion in the Electric Field," Phil. Mag. 28, p. 1. 1889.

"Passage of Electricity Through Hot Gases," Phil. Mag. 28, pp. 358, 441. 1890.

"Velocity of Transmission of Electric Disturbances," Phil. Mag. 29. 1890.

"Illustration of Properties of Electric Field by Means of Tubes of Electrostatic Induction," Phil. Mag. 29, p. 129. 1890.

"Discharge of Gases Through Exhausted Tubes Without Electrodes," Phil. Mag. 32, pp. 321, 445. 1891.

"On the Effects of Electrification and Electrical Action on a Steam Jet, and of Water Vapor on the Discharge of Electricity Through Gases," Phil. Mag. 36, p. 313. 1893.

"Vortex Ring Theory of Gases," Proc. Roy. Soc. 39, p. 23. 1885.



PROF. J. J. THOMSON.

"Resistance of Electrolytes to the Passage of Very Rapidly Alternating Currents," Proc. Roy. Soc. 45, p. 269.

"On the Effect Produced by Neighboring Conductors on the Rate of Propagation of Electric Disturbances Along a Wire," Proc. Roy. Soc. 46, p. 1.

"Specific Inductive Capacity of Dielectrics When Acted on by Very Rapidly Alternating Electric Forces," Proc. Roy. Soc. 46, p. 292. 1889.

"On the Rate of Propagation of Luminous Discharges Through a Rarefied Gas," Proc. Roy. Soc. 49, p. 84. 1890.

"Electrolysis of Steam," Proc. Roy. Soc. 53, p. 90. 1893.

"Electrical Oscillations on Spheres," Proc. Lond. Math. Soc. 15, p. 197. 1883.

"Electrical Oscillations on Cylinders," Proc. Lond. Math. Soc. 17, p. 310. 1885.

"Electrical Oscillations," Proc. Lond. Math. Soc. 19, p. 520. 1887.

"Rotation of Plane of Polarization of Light by a Moving Medium," Proc. Cambridge Phil. Soc. p. 250.

"Electric Discharges in a Uniform Field," Proc. Cam. Phil. Soc. 5, p. 291.

"On the Telephone," Proc. Cam. Phil. Soc. VI., p. 321.

"Effect of Pressure and Temperature on Electric Strength of Gases," Proc. Cam. Phil. Soc. VI., p. 325.

"Report on Electrical Theories," B. A. Report, 1885.

"Vibrations of a Vortex Ring," Phil. Trans. p. 62. 1882.

"Determination of 'v,'" Trans. A, 1883.

"Applications of Dynamics to Physical Phenomena," Phil. Trans. 1885. Part 2, 1887.

In connection with Mr. H. F. Newall:

"On the Formation of Vortex Rings," Proc. Roy. Soc. 39, p. 417. 1886.

"On the Rate at Which Electricity Leaks Through Bad Conductors," Proc. Roy. Soc. 42, p. 410. 1887.

"On the Effect of Narrow Crevasses on the Magnetization of Iron Rods," Proc. Cam. Phil. Soc. VI., p. 84.

In connection with Prof. Threlfall:

"Effect Produced by Passage of Discharge Through Nitrogen," Proc. Roy. Soc. 40, p. 329.

"On the Formation of Ozone," Proc. Roy. Soc. 40, p. 340.

In connection with Mr. G. F. C. Seale:

"Determination of 'v,'" Phil. Trans. A., 1883.

In connection with Dr. Monckman:

"Effect of Surface Tension on Chemical Actions," Proc. Cam. Phil. Soc. 6, p. 264.

Extracts from some of these papers have frequently found their way into the technical journals devoted to the application of electricity and magnetism. As a notable instance of the value attached to his papers it may be pointed out that prior to 1892 the effect of the thickness of soft iron plates in the magnetic circuit of alternating current transformers, upon the amount of energy lost in them in eddy currents, and in the diminution upon their magnetic quality by reason of imperfect magnetic penetration as a consequence of such eddy currents, was a vexed subject of discussion and debate. One paper of Prof. Thomson's, appearing in the London "Electrician" of April 8, 1892, page 599, has so completely exhausted the subject from its mathematical standpoint that no further discussion upon this point has since been raised.

Death of Dr. Zetsche.

Dr. Karl Eduard Zetsche, whose death has just been announced, was born in Altenburg, Saxony, in 183c. From 1851 to 1856 he visited the polytechnic schools and the universities in Dresden and Vienna, and afterward entered the employ of the Austrian Telegraph Service in Vienna, Padua and Trieste. In 1858 he became teacher of mathematics and mechanics at the Royal Technical School at Chemnitz in Saxony, and in 1876 he accepted the chair of professor of telegraphy at the Polytechnic School in Dresden. In 1880 he went to Berlin and became editor of the "Electrotechnische Zeitschrift," a position which he held for six years. From 1880 to 1887 he was also telegraph engineer in the German Postal Service. Since that time he has resided in Dresden, devoting his attention to literary and scientific occupations. He has published several books on geometry, trigonometry and telegraphy, most of which have run through several editions. For the fourth volume of his latest work, "Der Betrieb und die Schaltungen der Elektrischen Telegraphen," he and Herr Kohlfuerst received, in 1891, an honorary diploma at the Paris Exhibition, and in 1882 they were awarded a prize of 1,500 marks by the Verein der Deutschen Eisenbahnverwaltungen. Dr. Zetsche was a foreign member of the Institution of Electrical Engineers, of the Electrical Societies of Dresden, of the Saxon Society of Engineers and Architects, and of the American Institute of Electrical Engineers, and of other learned societies.

General Meeting of the American Institute of Electrical Engineers.

The following changes have been made from the programme for the Philadelphia meeting as published in our columns last week: The first paper of the Wednesday session on "Central Station Economy," by C. R. Van Trump, and the last paper of that day's session on "Some Storage Battery Phenomena," by W. W. Griscom, have exchanged places on the programme. Two papers have been added to the list of those to be read at the Thursday morning session,

as follows: "An Optical Phase Indicator and Synchronizer," by Prof. George S. Moler and Dr. Frederick Bedell, and "A New Method of Recording Any Kind of Variable Current," by Prof. A. C. Crehore.

Symbols and Nomenclature.

Those interested in the introduction of symbols may find some basis for arguments in the following words, which occur repeatedly in a single paragraph only a few inches in length in a German contemporary, with apparently no intention of being either witty or sarcastic: Oberpostdirektionssekretär, Fernsprechvermittlungsanstalten, Stadtfernsprecheinrichtungen, Fernsprechverbindungsanlagen, Vielschaltensystem, Klappenelektromagneten und Maximalwasserstandsmeldeapparate.

In justice to the Germans, it might be stated that to any one understanding the German language all these words are quite intelligible without the aid of a dictionary; moreover, a dictionary would not contain them. They are merely compounded-compound words, and there is no difficulty in understanding them if one can solve the problem of placing the omitted hyphens in their proper place, and of stopping to take breath at the right intervals.

Electric Railways in America Compared with Those in England.

In a recent paper by Mr. Wilkinson he refers to the fact that there are 5,000 miles of street railways in this country and states that "5,000 miles of tramways is 500 miles more than five times the total length of our tramways in England; and still they have not solved what most English tramway men now consider the essential problem for the general introduction of electric traction on English lines, viz.: a mode of working, commercially and practically successful, without the use of overhead wires."

Moonlight Tables for June, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of June under his modified form of moonlight schedule.

TABLE NO. 1. Standard Moonlight System.				TABLE NO. 2. Frund's New Moonlight System.			
Date	Light	Date	Extng.	Date	Light	Date	Extng.
1	7 50 P. M.	2	3 30 A. M.	1	7 50 P. M.	2	3 30 A. M.
2	7 50 "	3	3 30 "	2	7 50 "	3	3 30 "
3	7 50 "	4	3 30 "	3	8 00 "	4	3 30 "
4	7 50 "	5	3 30 "	4	8 00 "	5	3 30 "
5	8 00 "	6	3 30 "	5	8 00 "	6	3 30 "
6	8 00 "	7	3 30 "	6	8 00 "	7	3 30 "
7	8 00 "	8	3 30 "	7	8 00 "	8	3 30 "
8	8 00 "	9	3 30 "	8	8 00 "	9	3 30 "
9	8 00 "	10	3 30 "	9	8 00 "	10	3 30 "
10	8 00 "	11	3 30 "	10	8 00 "	11	3 30 "
11	8 00 "	12	3 30 A. M.	11	8 00 "	12	3 30 A. M.
12	8 00 A. M.	13	3 30 "	12	8 00 A. M.	13	3 30 A. M.
13	8 00 "	14	3 30 "	13	8 00 P. M.	14	3 30 A. M.
14	8 00 "	15	3 30 "	14	8 00 A. M.	15	3 30 A. M.
15	8 00 "	16	3 30 "	15	8 00 P. M.	16	3 30 A. M.
16	8 00 "	17	3 30 "	16	8 00 "	17	3 30 "
17	8 00 "	18	3 30 "	17	8 00 "	18	3 30 "
18	8 00 P. M.	19	3 30 P. M.	18	8 00 "	19	3 30 "
19	8 00 "	20	3 30 "	19	8 00 "	20	3 30 "
20	8 00 "	21	3 30 "	20	8 00 "	21	3 30 "
21	8 00 "	22	3 30 "	21	8 00 "	22	3 30 "
22	8 00 "	23	3 30 A. M.	22	8 00 "	23	3 30 A. M.
23	8 00 "	24	3 30 "	23	8 00 "	24	3 30 A. M.
24	8 00 "	25	3 30 "	24	8 00 "	25	3 30 A. M.
25	8 00 "	26	3 30 "	25	8 00 "	26	3 30 A. M.
26	8 00 "	27	3 30 "	26	8 00 "	27	3 30 A. M.
27	8 00 "	28	3 30 "	27	8 00 "	28	3 30 A. M.
28	8 00 "	29	3 30 "	28	8 00 "	29	3 30 A. M.
29	8 00 "	30	3 30 "	29	8 00 "	30	3 30 A. M.
30	8 00 "	1	3 30 "	30	8 00 "	1	3 30 A. M.
31	8 00 "						
Total hours, 131.20				Total hours, 132.40			

Note.—These schedules are made up on sun time. Where standard time is used and it varies considerably from sun time, the proper deduction or addition must be made to all the times here given.

The Midwinter Fair.—IV.



THE technical journals of the East frequently contain articles describing some new automatic high-speed engine which has been placed on the market and is recommended as being suitable for dynamo driving. These are without exception from the machine shops of the East, the West being hardly looked to as likely to produce anything of value. The Eastern public is apt to look on the Pacific slope as being almost in the condition it was in '49, and while manufacturers know that considerable machinery is used (especially for mining purposes), much of which is made on the coast, yet they would not

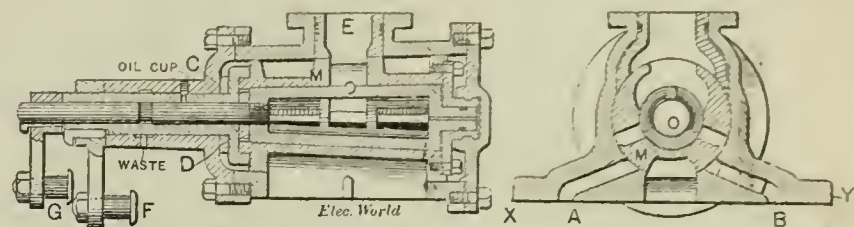
for a moment think it possible that anything had been done that was in any manner an improvement on the Eastern product.

An engineer from the East inspecting the exhibits in Machinery Hall at the Midwinter Fair cannot fail to notice that among the engines driving the dynamos are several with which he is unfamiliar, and a close inspection will certainly show some points that cannot fail to interest him. Several of these engines are in very extensive use on this coast for driving dynamos, as well as for general power purposes, and it is believed a description of them will not be without interest in some quarters.

It is a fact worth noting that whereas most of the modern high-speed engines made in the East are of the single-valve

A very neat exhibit of this kind is the Ohmen compound automatic cut-off engine, built by the Ohmen Engine Company. It is prominently located on the main aisle of Machinery Hall and drives three standard 50-light arc dynamos, all three being driven from a single flywheel. The wheel is of sufficient width to carry two belts side by side, the third belt running under one of the others.

The view given shows the engine very plainly. It is a tandem compound, cylinders 12 inches and 21 inches by 14

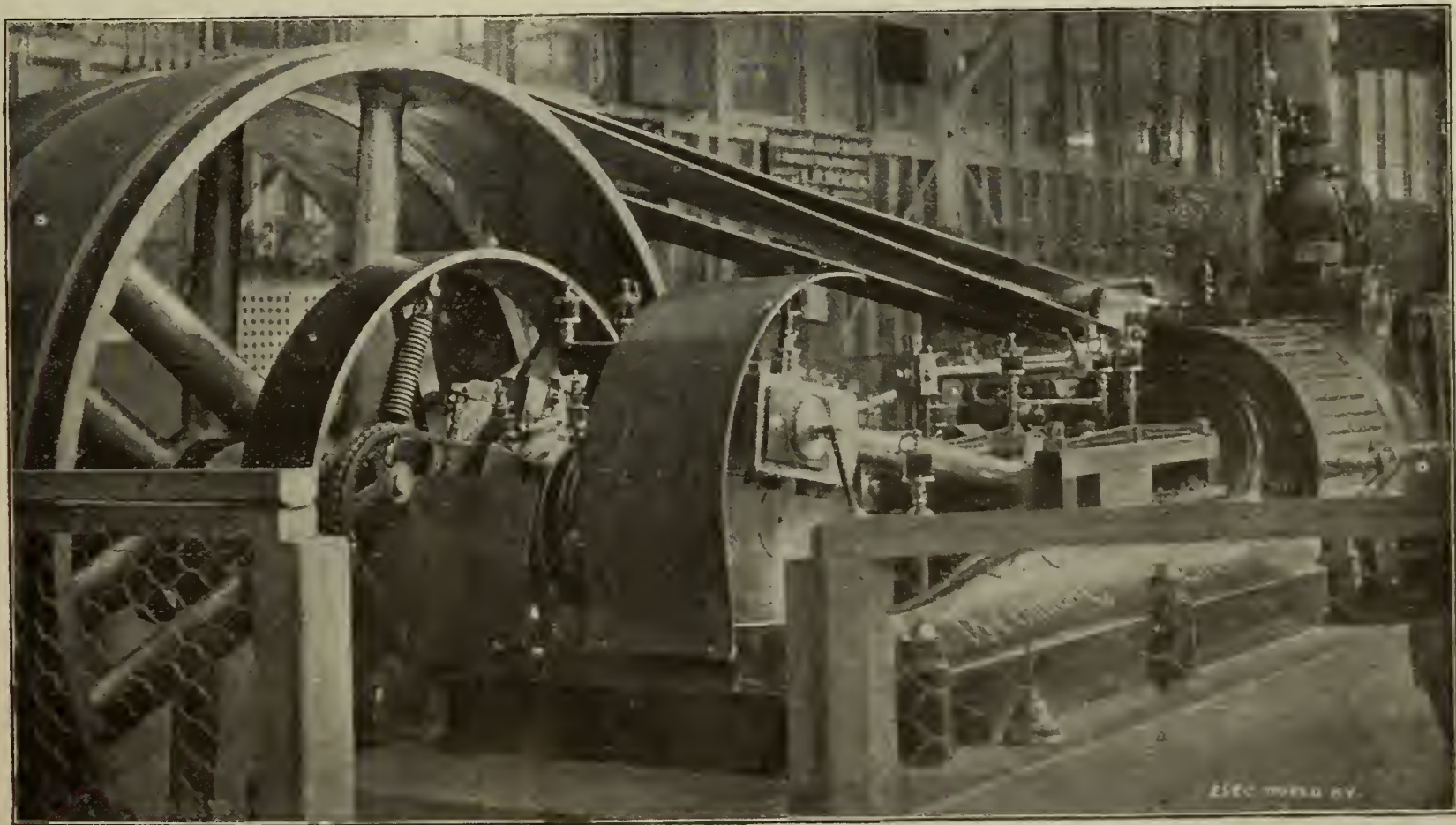


LONGITUDINAL AND VERTICAL SECTIONS OF OHMEN-SIMMONS VALVE.

inches, runs at 200 revolutions and develops 150 h. p. with 125 pounds of steam on the boilers. The duty claimed for it is 1-h. p. per hour on about 20 pounds of steam.

The low pressure cylinder is fitted with an ordinary "D" slide valve, but the high pressure carries the valve, which is the distinctive feature of the Ohmen engine and is covered by patents. It is the Ohmen-Simmons valve and is plainly shown in the longitudinal and sectional views given.

A conical valve chest is bolted to the cylinder along the line *XI*, *A* and *B* being the parts leading to the cylinder. In this chest is fitted the main distributing valve, *M*, which bears against the cast iron collar *C*. Within the distributing valve is the conical cut-off valve, *O*, bearing against the cast iron collar *D*. Steam enters at *E* and fills the bodies of both main and cut-off valves. The main valve and the valve of the low pressure cylinder are worked by a fixed eccentric and their motion is invariable, but the cut-off valve



OHMEN COMPOUND ENGINE DRIVING THREE STANDARD DYNAMOS.

type, those developed on this coast have double valves, and while the steam admitted varies as per requirements, the exhaust remains practically constant. This constant exhaust is not an altogether desirable feature, as when steam is cut off early the compression may not properly fill the clearance space, and live steam may be required for the purpose. Nevertheless, greater economy can probably be obtained than with a single valve, especially when compound engines are used with a double valve on the high pressure only.

is worked by a movable eccentric controlled by a flywheel governor of the usual type.

When the engine starts, the cut-off valve follows exactly the motion of the main valve and steam is taken nearly full stroke, but as the speed comes up the cut-off eccentric is shifted and the valve brought into play. As the cut-off valve has no motion independent of the eccentric, it cannot shut off steam very quickly, and there is considerable wire-drawing, as is the case with all engines in which the valves

have a positive motion, whether there is an independent cut-off or not.

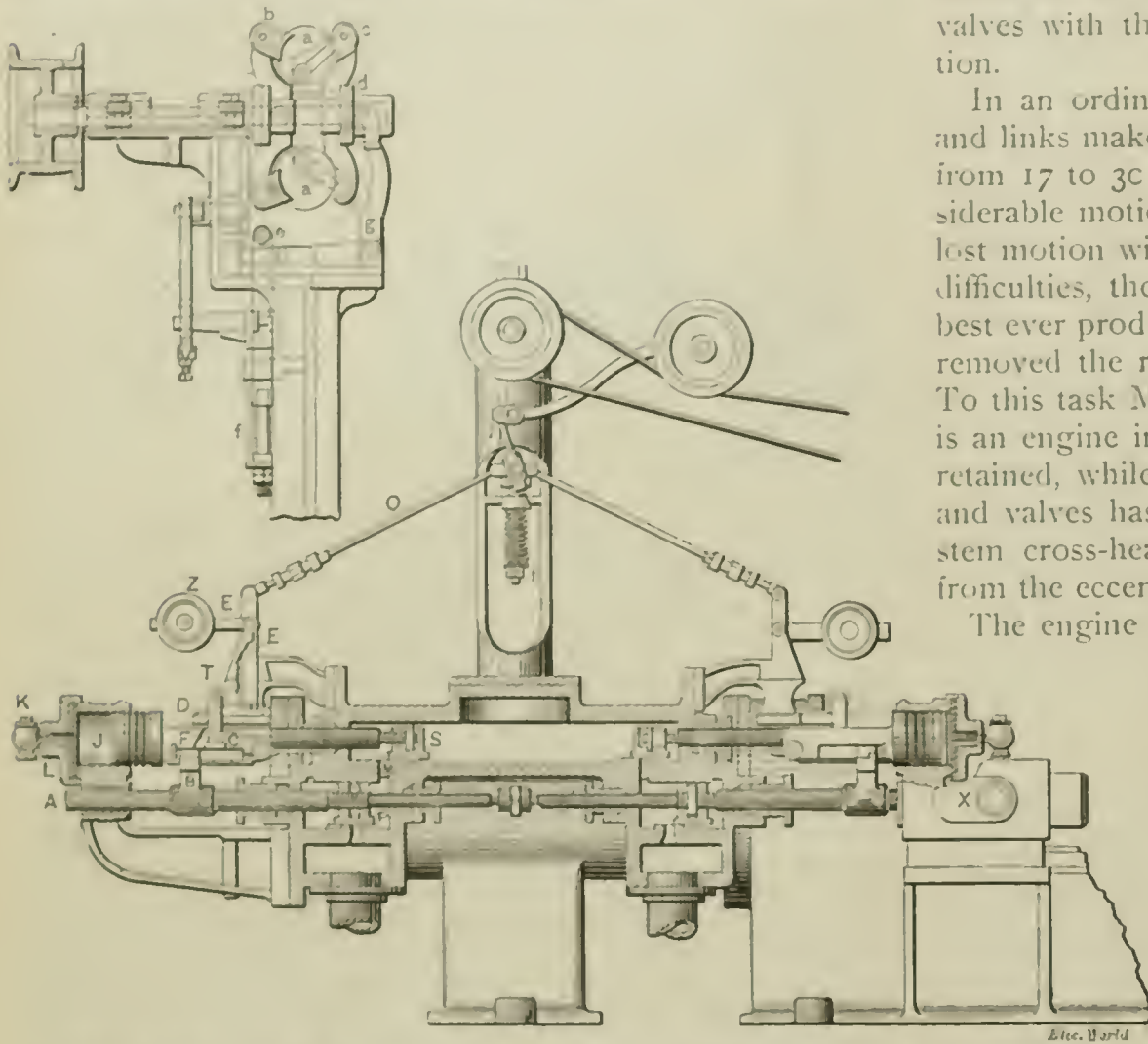
The single-cylinder engine has been on the market for several years and has given good satisfaction. The com-

types, two of which are quite unique and are important additions to the list of engines on the market. One of them is the I. F. Thompson slide valve Corliss, an engine in which the principle of the Corliss engine has been retained, but in which the valves ordinarily used have been replaced by slide valves with the result of greatly simplifying the construction.

In an ordinary Corliss engine the large number of rods and links makes a multiplicity of joints, the number varying from 17 to 30 in various styles. These joints all have considerable motion and consequent wear, and after a time the lost motion will become a serious matter. In spite of these difficulties, the Corliss engine, for moderate speeds, is the best ever produced, and it is evident that if its defects can be removed the resulting engine will leave little to be desired. To this task Mr. I. F. Thompson set himself, and the result is an engine in which the Corliss principle has been rigidly retained, while the number of joints between the eccentric and valves has been reduced to one only, that at the valve stem cross-head, through which the stem receives motion from the eccentric.

The engine at the Fair drives the 150-kw. Edison bipolar dynamo used for supplying current to the great searchlight and the electric fountain. It is compound, the cylinders being 12 inches and 22 inches by 30 inches; it runs at 120 revolutions with 125 pounds of steam, and at its maximum load develops about 225 h. p.

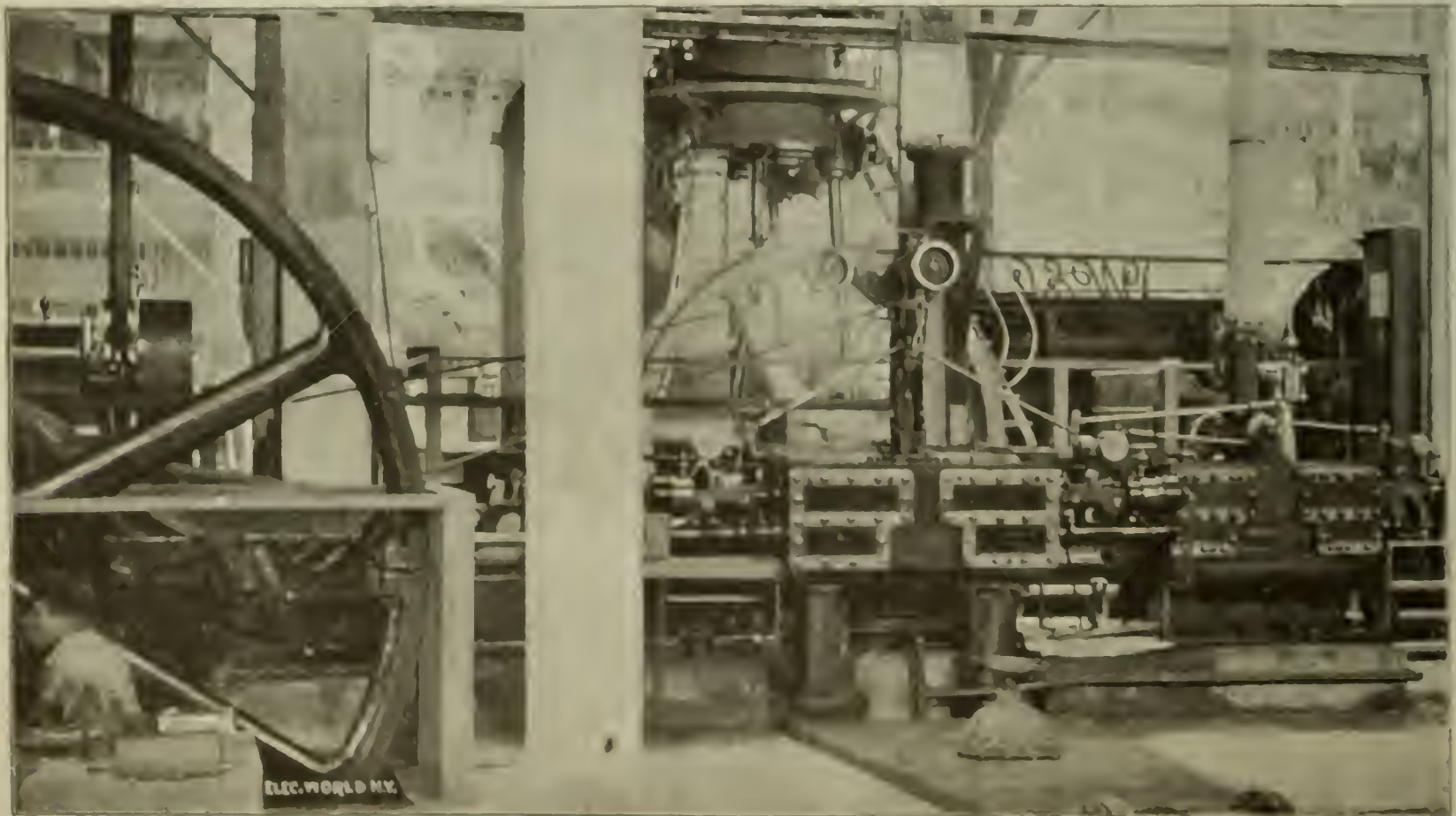
A sectional view of a single cylinder is given, showing the internal arrangement. The cross-head, *X*, receives motion from the eccentric rod and transmits it to the stem, *A*, which runs through the exhaust valve chests and underneath the steam chest, as shown. The steam chest is quite large, and acts as a reservoir for steam, from which the cylinder can draw a supply, thus enabling almost full boiler pressure to be received in the cylinder. Where a small



THOMPSON SLIDE VALVE CORLISS GEAR AND GOVERNOR.

pound engine was put forward about two years ago, and several of them are now running in electric stations. The workmanship is first class and the parts are made to gauge. It is built to run at speeds varying from 80 to 300 revolu-

as shown. The steam chest is quite large, and acts as a reservoir for steam, from which the cylinder can draw a supply, thus enabling almost full boiler pressure to be received in the cylinder. Where a small



THOMPSON SLIDE VALVE CORLISS ENGINE DRIVING G. E. 150-KW. DYNAMO.

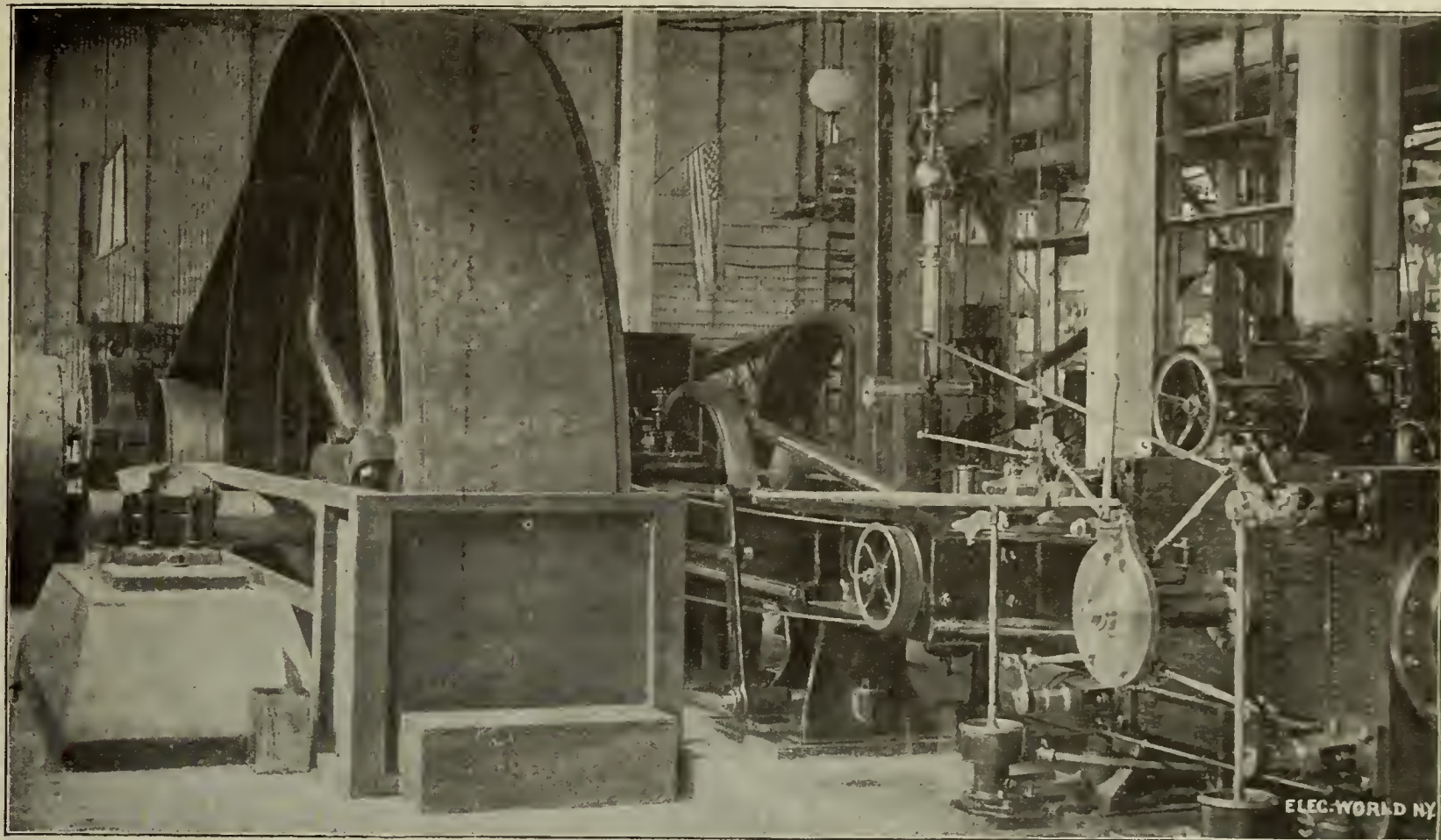
tions for such sizes as the one at the fair. One bad feature is that it is not self contained but has an outboard bearing.

The most extensive exhibitors are the Golden State and Miners' Iron Works, they having three engines of different

chest is used there must be considerable drop between boiler and engine unless the steam pipe is very large. As will be seen, the chest contains two small slide valves just large enough to give the proper covering for the post. They are

very light, and consequently the friction is small. The exhaust valves are similar to the steam valves, but are placed in chambers just large enough to give the necessary clearance. They are secured to the stem and having no connec-

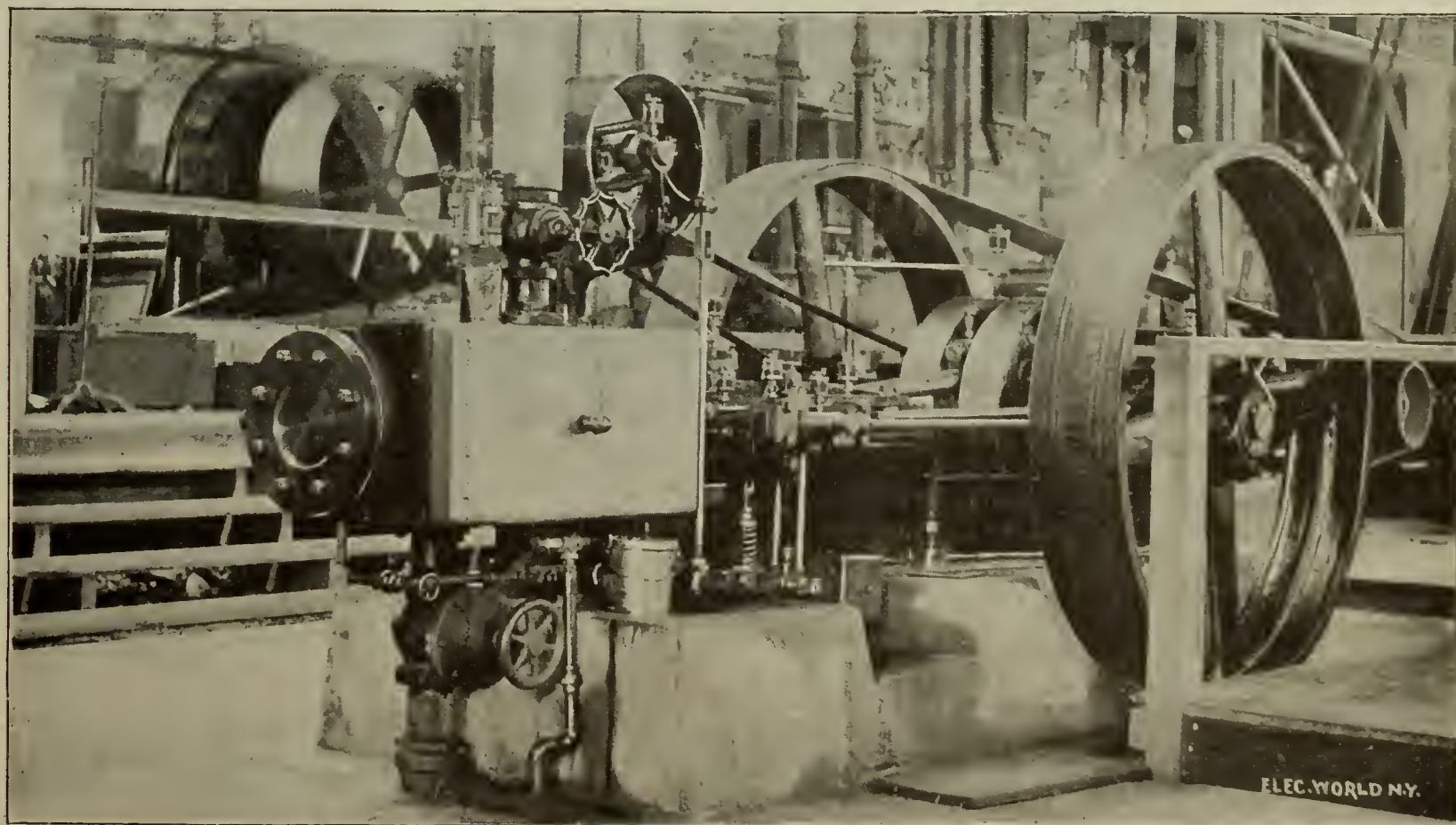
the steam valve stem and push the stem forward and with it the valve *S*, until sufficient steam is delivered to the cylinder to do the necessary work. Then the roller *T* rides on wedge *D*, and the trigger is lifted until it clears the steel



"GOLDEN STATE" CORLISS ENGINE BELTED TO CENERAL ELECTRIC 6,000-LIGHT ALTERNATOR.

tion with the governor, their motion, and consequently the point of closing of the exhaust, is fixed. Secured to the exhaust valve stem are two steel faced arms, *B*, which move the steam valve stem by means of knee triggers, *c*, which are pivoted to the valve stems, as shown. These triggers

ace of *B*. It will be seen that there is an effective area equal to that of the valve stem upon which the steam can act and when the knee trigger is released from *B* the stem is quickly pushed outward and the post closed by the valve *S*. This motion is necessarily very quick, and the post is closed in-



"GOLDEN STATE" HIGH SPEED ENGINE RUNNING WESTERN ELECTRIC DYNAMOS.

carry at the upper ends hard steel rollers, *T*, which, as the stem is pushed forward, can ride on the steel wedges, *D*, the position of which is regulated by the governor.

Live steam of nearly full boiler pressure filling the steam chest, the forward motion of the exhaust valve rod causes the steel face of arm *B* to engage with the knee trigger on

stantly, making a very sharp cut-off. Dash pots, *J*, with air cushion, arrest the motion of the valve and rod when they are thrown. An adjustable valve at the back of the dash pot regulates the escape of air, and consequently the amount of cushioning.

The wedge *D* being set so as to trip the trigger when the

engine is running at normal speed, every change of load or steam pressure is instantly followed by a change in position of the wedge, so as to vary the point of cut-off and adjust the power.

The great point is that all these valves are moved by a single eccentric with but one joint between it and the valves. In the case of a tandem compound engine with second cylinder built on the same plan, the additional valves are moved by the same eccentric and with no additional joint.

It will thus be seen that the merits of the Corliss have been retained, while the principal defect, the numerous joints, has been removed. The substitution of a flat slide valve in place of the cylindrical oscillating valve is also of some advantage. Cylinders with this style of valve gear can be placed on any engine frame when the old cylinders are removable, and several such changes have been made on this coast, generally from the old style Corliss.

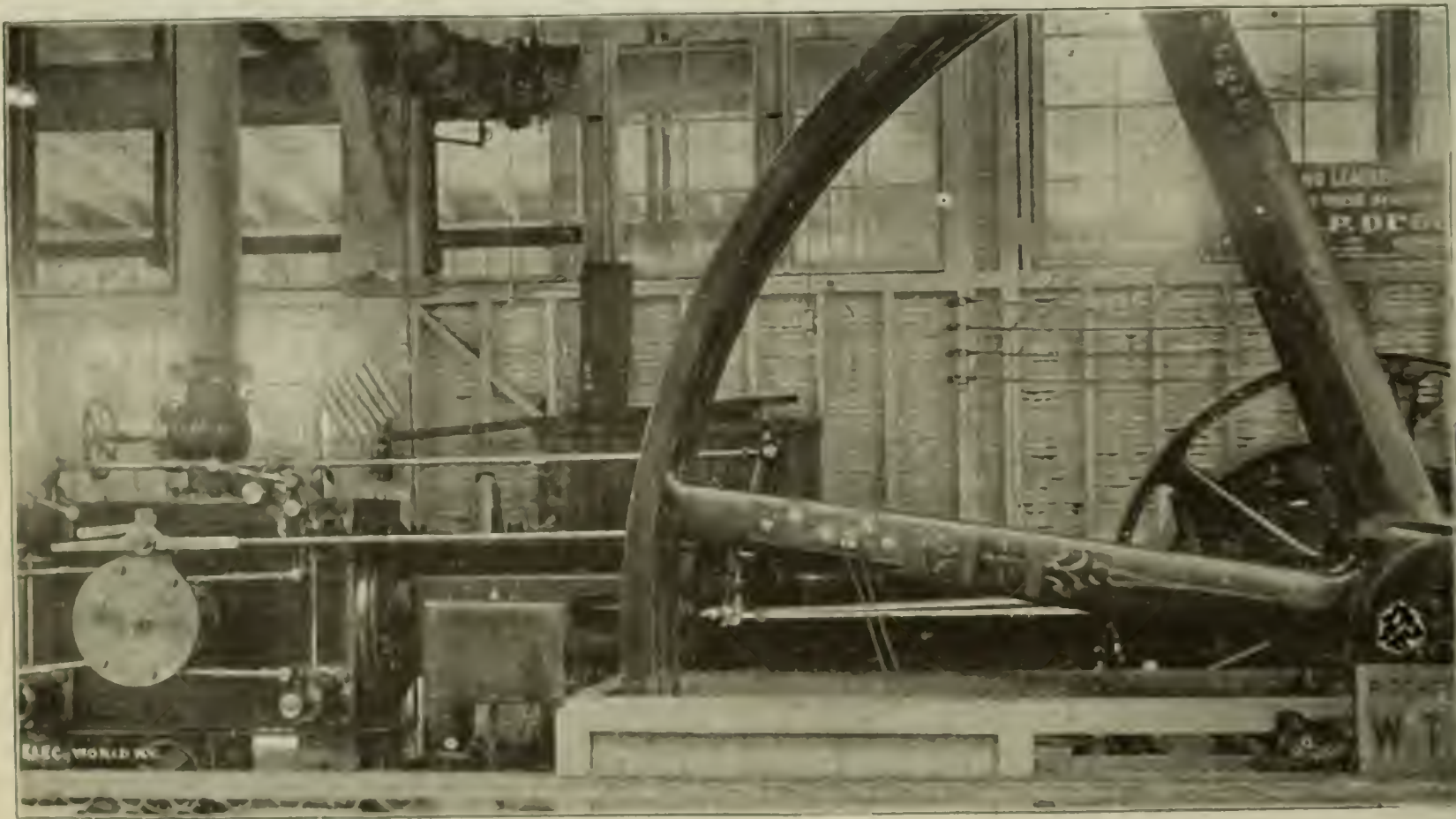
The governor used is also the invention of Mr. I. F. Thompson, and is covered by patents held by this company. It is very efficient and is clearly shown in the cut. A pair of revolving balls, *a a*, are pivoted by links to joints *c c*, and by ears to joints *b b*. As the speed increases and the balls fly out, the ears approach the horizontal, and the increasing length of arm exerts a powerful leverage, in virtue

cause all the parts are held in close contact by the pressure, which continually acts in the same direction.

The engine at the fair runs at 120 revolutions, but can easily be run at 150.

The engine which runs the big Thomson-Houston alternator is a standard Corliss, built by this company. It was formerly in the power house of the Powell Street Cable Railway Company, but was replaced by a slide valve Corliss.

Another important engine, built by this company, is an 8-inch by 16-inch single-cylinder high pressure engine driving a 50-light arc machine for the Western Electric Company. It runs at 265 revolutions and has developed 90 h. p. It is fitted with a Meyer valve, in which the cut-off blocks are separated automatically by means of a governor of the same design as that used on the slide valve Corliss. The view shows it very clearly, and it will be seen that the horizontal arm of the governor bell crank projects outward and is connected with a rod, which drops to the bottom of the engine frame close to the foundation, where it is jointed to one end of a horizontal lever, which is pivoted at the centre to the spring shown. The other end of the lever connects with two vertical rods, the upper ends of which are jointed to two bell cranks hidden behind the valve stem crosshead. The vertical arms of these bell cranks work two-valve rods.



PITCHFORD CORLISS ENGINE DRIVING WOOD ALTERNATOR.

of which the frame carrying the joints *c c* is forced against the collar *d*, and rocks the bell crank *g*. The horizontal arm of this crank lifts the vertical stems by means of the roller *e*, and this motion is communicated to the tripping wedges through rods *o*. The outward motion of the balls is counteracted by the spring *f*, which is used for strong adjustment, and by weights *h*, which are for finer adjustment. It will be seen that the action of both spring and weights can be regulated when the engine is running, and the speed can be varied 20 revolutions, in the sizes used at the fair, without stopping the engine.

As the spring shortens its action becomes relatively more powerful and a greater force is required to further shorten it, but at the same time the ears at *b a* approach the horizontal and a more powerful leverage is exerted, so that a small change of speed can make itself felt, and the governor is very efficient in keeping the speed within narrow limits.

No lost motion in the joints can offset its accuracy, be-

which enter the valve chest and are secured, one to each cut-off block of the Meyer valve. The connection is so made that the two valve rods move in opposite directions, and the distance apart of the cut-off blocks is automatically adjusted according to the requirements of the load. The two bell cranks are, of course, moved backward and forward by a cut-off eccentric.

Ordinarily, the cut-off blocks of the Meyer valve are on one stem, which extends outside the valve chest and is fitted with a wheel by which the cut-off can be varied by hand. It is a valve which has been used with good satisfaction on marine engines, and there is every reason to expect it to give good results as here applied.

This engine is the first one of this type made by the company, but they are now building another, in which the connections between governor and cut-off valve stems have been modified so as to get rid of some of the joints. It is evident that by having rack teeth cut on the outer ends of the valve stems and placing a spur gear between them, rocking the gear would move the stems in opposite directions.

The one making is on this principle, and the two bell cranks with their joints are eliminated.

Another engine out of the ordinary is the Pitchford Corliss, built by the W. T. Garrett company. A view of it is given, and it will be seen that it has a very great resemblance to an ordinary Corliss, but there are some important points of difference. It has the same four oscillating valves that are found in the Corliss, connected in the same manner to a rocker plate, but here the resemblance ceases. The valves are positively connected and must follow the motion of the eccentric, both for opening and closing the steam valves not tripping and closing quickly, as in the ordinary Corliss. A second eccentric, rotated as in modern high speed engines by a flywheel governor, moves backward and forward the upper rod shown. It will be noticed that the steam valves receive their motion from levers, the long arms of which are connected by rods to the rocker plate and the short arms by rods to one arm of bell cranks, which rock through the movement of the cut-off eccentric. It will be readily seen that if the cut-off eccentric is rotated through a change of speed, the limits of oscillation of the bell cranks will vary

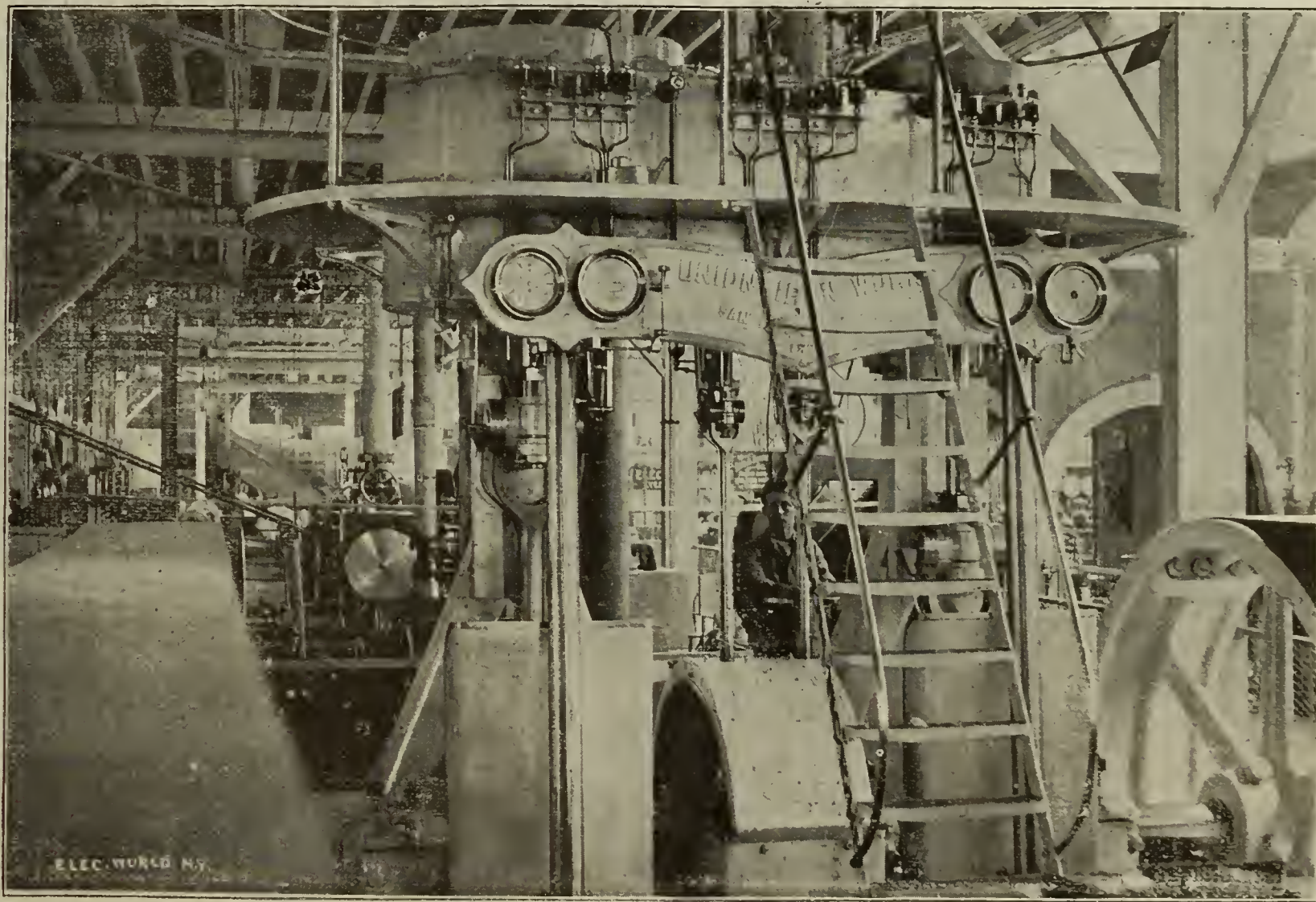
In the Mission street power house there will be two of this size and two developing 300 h. p. each, cylinders to be 16 inches and 28 inches by 24 inches, revolutions 160. After the plant is in running order, it is the intention to put in two more engines similar to these, but triple expansion, running at 600 revolutions and with the armatures built up on the shaft.

The Ball, Russell, and other standard Eastern engines are used for running some of the arc dynamos.

The Electric Motor.*

BY FRANCIS B. CROCKER.

In considering the history of the electric motor, Prof. Crocker states that Barlow's wheel was not only the first motor, but an invention remarkable from the fact that it antedated by eight years the disc machine of Faraday and his discovery of magneto induction in 1831. Not only was Barlow's wheel far ahead of Faraday's disc in point of time, but it was also a much better construction, the armature not being short circuited on itself as in the latter. The electric motor invented by Joseph Henry in 1831 has a better



VERTICAL COMPOUND MARINE TYPE ENGINE DRIVING WESTERN ELECTRIC GENERATORS.

with the result of changing the opening of the valves. The cut-off cannot, of course, be as sharp as with a tripping valve.

This engine runs well and is used for driving the large Wood alternator.

The two large 220-volt generators of the Western Electric Company are driven by a vertical compound engine of the marine type, built by the Union Iron Works. It is one of six intended for the power house of the Mission street electric road, now building, and its construction was hurried in order that it might be used in the exposition. The workmanship is of the high grade to which the Union Iron Works have become accustomed since they began to build men-of-war for the Government. The cylinders are 22 1-2 inches and 39 inches by 24 inches; they are intended to run at 160 revolutions and develop 600 h. p. on 130 pounds of steam. The high pressure cylinder is fitted with a piston valve and the low pressure with double ported flat valve.

right to the distinction of being called the first electric motor, it is declared, than Barlow's wheel, as it was the first which worked on magneto-electric attraction.

It is stated that in the United States there are probably about 50,000 stationary motors and several thousand railway motors, whereas the whole number in Europe is not much more than one-tenth of these figures. A parallel between the dynamo and motor is drawn and it is shown that one is exactly the converse of the other, and that a good dynamo is also a good motor. The tendency now is for manufacturers to make exactly the same machine for either purpose indiscriminately, with only slight changes in details of windings, connections, etc.

Prof. Crocker goes into the subject of counter E. M. F. at considerable length, stating that it is a key to the action of the motor and particularly of the difference between it

* Abstract of a lecture delivered before the Franklin Institute, Jan. 19, 1894.

and the dynamo. In the case of the dynamo there exists only one E. M. F., whereas in the motor there must always be two. The difference between the two cases may be expressed very simply in the following way:

One kilowatt dynamo,

$$C = \frac{E}{R} \quad (1)$$

$$10 \text{ amperes} = \frac{100 \text{ volts}}{10 \text{ ohms}}$$

One kilowatt motor,

$$C = \frac{E - e}{R'} \quad (2)$$

$$10 \text{ amperes} = \frac{100 \text{ volts} - 90 \text{ volts}}{1 \text{ ohm}}$$

C is the current;

E , the direct E. M. F.;

e , the counter E. M. F.;

R , the total resistance of the circuit;

R' , the resistance of the armature.

The current and direct E. M. F. are the same in the two cases, but the resistance is only one-tenth as much in the case of the motor, the difference being replaced by the counter E. M. F. of 90 volts, which acts like resistance to reduce the current.

That the counter E. M. F. of a motor is a necessary result of the rotation of its armature was shown by an experiment. One of two identical machines was connected to an electric light circuit, thus causing it to run as a motor, and the other one belted to it, thus driving the latter as a dynamo. As in both cases identical armatures revolve at the same speed in magnetic fields of practically the same strength, nearly the same E. M. F. must be generated in each armature, since practically the same number of lines of force are cut by an equal number of turns of wire revolving at the same speed. In the case of the dynamo this E. M. F. produces a current which may be used to feed a certain number of lamps. In the case of the motor the E. M. F. is opposed or counter to the direct E. M. F. of the electric light circuit, and the current produced is due to the difference between the two as expressed in equation (2).

In all cases where energy is converted, excluding those where it is frittered away in heat, as by friction or electrical resistance, there is a counter force, as shown in the storage battery, the decomposition of water magnetizing an electromagnet and when electrical energy is converted into heat by the Peltier effect.

In the case of the motor, the counter E. M. F. actually represents the amount of electrical energy converted into mechanical energy, and therefore determines the efficiency, the so-called electrical efficiency, or conversion-factor, being equal to

$$\frac{\text{Counter E. M. F.}}{\text{Direct E. M. F.}}$$

The actual or commercial efficiency is somewhat less than this, owing to friction, Foucault currents and hysteresis. The counter E. M. F. also determines the speed and many other facts in the working of the machine.

It is somewhat difficult to measure counter E. M. F., because from its very nature it is covered up, so to speak, by the direct E. M. F. The ordinary way to determine it is to find the value of the direct E. M. F., the resistance and the resulting current, the counter E. M. F. is then found by the following equation, which is derived from equation (2): $e = E - C R$. It is also possible to calculate it in the same way that the E. M. F. of a dynamo is determined, if the number of turns of wire, speed of rotation and number of lines of force are known.

An experiment may be so conducted as to actually show the existence of the counter E. M. F. A plain shunt wound

motor provided with a flywheel may be taken and run from a constant potential circuit of, say, 110 volts, and while running at full speed entirely disconnected from the circuit; it will then continue to run by the energy of the flywheel and act as a dynamo and generate an E. M. F. of nearly the initial volts, say, 105, which is tested by connecting a voltmeter to the two brushes. This E. M. F. is practically identical with the counter E. M. F. which the machine was producing the moment before while running as a motor, provided, of course, the test is made immediately, so that the speed does not have time to fall appreciably. If a lamp is kept connected across the terminals of the motor while the switch controlling the circuit is alternately opened and closed, it is possible in this way to compare the direct and counter E. M. F. by the variation in the brightness of the lamp and it will be seen that the latter is only slightly less than the former.

A still more striking demonstration of the reality of the counter E. M. F. may be given by running the motor with a certain amount of resistance in its shunt field circuit so that the field magnetism will be below its normal value, in which case the speed will be higher than usual. If the machine is now disconnected from the circuit and the resistance is afterward cut out of its field circuit, the E. M. F. produced will become actually higher than the original direct E. M. F.; in fact, it is possible to obtain two or three times the original voltage.

The important matter of governing the speed or power of electric motors depends largely upon the phenomenon of counter E. M. F. For example, the various methods of regulating street car motors, i. e., the simple rheostat, the "loop" for short circuiting one of the field coils, the "commutated fields" and the "series parallel controller," all act to adjust, or make up for, the variations in counter E. M. F. which result from changes in speed. The most awkward matter in working electric motors is to control the current when the counter E. M. F. is very low, due to the fact that the motor is starting or running slowly. The introduction of resistance in series with the armature is usually the simplest and most successful plan, but this is very wasteful of energy and involves the use of a large and clumsy rheostat.

The paradoxical fact that the speed of the ordinary shunt-wound motor increases if its field magnetism be weakened is also due to the counter E. M. F. This is easily understood if we remember that the counter E. M. F. is reduced by weakening the field magnetism, consequently the current is increased in strength, as is evident from equation (2), and the speed therefore rises until the counter E. M. F. reaches a sufficient value to shut off the excess of current.

Prof. Crocker referred to a demonstration of his in a Columbia College lecture several years ago, that a motor can easily be designed to run at the same, or at a higher, speed when fully loaded than when lightly loaded. This may be done by slightly exaggerating the effect of armature reaction so that the field magnetism will be considerably reduced by the large armature current which flows at full load, thus diminishing the counter E. M. F. and increasing the speed in the manner just explained. In this way the remarkable effect of greater speed with heavier load is obtained without any special device or construction, all that is necessary being a slight modification in design involving no increase in cost or complication.

No Wonder They Pop When They Break.

Those who have not made the calculations for themselves may be surprised to know that the pressure of the air on the outside of the bulb of a 2,000-c. p. incandescent lamp having a surface of 300 square inches is about 1 3-4 tons.

Practical Notes on Dynamo Calculation.—I.

BY ALFRED E. WIENER.



THE author has endeavored, in the following articles, to develop an entirely practical treatise on dynamo calculation, differing from the usual text book methods, in which the application of the various formulae requires more or less experience in dynamo design. The present treatment of the subject is based upon results obtained in practice, and therefore, contrary to theoretical methods, gives such practical experience. Information of this kind will, in the following, be presented in the form of original tables and formulae derived from the data and tests of nearly two hundred of the best modern dynamos, of American as well as European make, comprising all the usual types of field magnets and of armatures, and ranging in all existing sizes.

The author's collection of dynamo data, which has been considerably increased by material gathered during his recent World's Fair visit, contains full particulars of the following types of continuous current machines:

AMERICAN MACHINES.

Edison single horseshoe type.....	20 sizes.
“ ironclad type.....	10 “
“ multipolar central station type.....	10 “
“ bipolar arc light type.....	6 “
“ four-polar marine type.....	4 “
“ small slow speed motor type.....	4 “
“ railway motor type.....	3 “
Thomson-Houston spherical arc light type.....	9 “
“ “ spherical incandescent type.....	4 “
“ “ multipolar type.....	3 “
“ “ railway motor type.....	2 “
Brush double horseshoe (“Victoria”) type.....	16 “
Sprague double magnet type.....	13 “
Entz multipolar marine type.....	5 “
Weston double horseshoe type.....	3 “
Lundell multipolar type.....	
Short multipolar railway motor type.....	
Crocker-Wheeler bipolar motor type.....	

ENGLISH MACHINES.

Kapp upright horseshoe type.....	4 sizes.
Paterson & Cooper “Phoenix” type.....	2 “
Mather & Platt “Manchester” type.....	2 “
Mather & Platt “Edison-Hopkinson” type.....	2 “
Paris & Scott double horseshoe type.....	2 “
Crompton double horseshoe type.....	
Kennedy single magnet type.....	
“Leeds” single magnet type.....	
Immisch double magnet type.....	
“Silvertown” single horseshoe type.....	
Elwell Parker single horseshoe type.....	
Sayers double magnet type.....	

GERMAN MACHINES.

Siemens & Halske innerpole type.....	3 sizes.
Schuckert multipolar flat ring type.....	3 “
Guelcher multipolar type.....	2 “
Fein innerpole type.....	
“ ironclad type.....	
“ inward pole horseshoe type.....	
Lahmeyer ironclad type.....	
Fickemeyer ironclad type.....	
“Allgemeine” innerpole type.....	
Bollmann multipolar disc type.....	

FRENCH MACHINES.

Gramme bipolar type.....	
Marcel Deprez multipolar type.....	
Desroziere multipolar disc type.....	
Alsacian Electric Construction Company innerpole type.....	

SWISS MACHINES.

Oerlikon multipolar type.....	
Brown double magnet type.....	

In this list are contained the generators used in the central stations of New York, Brooklyn, Boston, Chicago, St. Louis and San Francisco, United States; of Berlin, Hamburg, Hanover, Duesseldorf and Darmstadt, Germany; of London, England; of Paris, France; also the General Electric Company's large power generator for the “Magic City” intramural railway plant, and other dynamos of fame.

In the author's possession, but not included in the above list, are, furthermore, particulars of various special designs, and incomplete data of generators and motors, too numerous to be mentioned. Besides these the author has at his command considerable data on alternating current machines; but since the present treatise is to cover the ground of continuous current dynamos only, no enumeration of the former has been made here.

The author believes that the abundance of his material entitles him to consider the following treatise, and especially the tables and data contained therein, as universally applicable to the calculation of any dynamo.

I.—CALCULATION OF ARMATURE.

1.—Unit Armature Induction.

It is evident that a certain length of wire moving with the same speed in magnetic fields of equal strengths will invariably generate the same electromotive force, no matter whether the said length of wire be placed on the circumference of a drum, or of a ring armature, and no matter whatever may be the shape of the field magnet frame, or the number of poles of the different magnetic fields.

In order to obtain such a constant, suitable for practical purposes, we start from the definition: One volt E. M. F. is generated by a conductor of unit length, if moving with unit speed, and cutting 10^8 C. G. S. lines of force per second.

From this definition, which is given in the absolute (C. G. S.) system of measurement, we can easily calculate a constant for our practical units.

Since the English system of measurement is still the standard in this country, we will take one foot as the unit length of wire, and one foot per second as its unit linear velocity. For the unit of field strength we take an intensity of 20,000 lines of force per square inch, this being a good average number occurring in practice, as can be seen from the table of practical field densities, which will be given later on.

Based upon these units, and upon the law: “The E. M. F. generated in a conductor is directly proportional to the length and the cutting speed of the conductor, and to the number of lines of force cut per unit of time,” the derivation from the definition above referred to has been made in tabular form as follows:

Length of conductor.	Cutting velocity.	Density of field.	E. M. F. generated.
1 cm.	1 cm. per second.	100,000,000 lines per cm. ²	1. volt.
1 foot.	1 foot “ “	“ “ “ “	30.48 “ (1)
“ “ “ “	“ “ “ “	“ “ “ “	929.03 “ (2)
“ “ “ “	“ “ “ “	20,000 “ “ “	.186 “ (3)
“ “ “ “	“ “ “ “	“ “ “ per sq. inch.	.0288 “ (4)

(1) 1 foot = 30.48 cm. (2) 1 foot per second = 30.48 cm. per second; $30.48 \times 30.48 = 929.03$. (3) $\frac{100,000,000}{20,000} = 5,000$; $\frac{929.03}{5,000} = .186$. (4) 1 sq. in. = 6.45 cm.²; $\frac{.186}{6.45} = .0288$.

The result thus obtained can be worded: “Every foot of conductor moving with the velocity of one foot per second in a magnetic field of the density of 20,000 lines of force per square inch generates an electromotive force of .0288 volt.

If two or more equal lengths of wire are connected in parallel, in each of these lengths every foot of wire will generate .0288 volt, but these parallel E. M. Fs. will not add, but the total E. M. F. generated in one length will also be the total E. M. F. output of the combination.

In an ordinary bipolar armature, now, there are generally two such parallel branches, each branch generating the total E. M. F. This necessitates one foot of generating wire in each of these two parallel circuits, or altogether two feet of wire, under our unit conditions, in order to obtain an E. M. F. output of .0288 volt; or, in other words: Every foot of the total generating wire on a bipolar armature, at a cutting speed of one foot per second, in a field of 20,000 lines per square inch, generates .0144 volt of the output E. M. F.

In multipolar armatures the number of electrically parallel portions of the winding usually is equal to the number of

poles, $2P$, the number of pairs of poles being denoted by P . In such armatures it therefore takes $2P$ feet of generating conductor to produce .0288 volt of output, or the share of E. M. F. contributed to the total output by every foot of the generating wire on the entire pole-facing circumference is $\frac{.0288}{2P}$, or $\frac{.0144}{P}$ volt, that is, .0144 volt per pair of poles.

This theoretical value of the "unit armature induction," however, has to undergo a slight modification for the practical use, owing to the fact that generally only a portion of the total generating or "active" wire of an armature is "effective." "Active" is all the wire that is placed upon the pole-facing surface of the armature, "effective" only that portion of it which is actually generating E. M. F. at any time; that is, the portion immediately opposite the poles and within the reach of the lines of force, at that time.

The percentage of effective polar arc, in modern dynamos, according to the number and arrangement of the poles, varies from 50 to 100 per cent., and, usually, lies between 70 and 80 per cent. The lowest values of the effective arc, 50 to 60 per cent. of the total circumference, are found in the multipolar machines made by Schuckert, with poles parallel to the armature shaft, and having no separate pole shoes; in these the space taken up by the magnet winding prevents the poles from being as close together as in machines of other types. The highest figure, 100 per cent., is met in some of the Allgemeine Elektrizitäts Gesellschaft dynamos, in which the poles are united by a common cast iron ring (Dobrowolsky's pole bushing).

For these various percentages I have found the following average values of the unit armature induction per foot of the total active wire:

TABLE II—PRACTICAL VALUES OF UNIT ARMATURE INDUCTION.

Percentage of polar arc	E. M. F. per foot of active armature conductor, at unit velocity, 1 ft. p. s., and full field strength, 20,000 lines per sq. in.	
	Bipolar dynamos	Multipolar dynamos
100	.0144	.0144
95	.0142	.0135
90	.014	.013
85	.0135	.0125
80	.013	.012
75	.0125	.0115
70	.012	.011
65	.0115	.0105
60	.011	.010
55	.0105	.0095
50	.010	.009

It will be noticed that the values for multipolar machines run somewhat below those for bipolar ones. This means that, at the same rate of polar embrace, a greater percentage of the total active wire is effective in the case of a bipolar machine, which is undoubtedly due to a greater circumferential spread of the lines of force in bipolar fields.

2. Specific Armature Induction.

Knowing the values of the induction per foot of active armature wire at the assumed unit conditions, a general expression can now easily be derived for the "specific armature induction" at any given conductor speed and field density. The induction per foot of active conductor, in any armature, is

$$V = \frac{v}{P} \times S \times \frac{F}{20,000}, \quad (1)$$

where V = specific induction of active armature conductor, in volts per foot;

v = unit armature induction per pair of poles, in volts per foot, at $S = 1$ foot per second, and $F = 20,000$ lines per square inch, from Table II.;

P = number of pairs of magnet poles;

S = cutting speed, or conductor velocity, in feet per second, from Table III.;

and F = field density, in lines of force per square inch, from Table IV.

In this formula it is supposed that, as is usually the case, the number of electrically parallel circuits in the armature corresponds to the number of magnet poles. If these two numbers, however, are not identical, half the former number is to be substituted for P .

(To be continued.)

Alternate Current Electromagnets.

In a paper read before the Physical Society on April 27, Prof. S. P. Thompson points out that alternate current electromagnets have an advantage in the greater constancy in the pull which they exert over a given range. An advantage of the alternate current electromagnet is the greater constancy in the pull which it exerts over a given range. If supplied at constant voltage a fairly constant pull on the armature can be obtained over a considerable range. The reaction set up by the core tends to set up a back electromotive force, the limiting value of which is equal to the impressed voltage. If the resistance of the coil were actually zero and the magnetic leakage also negligible, this limiting value would be attained. Now, suppose that when acting upon its armature at a distance the self-inductive reaction chokes the current down to a certain value, the magnetization of the core going round cycles between definite maxima. Now suppose the core to be drawn in nearer to the pole, the reluctance of the magnetic circuit is lessened, and fewer ampere turns will suffice to produce an equal magnetization; but because the reluctance is lessened the coefficient of self-induction is correspondingly increased, and the current choked in corresponding proportion. These two effects counterbalance one another, the magnetization going round cycles of practically the same amplitude as before. Hence, the pull will be practically unchanged, save in so far as any change in the magnetic leakage at the different positions of the armature comes in to affect the question by weakening the field between the pole faces and the armature. Were the pole faces made relatively large so as to obviate the tendency to leakage and insure the field being nearly uniform in the gap spaces, the pull should be also very nearly constant throughout a range equal to at least one-third of the breadth of the pole face.

The Practical Importance of Resonance in the Transmission of Electrical Power.—III.

BY E. W. DUNBAR

As a graphical construction, if simple, greatly aids in the comprehension of an equation, a graphical representation of the equation of current in a circuit is given in Fig. 3.

The equation is

$$I = E \sqrt{\frac{2C\omega}{(R^2 + L^2\omega^2)(\cosh \rho l - \cos al)}}$$

R and $L\omega$ as usual are laid off at right angles. Their hypotenuse is then equal to $\sqrt{R^2 + L^2\omega^2}$. The angle μ

is made equal to $\frac{1}{2} \tan^{-1} \frac{L\omega}{R}$, that is the vertical angle between the hypotenuse and the perpendicular is bisected and this new hypotenuse made equal to the product of the length of the circuit and the square root of the other hypotenuse times the quantity $C\omega$. The vertical and horizontal sides of this triangle are respectively al and ρl , for we have shown that

$$\tan \mu = \frac{a}{\rho} = \tan \frac{90^\circ + \tan^{-1} \frac{L\omega}{R}}{2}$$

We have now all the elements for either the calculation

of the current at the distant end of an existing line or for the designing of a new line.

1. If R , L , ω and l are given to find I . Lay off R and $L\omega$ at right angles. Their hypotenuse is $\sqrt{R^2 + L^2\omega^2}$. Bisect the vertical angle and draw a hypotenuse equal to l times the square root of the product of $C\omega$ and $\sqrt{R^2 + L^2\omega^2}$.

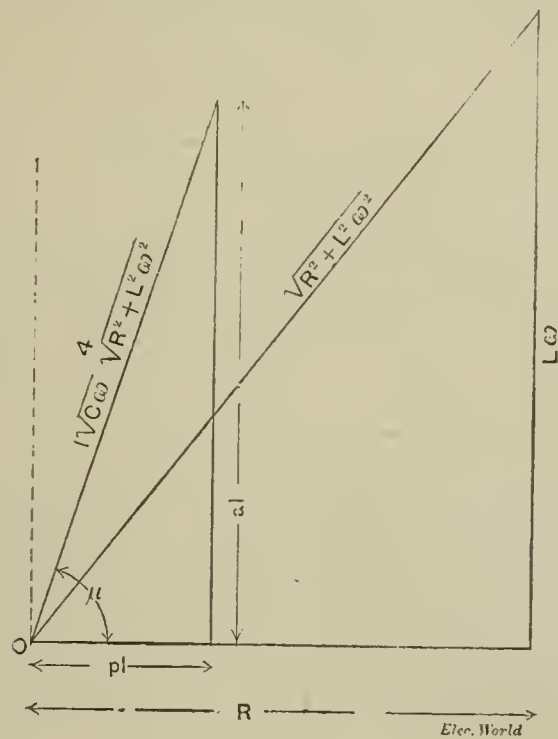


FIG. 3.

Then the two perpendicular sides of this triangle are the values of al and pl .

The values of $\cos al$ and $\cosh pl$ are found directly from a table of circular and hyperbolic cosines. The value of I may then be found directly from the equation.

This graphical construction is identical with the construction which Mr. Kennelly used in his very interesting article which recently appeared in the columns of The Electrical World, except that the use of the complex quantity $\sqrt{-1}$ is avoided.

It is evident that as the value of the cosine of a circular angle is periodic and varies from 1 to 0, and as the value of a hyperbolic cosine is not periodic and varies from 1 to ∞ , if the value of al be kept small, and thus $\cosh pl$ kept small, then when the $\cosh al = +1$, a maximum current will result. Thus, as we have already determined, $\tan \mu$ must be large and when $\frac{al}{\tan \mu} = .2$ no further gain can be made by decreasing pl .

To design a line for resonance then, by diagram, erect

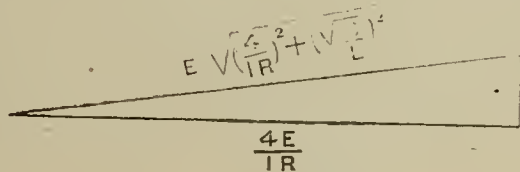


FIG. 4.

$al = 6.28$, draw $pl = 1.25$ and the hypotenuse will be equal to $l\sqrt{C\omega}\sqrt{R^2 + L^2\omega^2}$. Lay off an angle to the right of this hypotenuse equal to the vertical angle at its left and at a distance R from o erect a perpendicular until it cuts this second hypotenuse. Then this perpendicular gives the minimum value of $L\omega$ and the hypotenuse the value $\sqrt{R^2 + L^2\omega^2}$. Substitute this value of $\sqrt{R^2 + L^2\omega^2}$ in the other hypotenuse and the value of $C\omega$ is at once determined.

Having now shown that it is possible to bring into resonance any circuit by suitably adjusting the constants L and C , just as it is possible to tune any length string by suitably altering its tension and weight, we will now investigate the gain that may be derived from so doing.

The equation expressing the current at the distant end is

$$i = E \sqrt{\frac{2C\omega}{(R^2 + L^2\omega^2)^{1/2} \left(\cosh \frac{al}{\tan \mu} - \cos al \right)}} \sin \left\{ \omega t - \mu + \tan^{-1} \frac{\tanh \left(\frac{al}{2 \tan \mu} \right)}{\tan \frac{al}{2}} \right\}$$

Now we have shown that for small angles

$$\cosh \frac{al}{\tan \mu} - 1 = \frac{a^2 l^2}{2 \tan^2 \mu}$$

and that when the circuit is in resonance $al = 2n\pi$ and that $\cos al = +1$, also that $(R^2 + L^2\omega^2)^{1/2}$ is practically equal to $L\omega$. Hence

$$I = E \sqrt{\frac{2C\omega}{L\omega} \frac{8L^2\omega^2}{\pi^2 R^2}} = \frac{4E}{R} \quad (19)$$

and the phase $= \sin \left\{ \omega t - \mu + \tan^{-1} \mp \infty \right\}$
 $= \sin \left\{ \omega t - \mu \mp 90^\circ \right\}$

But as μ is nearly 90° when the circuit is resonant its sine is practically unity and we may write

$$i = \frac{4E}{R} \sin (\omega t + n\pi),$$

where n is the number of wave lengths in the circuit. This may be written

$$i = \mp \frac{4E}{R} \sin \omega t, \quad (20)$$

the double sign indicating whether the phase is coincident with, or in opposition to, the phase at the origin. We see, then, that when the line is in resonance, the current at the distant end is in coincidence with the phase of the E. M. F., and, farther, that its maximum value is *double the value that would result were the line devoid of capacity and inductance*. That is, if a constant E. M. F. of the same magnitude as the maximum point of the alternating E. M. F., which we have assumed, $2E$, were applied to the line, the current at the distant end would be but one-half the maximum value obtained with the alternating E. M. F. when the line is in resonance. The importance of this point is too obvious to be dwelt upon, and it may merely be remarked that a line of any length and any resistance may be brought into resonance for some period of alternation, and a 50 per cent. saving in copper thereby effected. The remaining important point is to examine the current at the origin when the line is in resonance. For, if the advantage of securing a current at the distant end of double the value which can be secured by a continuous E. M. F. and which is exactly in phase with the E. M. F. should be accompanied by a large percentage loss upon the line, then the commercial advantages of a resonant circuit would be, to a certain extent, offset by the loss upon the line.

The equation for the current at the origin is

$$i = E \sqrt{\frac{C\omega}{(R^2 + L^2\omega^2)^{1/2} \left(\cosh \left(\frac{al}{\tan \mu} \right) + \cos al \right)}} \sin \left\{ \omega t - \mu + \tan^{-1} \frac{\sinh \left(\frac{al}{\tan \mu} \right)}{\sin al} \right\}$$

When in resonance the phase is

$$\sin \left\{ \omega t - \mu + 90^\circ \right\} = \sin \omega t.$$

Hence, the current is also coincident in phase with the E. M. F. at the origin.

$$\text{As before } \cosh \left(\frac{al}{\tan \mu} \right) - 1 = \frac{\pi^2 R^2}{2 L^2 \omega^2}$$

$$\therefore I = E \sqrt{\frac{C}{L} \left(\frac{4 L^2 \omega^2}{\pi^2 R^2} + 1 \right)} = E \sqrt{\left(\frac{4}{R} \right)^2 + \left(\sqrt{\frac{C}{L}} \right)^2} \quad (21)$$

Thus, the current at the origin is equal to 1-2 the acting E. M. F. times the square root of the sum of the squares of $4 \times$ the conductivity of the line and the square root of the (reciprocal of the) products of its elasticity and inertia. Thus, referring to Fig. 4, the current at the origin is the hypotenuse of the right triangle, of which one side is the current at the distant end and the other is the factor $\sqrt{\frac{1}{\left(\frac{1}{C}\right) L}}$ corresponding to the mechanical property of a

stretched wire $\sqrt{\frac{1}{P M}}$, where P is the elasticity and M is the inertia.

However the factor $\sqrt{\frac{C}{L}}$ is so small in comparison with $\frac{4}{L R}$ in electrical circuits when in resonance that it may be neglected and we finally have,

$$i = \frac{4 E}{L R} \sin \omega t, \quad (22)$$

which is identical with the current at the distant end, save that it always has a positive phase. Thus, when a line is in resonance:

(1) The current at all points is in phase with the E. M. F., and consequently the power factor is a maximum.

(2) There is no noticeable decrease in the current as we approach the distant end, and consequently the line loss is proportional to the length of the circuit.

(3) The apparent resistance of the line is one-half the resistance offered to a continuous current, or the current is double that which a continuous E. M. F. would secure.

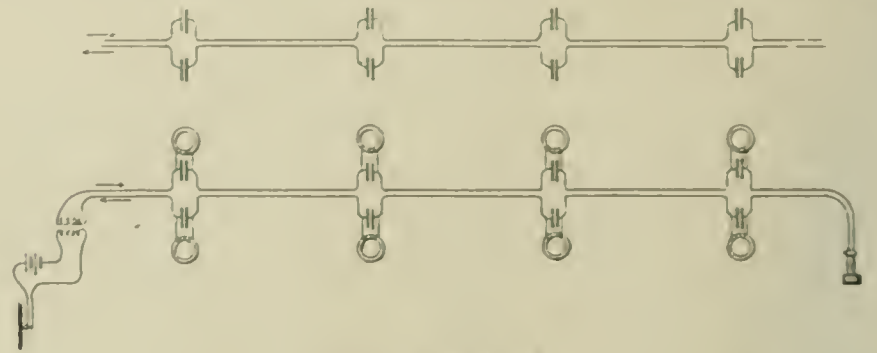
Submarine Rapid Telegraphy and Telephony.

Two important patents were issued to Prof. M. I. Pupin, of Columbia College, on May 8, for methods and apparatus for transmitting alternating currents, by means of which the effects of electromagnetic impedance and distributed capacity can be overcome, and the time constant of a circuit varied. One patent relates to the general principles claimed, and the other to the construction of a transformer for telegraphic, telephonic or other electrical systems, and the combination of such a transformer with a line conductor having in circuit telephone or telegraph instruments, or both. The clear, logical and scientific language in which these patent papers are written is worthy to be noted, and offers a striking contrast to the jargon usually found in patent specifications.

The difficulty of transmitting alternating, intermittent or any other kind of variable current through long cables, especially submarine cables, is stated to be owing to the combined action of self-induction and the electrostatic capacity and absorption of such cables, which, according to present methods of construction and working, offer an insurmountable barrier. By the principle contained in these patents, however, it is claimed that such currents, even when their rate of variation is high, can be easily transmitted over land and submarine cables of even very considerable length, as, for instance, the length of a transatlantic cable. The physical facts and underlying principles of the method invented are explained, reference being made to several papers of Prof. Pupin in which some of these were for the first time enunciated.

The principle of the method is as follows: If the parts into which a circuit is divided act upon each other by electrostatic induction, then the period of the total circuit is equal to the period of any one of its parts, if said parts are equally and essentially similar. Hence according to the physical facts demonstrated by Dr. Pupin, if the ohmic and other frictional resistances in such a circuit due to dielectric and magnetic

hysteresis are reduced in each part in such a way that the period of any part depends practically on the self-induction and the electrostatic capacity of that part, then the period of the whole circuit, no matter what length it may be, will depend upon the self-induction and the electrostatic capacity of any one of the parts, and on nothing else; but if said parts are not equal nor similar to each other, then the circuit may be said



FIGS. 1 AND 2.

to contain as many periods as parts. There will be, however, one period, called the period of the circuit, lying between the shortest and longest partial period, for which the electromagnetic impedance of the circuit will be a minimum. Then the conditions of resistance above mentioned being fulfilled, both the partial periods and the resultant period will depend on the inductance and electrostatic capacity of the various parts and on nothing else, provided that the ohmic and other frictional resistances are not beyond limits that would render the several parts of the conductor aperiodic.

The method is carried into practical effect by dividing a

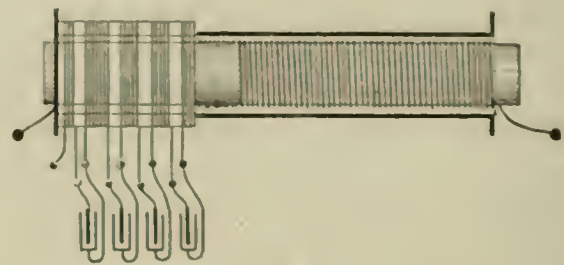


FIG. 3.

cable or an air line possessing appreciable distributed capacity into a number of parts and interposing condensers in series, as shown in Fig. 1. For example (it must be noted that the most difficult conditions that can arise in practice have been selected), if we suppose a cable 6,000 miles long with a total electrostatic capacity of 500 microfarads to have a condenser of 20 microfarads interposed between each of the mile lengths, the effective electrostatic capacity would be reduced to nearly one one-hundred and five thousandth of its original value, and the line capacity would also be very small in comparison with that of the interposed condensers. The cable, therefore, may be so constructed that the static charge of the line at any moment during the variable

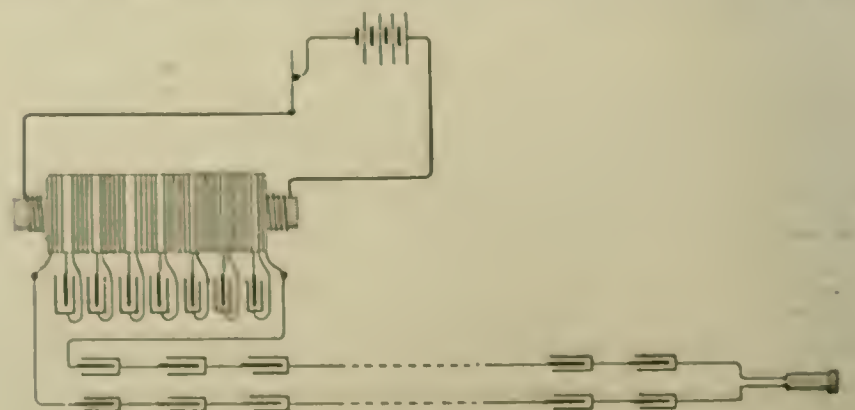


FIG. 4.

flow of electrical current along the cable can be made small in comparison to the static charge in the interposed condensers. Hence the electrostatic absorption on the whole cable can be made practically independent of the dielectric properties of the insulation of the cable itself and confined entirely to the dielectric properties of the insulator employed in the condensers. If

condensers, therefore, possessing practically no electrostatic absorption for small differences of potential are used, as, for instance, carefully constructed mica condensers, the electrostatic absorption of the total cable can be reduced to any practical limit that may be desired.

It is preferred in practice to place in shunt with each condenser an induction coil, as shown in Fig. 2, having a closed, or nearly closed, magnetic circuit. Such a coil, when the frequency is above 50 p. p. s., will allow only an inappreciable part of the main current to pass, but if the condenser should break down, would continue the main circuit, and thus make possible the location of the fault by ordinary methods.

The various data of two cables are calculated, one for telegraphic and the other for telephonic transmission; the latter is called a high pitch cable, and it is shown that in it the quality of telephonic sound would be little changed.

The following is given as a concise statement of the invention: Consider the current in the conductor of any section of the cable. That current consists of two distinct parts, one of which is due to the charging of the terminal condensers of that section, and the other to the charging of the surfaces of the conductor itself. The first current is called the longitudinal displacement component, and the second the lateral displacement component of the current in that section. The invention consists, therefore, in diminishing the ratio between the lateral and the longitudinal displacement components of a rapidly varying current. The wasting of a current due to the lateral displacement components in the various parts of the cable acts evidently like impedance, therefore it is to be

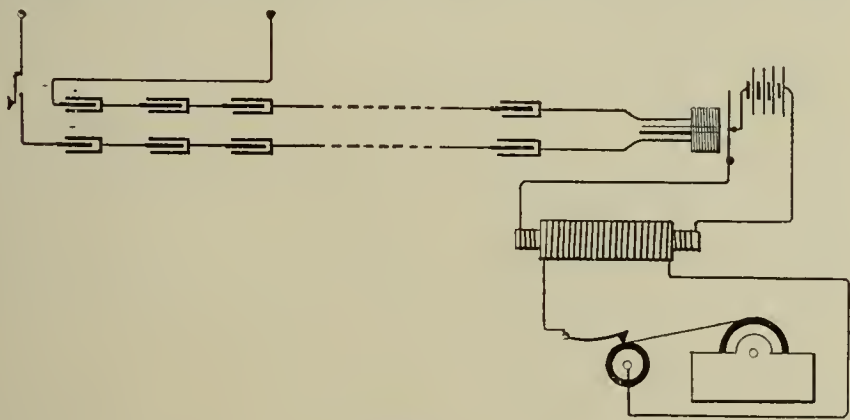


FIG. 5.

understood that the word impedance herein includes the impedance due not only to ohmic resistance, self-induction, etc., but also the waste of the longitudinal current resulting from the lateral displacement currents.

The transformer, which is the subject of a separate patent, is shown in section in Fig. 3; in Fig. 4 it is connected to a telephone line, and Fig. 5 shows the arrangement of the same line for both telegraphic and telephonic purposes, *I* being a telegraphic key. *A* is the core of the transformer, preferably of fine iron wire, *B* the primary coil and *D* the secondary coil wound on the spool *C*.

The condensers shown interposed in the secondary enable the time constant of the coil *D* and its capacity effect to be reduced to any desirable limit. If such a transformer be combined with a line conductor, as shown in the illustrations, and both the transformer and line be properly tuned, then it is claimed that the rapidity of transmission may be exceedingly great, the number of messages transmitted will be independent of electrical conditions, simultaneous telegraphy and telephony are practicable, and a telephonic current will control a recording telegraphic receiver. Any known means for very rapid telegraphy, such as the Wheatstone system, may be employed and the number of messages which can be transmitted will be limited only by the mechanism of the transforming and receiving devices. By the same method long distance telephones can be operated with small currents and high E. M. Fs., instead of the reverse, as at present, the necessity of a short secondary on account of the effects of self-induction on the upper harmonics being obviated by this method.

The Pollard Lamp.

The recent suit of the General Electric Company against the Boston Incandescent Lamp Company, an account of which we published in our issue of April 28, and referred to editorially in our last issue, is based on the method devised by Edward Pollard, now deceased, for passing the current into an incandescent lamp by making the glass stem which supports the filament serve as a conductor of electricity through the application of lines or films of silver to the same. An iron leading wire is then fused into the inner end of the glass stem by simply heating the glass, inserting the iron wire to the extent of about one-fourth part of an inch, and squeezing the glass upon it so that the silver-coated surface shall be in permanent contact with it. It is claimed that by the use of the Pollard invention the entire cost of platinum is saved, the cost of the silver used being negligible. The affidavit of Peter H. Walsh, submitted in the suit, gives the following account of the manufacture of the stem:

"I have witnessed in the manufacture of the Pollard lamp the operation of painting a narrow strip of printers' ink upon the inner surface of the glass tube, the introduction of the metallic silver in the state of an impalpable powder or molecular state of division, also the subsequent burning off of the printers' ink, leaving a film-like deposit of metallic silver upon the glass, and the remaining operations involved in forming the stem, and was not only interested, but much surprised at the rapidity with which these operations were performed. As observed by me during my visit to the works, the deposition of silver upon the glass tube was accomplished at the rate of about a thousand per day by one girl. The process is highly ingenious and original, and from a scientific point of view very interesting and beautiful. I made several determinations of the weights of silver deposited upon each tube by accurately weighing the tube before and after deposition upon a delicate balance, and found the maximum weight of metal to amount to 12 milligrammes, or about .19 of a grain, and having a value of .026 of a cent."

In reply to an affidavit of Mr. Jno. W. Howell, of the Edison Lamp Works, stating that "The employment of conducting films, as in the defendants' lamps, does not form an advance in the art over the use of small platinum wires, because the manufacturing operations are evidently more difficult and expensive with the former," Mr. Thomas H. Cabot, treasurer of the Boston Incandescent Lamp Company, in an affidavit, states positively that this is entirely without a foundation of fact. The manufacturing operations, he adds, are not in any way more difficult, and the saving in expense to his company from the use of the conducting film is sufficient at the present rate of production to pay a dividend of 10 per cent. on the capital stock. The Buckeye Electric Company, of Cleveland, Ohio, although free to make the Edison lamp, by the decision of Judge Ricks, found it to their advantage, he asserts, to manufacture the Pollard lamp in preference to the Edison, solely on account of the saving in cost of production.

In its brief the Boston Incandescent Lamp Company claims that the evidence proves that a substitute for platinum leading-in wires has been sought for with labor and expense for years by the owners of the Edison patent and by many others, and that the Pollard invention of the use of powdered silver was an invention in fact, and one which was not believed by experts to be workable, until they had seen it in operation.

The decision of the Court as to the application of the complainants for a preliminary injunction against the further manufacture of incandescent lamps, including the Pollard invention, was reserved, Judge Colt remarking that it involved important points of law.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

COMPILED FROM
PRINCIPAL FOREIGN
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ELECTRICAL JOURNALS
BY CARL HERING

ELECTRO-PHYSICS.

Cathode Rays.—A few remarks by Dr. Lodge and a translation of Hertz's paper of 1892 on the passage of cathode rays through thin metallic films are given in the Lond. "Elec.," April 27; Dr. Lodge thinks with Prof. Fitzgerald that it is extremely improbable that in these rays in the Lenard experiment there is any directly ethereal manifestation, everything points to the action of residual matter.

Conductivity of Solutions.—The Lond. "Elec. Eng.," April 27, mentions a paper by Mr. MacGregory from the "Ann. Phys. Chem.," the molecular conductivities are in general of a perfectly rectilinear character, except for silver acetate, which shows a change of curvature for dilute solutions.

Conductivity of Flames.—An article from the "Zeit. f. Phys. Chem.," Volume XII., page 24, is abstracted briefly in the Lond. "Elec. Rev.," April 27.

Theory of Hail.—The Lond. "Elec. Rev.," April 27, abstracts briefly an article by Mr. Marangoni on this subject, showing the attending electrical phenomena.

Double Electric Refraction.—"La Lum. Elec.," April 21, contains an article by Mr. Blondin on this subject.

MAGNETISM.

Magnetic Qualities of Iron.—The paper by Prof. Ewing and Miss Klaassen is concluded in the Lond. "Elec.," April 27; the heating effect of reversals is discussed; measurements were made with two exactly similar rings, in one of which the core is subjected to reversals, while the other was heated to an equal amount by a steady current, the temperature being adjusted by means of a thermo-electric circuit embedded in the core of each ring; the magnetizing current was passed around both, the winding being non-inductive in the second ring. It was intended to find whether the heat was the same when the transformer is loaded as when it is not; contrary to the results of Ryan, Morley and Ayrton, in which a marked reduction was shown in the loaded transformer, the present experimenters found that no change could be detected between the variation from no load to a very excessive load; these experiments are described in detail with a diagram of the connections and a few of the results. The magnetic curve tracer is briefly described; when the reversals take place rapidly more work is done than when they take place slowly, and it is an open question whether the excess is due to Foucault currents, as there may be a genuine time lag; that there is an increased amount of energy is shown from other experiments.

Magnetization of Hollow Cores.—In the "Elek. Zeit.," April 12, Mr. Foeppel endeavors to reconcile the apparently contrary results of Mr. Schulz (see Digest, March 10) and Mr. Grotrian (see Digest, Feb. 17), the latter claiming that hollow magnets were better under certain conditions; Mr. Foeppel claims that the flux penetrates the iron core from

the outside, that is, from the windings, that this penetration is more or less gradual and that it may, under certain circumstances, not reach the centre of the core; he cites as an illustration the fact that the inner parts of a large steel magnet cannot be magnetized and that such magnets must therefore be made of lamina separately magnetized. He suggests that while hollow cores might not be applicable to dynamos, they might be of use in certain transformers; by thus reducing the thickness of the iron he thinks it will be found that the coefficients of self and mutual induction of the two coils will not diminish in the same ratio. In conclusion, he suggests that in what has been written lately about screening delicate instruments from magnetism, no notice seems to have been taken of the fact that hard iron will make a much better screen than soft iron.

Electromagnet for Intense Fields.—The magnet of Dubois, mentioned in the Digest May 5, is described and illustrated in "La Lum. Elec.," April 21; it consists essentially of a ring with one air space into which the piece of iron to be tested can be introduced; a field of 40,000 units can be produced in a space several millimetres long.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Units and Terminology.—In "L'Ind. Elec.," April 25, Mr. Hospitalier reprints the arguments of Messrs. Houston and Kennelly in favor of the proposed names of the magnetic units, stating that the need of such names is becoming more and more important every day, and that he favors their adoption, notwithstanding the opposition from theorists; he states that had the suggestions come from France they would have been systematically rejected, but coming from America they will stand a good chance of being adopted. He also gives the suggestions of Messrs. Houston and Kennelly regarding the new prefixes, to which, however, he says there are certainly more objections than to the names of the magnetic units, but he is pleased to see that the subject is being agitated.

System of Nomenclature.—In the Lond. "Elec. Eng.," Mr. Hayward suggests a new system; he criticises that of Houston and Kennelly, saying that it deals only with thousandths and millionths, but not with hundredths, ten-thousandths, etc., and that the terms are not self-interpreting, and are therefore liable to be forgotten. In this system he affixes -n, -en, or -on to express ten times a unit, and affixes -t or -et to express one-tenth of the unit; he prefixes the syllables mono-, di-, tri-, tetra-, etc., to express the index of the power of ten, by which the unit is multiplied, the syllable used with the -n affix denoting a positive and that with the affix -t a negative index; he gives a number of illustrations.

Universal Shunt Box.—In a communication by Mr. Mather in the Lond. "Elec.," April 27, he shows that the statements made in that journal criticising adversely this new device (see The Electrical World, April 21, page 541,

and Digest, April 28) regarding damping and the want of proportionality are incorrect; in an editorial reply it is claimed that the remark regarding the serious amount of damping is justified by the fact that the working ratio of the shunt for quantity measurements sometimes differed from the corresponding ratio for current measurements by as much as 12 per cent.

Symmetrical Arrangement of Lissajou's Mirrors.—A symmetrical arrangement of these mirrors for measurements such as those of alternating currents is described in the "Elek. Zeit.," April 19, the principle being that the ray of light strikes the mirrors at their axis of rotation.

DYNAMOS AND MOTORS.

Variable Speed Motor.—An arrangement used in a French factory in which the motor was required to run at greatly varying speeds is described and illustrated in "L'Elec.," March 31, being based on the fact that the speed will be proportional to the difference of potential if the field of the motor is constant; the generator and motor are separately excited by a separate dynamo, the field of the generator being varied at the motor end by inserting a field resistance; variations of speeds from 25 to 80 can thus be obtained at an almost constant efficiency; as it is necessary to be able to stop the motor instantly, the resistance switch is so arranged that on moving it to its full extent the field of the generator is opened and the armature of the motor is short circuited, the field of the motor remaining constant.

Electric Motors vs. Gas Engines.—In "L'Elec.," April 7, Mr. Rechniewski cites a case in which a 4.5-h. p. motor was required and gives the cost of running a gas engine and a motor, both for no load and for full load, on the basis of 6 cents per cubic metre for gas and 9 cents per horse power hour for the current; running empty the cost for the electric motor is about one-third that of the gas engine and when fully loaded the proportion is about as 5 to 7 in favor of the gas engine; at about 3 h p., or about 66 per cent. of the maximum power, the cost is the same in both, thus showing that below this amount the motor was the cheaper; as the power required averaged less than this amount the electric motor was cheaper, even though the tests for full load show that the gas engine was the cheaper. An abstract is given in the Lond. "Elec. Eng.," April 13.

Coupling Alternators in Parallel.—Mr. Mueller, in the "Elek. Zeit.," April 19, describes a switching arrangement, by means of which the same voltmeter may be used to indicate the voltage as well as the synchronism.

Synchronous Motor with an Alternating Current.—The mathematical principle is abstracted briefly in the Lond. "Elec. Rev.," April 27, from a recent paper by Prof. Ferraris.

TRANSFORMERS.

Continuous Alternating Current Transformer.—The Hutin and Leblanc apparatus for transforming continuous into alternating currents of one or more phases, or the reverse, is described in detail and at considerable length by Mr. Aliamet in "L'Elec.," April 21, with the aid of 16 illustrations. It consists in principle of a Gramme ring, having a number of permanent connections from different parts of the windings to contact rings, where currents of different phases may be led off; it also contains a transformer and a commutator, the combination of all of which enables these results to be obtained, while at the same time the current may be transformed from a high to a low potential; the system is said to work admirably and that the efficiency is exceedingly high.

ARC AND INCANDESCENT LIGHTS.

Alternating Arc Lamps.—According to an abstract in the Lond. "Elec. Eng.," April 27, tests made at the Cologne and Amsterdam stations show that a greater voltage than 28 is not advantageous, the spherical illumination at 28.5 volts and 11 amperes being 275 spherical candles, while at 32.5 volts and 10.5 amperes it was 205 spherical candles, the

horizontal intensity being considerably greater in the first case than in the second; the horizontal, maximum and spherical illumination is given for various currents; for 50 amperes the spherical illumination was 2,625 and for 10 amperes 275.

Incandescent Lamp.—An article on this subject by Mr. Bainville is begun in "L'Elec.," March 31; he reviews briefly the history and gives some formulas regarding the dimensions of the filament; he finds that the diameter for a given efficiency and candle power is equal to a constant multiplied by the current raised to the two-thirds power, and that the length is equal to another constant multiplied by the candle power and divided by the diameter; the two constants must be determined by experiment and must be applied only to the same filaments.

Incandescent Lamp Manufacturers.—According to the Lond. "Elec.," April 27, a recent meeting was held of the lamp makers of Europe with a view to the formation of a union; the minimum prices were fixed at 30 cents for direct consumers and 26 cents for merchants and dealers.

A Simple Pump for Incandescent Lamps.—In the "Elek. Echo," April 7, Mr. Schenk describes a simple oxygen pump based on the principle that when alcohol is burnt in a bottle which is closed after the ignition, there will be no oxygen left after the flame is extinguished; a lamp bulb connected with such an apparatus may then be used for an incandescent lamp, as it contains no oxygen.

ELECTRIC RAILWAYS.

Novel Overhead System.—The Jex system is described briefly in the "Elec. Tech.," March 31; it is an overhead system in which the overhead wires run transversely across the street at intervals equal to about the length of a car; above the middle of the track the wires are cut and joined with an insulator, all the wires at one side being positive and those on the other negative; there are two contact devices on the car, one for each polarity, and they are of sufficient length to touch one wire before leaving the other; by this means no ground return is required; no illustrations are given. (The advantages of an insulated return seem to have been obtained at the expense of very great complications.) In the issue of April 15 a modification of this system is described (really an entirely different system), in which an insulated conductor is surrounded by a conducting tube in insulated sections with means for connecting these sections with the conductor, operated by a magnetic device carried by the car; it is suggested that this device would be of great use in temporary military lines to be laid in case of war; neither of the methods has yet been used in practice.

Electric Traction.—In the Lond. "Elec. Eng.," April 27, Mr. Lea discusses the views of Prof. A. B. W. Kennedy on electrical traction in the paper abstracted in another column under the heading of "Electrical Engineering." Prof. Kennedy gives the efficiency of electric railways as 35 per cent. and that of steam railways as 80 per cent., about which Mr. Lea says: "For the Professor's sake I will assume that they were obtained some considerable time ago. One can otherwise hardly credit the statement which he made as to the total efficiency of electric railways or tramways." He suggests that the working returns of the Liverpool Overhead Railway were apparently not analyzed by Prof. Kennedy, the ratio between the electrical horse power on the line and the indicated horse power at the station is as much as 88 per cent., also that on this line the locomotive has been abolished altogether; he also calls attention to the numerous rack railways in mountainous districts in Switzerland, calling particular attention to that of Mount Saleve, which is given as the most important, in which the main working efficiency, with a most unfavorable arrangement of gearing is not less than 52 per cent., and among the losses 16 per cent. is credited to imperfect gearing, so that by improvements in this alone the efficiency on the line would reach nearly 70 per cent.

Compressed Air Traction.—A paper by Mr. Victor Popp, the well known compressed air advocate of France, on a comparison between compressed air and electricity, is reprinted in the Lond. "Elec. Eng.," April 20; he claims that there are great disadvantages in every form of electric traction and describes compressed air traction with reservoirs and with a continuous supply along the line through a slotted conduit between the tracks; great claims are made for the compressed air system.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Cost of Electrical Energy.—A long and interesting Institution paper by Mr. Crompton is published in full in the Lond. "Elec. Eng.," and in part in the "Elec." and "Elec. Rev.," April 27; no cuts are given in any of these, but they are promised in a subsequent number of the "Elec. Eng." The paper is well worth reading in its entirety; it is impossible to give more than a general idea of it in an abstract. He deals only with stations using some form of fuel; the total cost to the user is grouped under four heads: works' cost, maintenance, management and profit, which are sub-divided into 12 divisions, of which he deals only with those of the first two heads; he assumes that the ideal station is designed for the most economical production of 5,000,000 units of energy per annum distributed to users in a large town under average conditions; the total cost should not exceed \$2,500,000 (in these reductions the pound sterling is assumed to be equal approximately to \$5), based on data of existing companies; he assumes that it will yield a profit of 7 per cent. on the whole sum, made up of \$1,000,000 in 4 per cent. debenture stock, \$400,000 in 6 per cent. preference stock, and \$1,000,000 in ordinary stock, at 10.5 per cent.; he estimates that \$45,000 a year is ample for the management charge. He discusses the question of what chance there is of reducing the present works' cost and maintenance cost to such an extent that the energy may be sold to the public at the low figure of 6 cents per kilowatt-hour; a load factor much above 20 per cent. can hardly be hoped for for many years to come; at this factor the maintenance charges are nearly five times as great as when the output is continuous; he gives a table of figures for the ideal standard works' cost, which he hopes may be reached at no distant period; they show a working cost of 44 per cent. of the receipts; a fuel consumption for the winter months of five pounds of Welsh coal per unit sold has several times been recorded; he assumes one-half of this and gives the reasons, based on a calorific value of 14,500 heat units per pound. He gives a large table for calculating the heat units in one pennyworth (two cents' worth) of fuel of various qualities and prices. The greater part of the paper is devoted to the subject of fuel and water, divided into boilers, economizers, etc., the effect of the efficiency of steam engines on dynamos or alternators and the effects of distribution efficiency; under the latter heading he gives a table giving this efficiency for quite a number of stations, showing that for direct systems, including meter losses, it varies between 85 and 90.1 per cent., whereas with alternating current systems it varies between 60 and 82 per cent., the higher being found where the system of switching transformers in and out of the circuit is practiced; in the very small loss of from 10 to 12 per cent. observed in the direct systems are included all those due to accumulators, in the mains, leakage and meters failing to register, and he thinks that it is not likely that this will be improved very much, if at all; he states that Americans claim that it would be better to reduce this efficiency by using less copper, but he considers the English practice right, and that at the present price of copper it can easily be shown that it is best to do so. The paper concludes with the subject of stores, water, labor and superintendence, for which he gives a table containing data from a number of stations; for maintenance he gives the figures for the Kensington and Knightsbridge companies for the past four years,

showing a cost of maintenance of 1.35 per cent., based on the original cost.

St. Pancras Station.—Some figures for the past year are given in the Lond. "Elec. Eng.," and less fully in the Lond. "Elec.," April 20. The revenue has increased over the previous year, while the expenses have increased only 4.5 per cent.; the profit was about \$30,000, as against \$13,000 in the previous year; it will be remembered that this is a municipal plant.

Scott System.—In "L'Ind. Elec.," April 25, Messrs. Kando and Chenet describe the system of Mr. Scott (see The Electrical World, March 17 and 24) for transforming diphasic into triphasic currents, and add an interesting discussion of the relations of the currents when the charges are different in the different branches; the subject is treated in a very simple, graphical manner; they show that in this system there is no need of a fourth or neutral conductor in the three-phase part, even in case the discharges in the two branches of the diphasic system are different; in general, they show that the irregularities in the three branches of the Scott system are less than those in the simple triphasic system with a fourth wire, and that this new system is therefore even better than the simple triphasic system.

Wind Motor.—The English journals, April 20, contain short illustrated descriptions of a 5-h. p. Rollason windmill, which has been erected; it is estimated for a wind velocity of 18 miles an hour, the dynamo being uncoupled when the wind is much higher than this; the normal speed of the shaft is seven revolutions, the windmill shaft is vertical and has four vanes, 19 by 20 feet; the price is about \$200 per maximum horse power development. The Lond. "Elec." estimates that the motor plant alone would cost from \$400 to \$600 per average useful horse power and the electrical plant (presumably including accumulators) it estimates at \$600 per average useful horse power, bringing the total up to more than \$1,000, while a good gas engine can be obtained for about \$120 to \$150 per horse power, the cost of the electrical plant for it being not much greater, and there would be less cost of maintenance and repairs; it is also remarked that it would probably not be possible to build a very much larger wind motor than this one, which it estimates at about 3 h. p. In the Lond. "Elec. Rev." the power is given as 6 h. p., which is thought to be very small for such a large structure; it is said that this is the largest windmill of the kind yet constructed in England; fears are expressed that the use of such motors is somewhat limited; a more detailed description is promised. In a communication by Mr. Rollason in the Lond. "Elec.," April 27, he claims that the criticism in that journal is not just; assuming that light is required three hours a day, a gas engine, to accomplish this, would have to be of 10 h. p. working for three hours instead of a wind motor of 3 h. p. for 10 hours, thereby bringing the cost of the former to more than that of the wind motor in addition to the cost of the gas; he claims that these motors can be made up to 20 h. p.

Motors in Berlin.—In a paper by Dr. Passavant, reprinted in the "Elek. Zeit.," April 19, he discusses the rapid increase of the motors connected to the Berlin station, showing the same by means of some curves and giving also the numbers of motors used for various purposes.

Substitutions in Paris.—Recent changes have been made in the compressed air companies' electric stations in Paris, which are described in "L'Ind. Elec.," April 10, a translation in abstract being given in the Lond. "Elec. Eng.," April 20; among others is the use of continuous current transformers to replace in part the accumulators which have heretofore supplied the whole current; a diagram of the complete connections is given.

Polyphase Installations.—In "La Lum. Elec.," April 7 and 14, the Lahmeyer installation in the workshops of the Jura-Simplon Railway is described and illustrated, interior

views and illustrations of the motors and dynamos being given; the installation is similar to that at Bockenheim, which was described and referred to in the Digest, Sept. 10-23, Nov. 4, Dec. 30, and Jan. 6.

Three-Phase Plant at Eiding, Austria.—A well-illustrated description of this plant is given in "L'Ind. Elec.," April 25.

Distribution System at Maethouse.—"L'Elec.," April 21, gives the proposed plan for a central station for distributing power and light to all the factories of this industrial city.

Hanover.—The output and cost of this station for the past two years are given in the Lond. "Elec.," April 27.

Glasgow.—A paper by Mr. Arnot descriptive of this station is abstracted in the Lond. "Elec.," April 27.

WIRES, WIRING AND CONDUITS.

Underground Mains.—The discussion of the papers of Messrs. Kider and Clirehugh (see Digest April 14) is concluded in the Lond. "Elec. Eng." and is given less fully in the "Elec.," April 20. Mr. Wooler agreed that vulcanized rubber joint making was a costly operation; regarding the use of soft soap for drawing in cables, he stated that great care must be taken that only the pure natural soap was used, as otherwise the objectionable ingredients might have a bad effect; Mr. Corlett gave some reliable figures concerning bare copper strips; in Hove in wet weather the average insulation resistance varied from 0.35 to 0.5 megohm per mile and in dry weather from 2 to 3; he gave the actual cost of laying this system from the Kensington station; assuming it to have been \$250,000, he showed that the cost of maintenance during the last four years was 0.43 per cent. per year. Mr. Callender stated that out of the 82 stations in the United Kingdom only about one-third used rubber insulation throughout; Mr. Nisbett agreed that for low tension mains a built-in system should be used for the distributors and a draw-in system for the feeders, as in that case the cost of the conduits was relatively small, but for high tension work the conduits might actually cost more than the cable itself, which he showed by giving figures; he thought 250 yards as a maximum distance between feeding points was too little; in the city of London they had provided for an average demand of 4.5 lamps of 8 c. p. per yard of frontage; he did not agree with Mr. Clirehugh that india rubber cables were best from a scientific point of view; impregnated rubber cables had the advantage that they could not be adulterated while rubber often is; he cited cases where as much as 185 yards of cable were drawn in in one length, the cable weighing two tons.

Internal Wiring.—An improved form of tubes for house wiring is described and illustrated in the "Elek. Anz.," March 29.

Cables.—The new cables of Felten & Guillaume are described and illustrated in "La Lum. Elec.," April 21; they consist of several stranded cables separated from each other and insulated on the outside by a thick layer of insulating material of an X or Y shaped cross-section and twisted spirally.

Communication with Lightships.—The Stevenson system, mentioned in the Digest, April 7, is described briefly in the Lond. "Elec. Rev.," April 20; a cable is laid from the shore to the location of the vessel, where it makes one or more turns around the area over which it is possible for the anchored ship to travel; on board the ship is an insulated coil of a number of turns of thick copper wire, batteries and telephones being in each of the two circuits; the distance between the two coils is always within 100 yards; he has made the coils work at 600 yards outside each other with only eight turns on each coil and five cells of battery, the coils being about 200 yards in diameter, showing that a very feeble battery power is required.

The Lond. "Elec. Rev.," April 20, publishes a second report of the Royal Commission on the "Electrical Communi-

cation with Lighthouses and Lightvessels," including an appendix on the systems in Canada and the United States.

Microphone.—In an article in "La Lum. Elec.," April 7 the Mercadier-Anizan device is described and illustrated, the object of which is to enable any microphone to be used at its maximum intensity for long distances and to give the required clearness for short distances; this is accomplished by a simple switch, the handle of which is placed in one of two positions, the one being for long and the other for short distances, the switch operating a resistance either in shunt or in series with the microphone contacts, or both.

The Damseaux microphone is described and illustrated in "La Lum. Elec.," April 14; the object is to reduce the contact surfaces as much as possible and to give it great elasticity; against a horizontal carbon rod connected to the diaphragm, rest four carbons hinged at the top and inclined sufficiently to produce a slight pressure at the points of contact.

Telephone.—The Bonnard & Piat telephone is described and illustrated in "La Lum. Elec.," April 21; the object is to enable different telephones in a private plant to be called without the use of a central station for making connections.

Central Telephone Station.—The first part of an article by Mr. Keramon, describing the large central station in Paris, with the aid of a number of diagrams of the switch-board details, is given in "Cosmos," April 14.

Slowly Vibrating Bell.—A system is described and illustrated (though not very clearly) in the "Elek. Zeit.," April 19, in which a flywheel arrangement is used.

German Telegraph and Telephone Statistics.—The Lond. "Elec. Rev.," April 27, contains a brief summary for the year 1892.

ELECTRO-CHEMISTRY.

Purification of Sewage.—In a letter by Mr. Cripps in the Lond. "Elec. Rev.," April 13, he refers to the recent unfavorable report of the experiments at Worthing and states that although his tests are yet incomplete, they are distinctly at variance with those of Dr. Kline, mentioned in the Digest April 28 in the report of Dr. Kelly. The report of Dr. Piton, abstracted in the Digest April 2, is given somewhat more fully in the Lond. "Elec. Eng.," April 20. A translation of the article abstracted in the Digest April 2 is given in the Lond. "Elec. Rev.," April 27, together with most of the illustrations. Copies of the report of the experiments of this system at Brest are published in pamphlet form by Messrs. Spon.

New Form of Accumulator.—According to a paper briefly abstracted from an Austrian journal, in the Randnitz accumulator, neither lead nor lead oxides play any part primarily as materials, but the nature of the compound is kept secret; the compound is charged into the plates and becomes converted into a stone-like peroxide without buckling or altering its shape; a cell of three plates weighing 1.39 kilograms has a capacity of 32.8 ampere hours of 30.1 per kilogramme, which, compared with that of other cells, is enormously greater. Somewhat more detailed information is given in the "Elek. Tech.," March 31, in which it is stated that it is a lead compound; the peroxide plates formed by electrolysis do not change their form and have a structure like stone, which is said to last years; the compound is spread on ebonite frames, and when used up can readily be replaced at small cost; the voltage is given at 2.05; a three-plate cell was tested with a current of about three-quarters of an ampere, but the test was not continuous, as it included four periods of rest of from a half to 1 1-2 days; the results are those given above. (As the current was exceedingly small, and the discharge not continuous, the results are of little value, especially as the voltage of the whole discharge is not given.)

Platinum Plating.—The following formula of Dr. Lang-

bein is published in the "Elek. Anz.," April 8, and is said to be an improvement on that of Prof. Boettcher; 500 grams citric acid are dissolved in two litres of water and neutralized with sodium hydrate; when heated to a boiling heat the freshly precipitated salammoniac from 75 grams of dry platinum chloride is dissolved; after cooling enough water is added to make five litres; to make the bath conduct better, 20 to 25 grams of salammoniac may be added, care being taken not to use too much of the latter. Other formulas are given in the issue of April 19.

Polishing.—In the Huber process, mentioned in "La Lum. Elec.," April 7, the metal is placed as an anode in an electrolyte capable of attacking the metal and leaving it in an insoluble or nearly insoluble state and then reversing the process and leaving the metal in a spongy state; for tin a solution of 0.5 per cent. of fluoride of ammonium is used; for zinc and lead five parts of iodide of potassium in 150 parts of water; for iron a weak solution of 0.5 per cent. of fluoride of sodium; after this treatment the metals are ready for polishing.

Dissociation Theory.—The Lond. "Elec. Rev.," April 20, contains an editorial note calling attention to the confirmation of the law of Ondemans, that the molecular rotation of salts in dilute solution is independent of the character of the inactive ion of the salt.

Electrolyzer.—The Kellner electrolyzer is described and illustrated in "La Lum. Elec.," April 21.

MISCELLANEOUS.

Reverberatory Furnace.—According to an editorial in the Lond. "Elec. Rev.," April 13, Mr. Moissan has obtained two kilograms of metallic chromium in an hour from the raw ore in the new form of his electric furnace with a current of 600 amperes and 60 volts.

Electrical Engineering.—The presidential address of Prof. A. B. W. Kennedy before the Institution of Mechanical Engineers is published in part in the Lond. "Elec. Eng.," "Elec. Rev.," and Lond. "Elec.," April 27, and is unfavorably discussed editorially in the first two. He discusses the electrical problem of to-day in that country and the way it presents itself from a mechanical engineer's point of view. It is quite pessimistic in its nature, and is likely to give quite incorrect impressions, in some respects at least; his figures are, in general, not favorable to electrical engineering, but the data on which he bases them are quite misleading; in discussing electric traction, the efficiency of a steam locomotive is given at 80 per cent., and that of the electric railway at 35 per cent.; electric railways are spoken of very discouragingly. A very able discussion of his views on electric traction, by Mr. Lea, is abstracted under "Electric Railways."

Exhibition.—A number of journals announce that there is to be an exhibition in the city of Budapest from the 27th of May to the 30th of September, 1894, of machines driven by electric motors.

It has been announced in several journals that there is to be an electrical exhibition in Paris in 1895; "L'Ind. Elec.," April 25, states that this information is premature.

Quantity of Lightning Discharges.

Prof. W. Kohlrausch has shown that the quantity of the average lightning discharge is from 52 to 270 coulombs.

Street Railways in Aix-la-Chapelle.

The municipality of this city has agreed to run the street railways by means of electricity and to take the current from the central lighting station; the length of the first line to be constructed is about 14.4 miles, and when the suburban lines are connected the diameter of the whole network will

be 18 miles. The town is quite hilly, 5 per cent. grades being frequent, the maximum grade being 8 per cent.; the overhead trolley system will be used; out of 34 cars 19 will have motors of 15 h. p., and the others of 10 h. p. The installation will be erected by the Elektrizitäts Company, formerly known as Schuckert & Co., of Nuremberg.

The Berliner Patent.

The Harrison International Telephone Company recently obtained opinions from several eminent firms of patent lawyers in regard to the validity of the Harrison and Ford telephone patents, all of the opinions declaring that there is no infringement of the Berliner patent. The opinion of Messrs. Witter & Kenyon is particularly interesting on account of its analysis of the status of the Berliner patent, which is as follows:

"The Berliner patent only covers the use of electrodes that are *in constant contact* and that operate by variations of the pressure of contact. *Your telephone operates by a making and breaking of contact; its electrodes are not in constant contact.* The Berliner, like the Bell telephone, throws upon the line wire *an undulatory current.* *Your telephone throws upon the line wire a pulsatory current.* Such a pulsatory current was not covered by the Bell telephone patent of 1876, and the United States Supreme Court so decided in the telephone cases. The Berliner patent is no broader in this regard than the Bell patent was. The method of operation of your telephone is thus substantially different from that of the Bell and Berliner telephones. This fundamental difference was, as we understand it, the ground on which the United States Circuit Court in Arkansas refused a preliminary injunction against your company several years ago under the Bell patent, although the injunction was asked for after the United States Supreme Court has sustained that patent. We quote here the two broadest claims of the Berliner patent to show its meaning and scope. The italics are ours.

"1. The method of producing in a circuit *electrical undulations* similar in form to sound waves by causing the sound waves to vary the pressure between electrodes *in constant contact*, so as to *strengthen and weaken the contact* and *thereby* increase and diminish the resistance of the circuit, substantially as described.

"2. An electric speaking telephone transmitter, operated by sound waves and consisting of a plate sensitive to said sound waves, electrodes *in constant contact with each other*, and forming part of a circuit, which includes a battery or other source of electric energy and adapted to increase and decrease the resistance of the electric circuit *by the variation in pressure* between them caused by the vibrational movement of said sensitive plate."

"This view of the meaning of the Berliner patent is confirmed by the proceedings in the Patent Office during the fourteen years while this application was pending, which proceedings we have examined; and in our judgment, under all the circumstances of the case, this Berliner patent will be construed by the courts as narrowly and strictly against the Bell Telephone Company and in favor of the public as is possible.

"Again, we are of opinion that the Berliner patent is in any event *wholly invalid and void*, and will be so declared by the United States courts, either in the pending Government suit or in the first suit for infringement that the American Bell Telephone Company may see fit to bring. The same invention was patented to Berliner in an earlier patent, and no one can have two patents for the same invention. The claims of that earlier patent are narrow and do not cover your telephone, but under recent decisions the later patent is wholly invalid.

"Again, the Berliner application, while pending in the

Patent Office, was unlawfully and illegally amended in such a way as to strike out from it the real invention which had formed the subject matter of the original application and to interpolate new matter and a new and different invention in fraud of other applicants and of the public, a thing which cannot lawfully be done and which cannot form the basis of a valid patent.

"Again, before the real invention which is now patented in the Berliner patent appeared, even by way of amendment, in the Berliner application, it had been in public use and on sale in the United States for more than two years, a fact which would have constituted a statutory bar to the filing of a proper and lawful application at that time and which now equally invalidates the patent, for the law does not permit the obtaining by indirection of what it bars if openly and properly sought.

"Again, the application was abandoned and forfeited prior to the issue of the patent."

Gillette Interior Telephone System.

The advantages from the use of telephones over the time honored annunciator system for hotels, houses, etc., are so apparent that the expiration of the fundamental telephone patent may be said to have also marked the end of the old methods of communication by means of annunciators. The great expense of rewiring a large hotel or house, however, is sufficient to deter the adoption of telephones in many cases, and it is to meet these conditions, as well as for installation in new buildings, that Mr. Webster Gillette, so widely known for his work in long distance telephony, has devised the system which we describe herewith, and which can be installed by merely replacing each push button with the neat box containing the local apparatus and adding a simple spring jack board to the ordinary annunciator, which is retained.

Fig. 1 is a diagram of the ordinary annunciator and bell circuits, showing the local telephone box replacing a push button and spring jacks added to the usual annunciator. The apparatus to the left is a duplicate of one of the local boxes, and by means of which telephonic communication may be held with any room, as described below.

The principle of the system involves a closed main circuit,

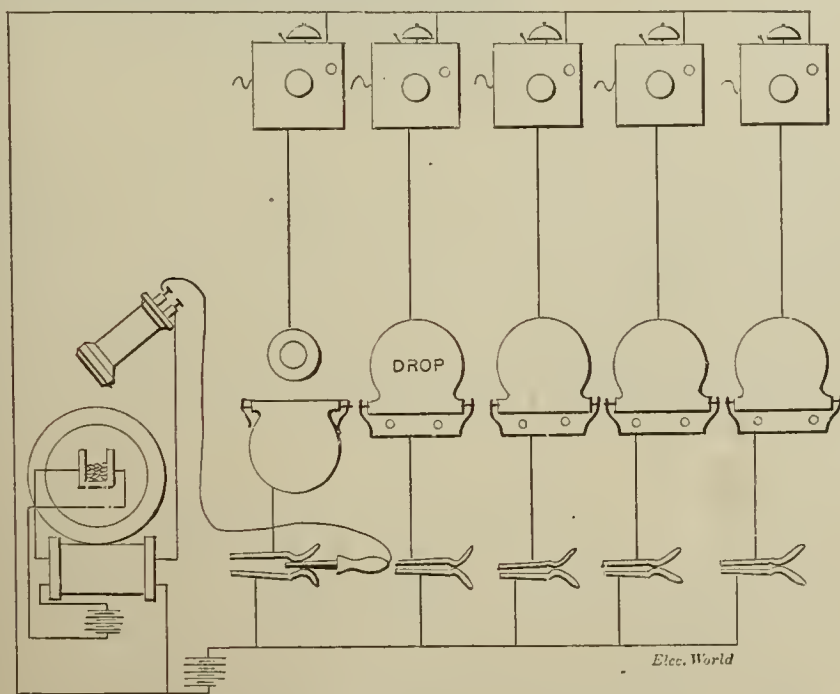


FIG. 1. GILLETTE INTERIOR TELEPHONE SYSTEM.

which, if broken in any room, releases the corresponding drop at the annunciator; or, if a spring jack is plugged at the office, the bell in the corresponding room rings.

Referring to Fig. 2, by pressing on the push button, 16, the main circuit, 16—8—1—11—10—18—24, is broken, and the hammer of the local bell released; the bell then acts as an ordinary vibrating bell whose circuit is 10—23—22—6—3

—9, a small local dry cell, 22—23, in the box supplying the necessary current; or, when the button is pressed, it may cut out the local, and only ring the office, bell, the advantage of the former arrangement being that it indicates the line in working order. At the same time the annunciator bell rings and the corresponding annunciator drop is released. By entering a spring jack at the office, as shown in Fig. 1, the same operation is performed, the room being thus called up.

After calling the office the button, 16, is released and when the spring jack is plugged at the office the bell in the room rings again, when the telephone is taken off its hook, which cuts out the bell circuit at 1 and cuts in the telephone circuit. The transmitter circuit is 25—4—5—23—22, and

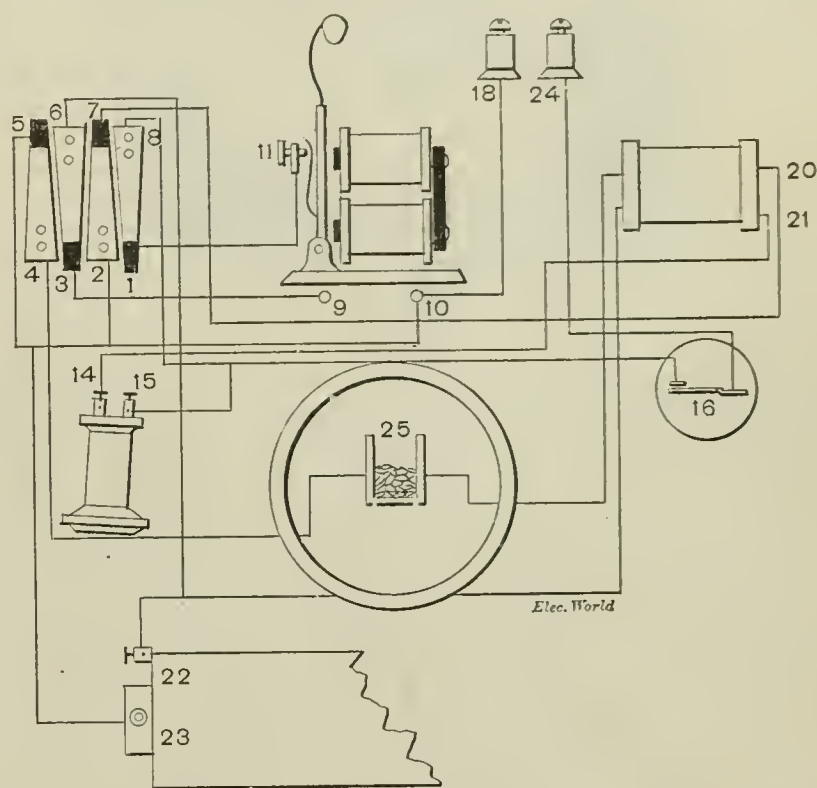


FIG. 2. GILLETTE INTERIOR TELEPHONE SYSTEM.

includes the dry cell, 22—23, also used to ring the local bell. The secondary of the transmitter circuit, which is also the receiver circuit, is 24—16—15—14—21—20—7—2—10—18.

While these circuits may seem somewhat complicated it should be remembered that they are all included in the small local box which is wired at the factory; in installing, it is only necessary to connect the two old push button wires to 18—24, and in operation it is only necessary to press the push button and when the answering signal is rung, to take the telephone off the hook, which latter operation automatically makes the necessary connections by means of the springs, 2—4—6—8. At the office the only operation is to connect the office telephone box, either to ring up or answer, by plugging the spring jack as indicated in Fig. 1.

The local current, as stated before, is taken from a small dry cell, 22—23, which is also the transmitter cell, and as current is only given forth when calling or for the transmitter when in circuit, the demand upon it is small. The main current, whose duty is to hold off the hammers of the various bells, may be supplied by any constant current battery such as is used in telegraphy, or a tap may be taken from an incandescent lighting circuit. By means of a switch, any number of which may be placed on the return wire of the main circuit, the latter may be opened in case of fire, which would cause every bell connected to ring; thus the system without any other addition than the switches referred to, can also be made an admirable one for transmitting a general fire alarm.

The transmitter is also the invention of Mr. Gillette, whose present address is 253 Broadway, New York, and consists of a box filled with carbon granules, two opposite sides of the box being of carbon and the other sides of an insulating material.

New Time Recorder.

The new National Time Recorder Company, of Milwaukee, Wis., is placing on the market an autograph recorder for electric light and power stations. Fig. 1 represents the device, which is 17 inches square. The clock which drives the

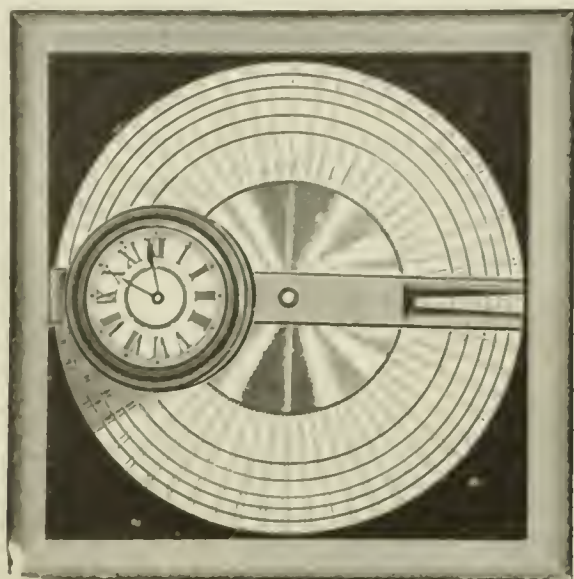


FIG. 1.—TIME RECORDER.

record dial is supported in a casting, the ends of which are securely fastened to the wooden frame. The record dial is secured inside of the frame under lock and key. A small section of the dial is shown in Fig. 2. It is 15 inches in diameter, and when in operation is entirely covered by plate glass with the exception of an opening 1-2 by 3 1-2 inches on the right-hand side, through which the engineer or dynamo tender can write his signature and also the record desired. By referring to Fig. 2 it will be seen that the record dial is divided by parallel radial lines into 30 minute spaces, so that a record can be made every half hour of the amperes, volts, steam pressure, vacuum, dynamos cut out and dynamos started, which records are separated by concentric lines. The heavy black line is the night line and represents the time from 6 P. M. to 6 A. M. Fig. 2 shows a record made at 5 P. M. by J. Davis, the day man, and a record made at 6:30 P. M. by S. Snow, the night man. These two records are made simply as an illustration. On a dial having been used it should show a record every half hour. The dials are made to cover a space of 30 hours, so that in case whoever keeps the record does not always change the dials at a certain hour each day there will be six hours leeway, so that the records cannot be confused. By an in-

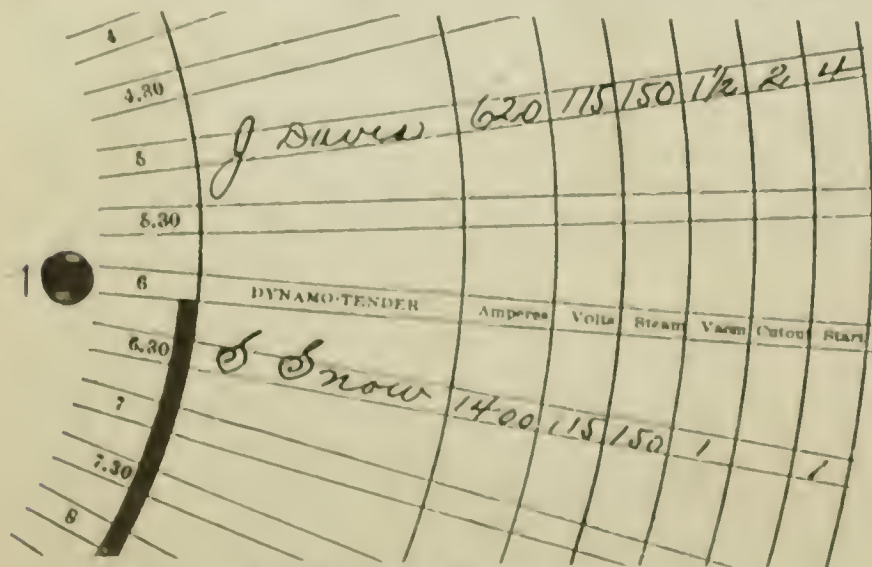


FIG. 2.—TIME RECORDER.

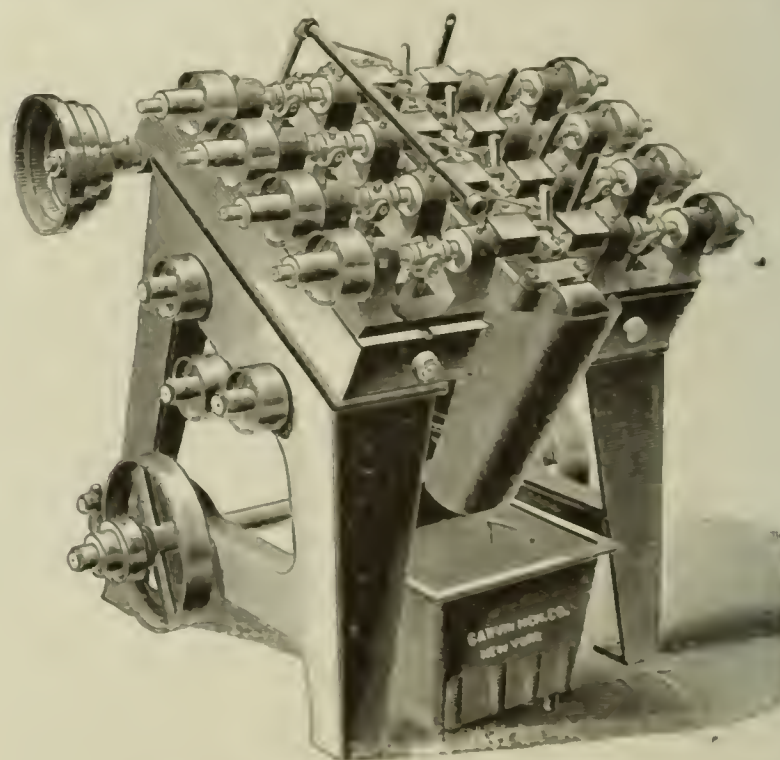
genious device in changing the dials each day the dials are always synchronized with the clock.

By the use of this recorder it is absolutely necessary that the employee should make his record regularly at stated intervals, otherwise that portion of the dial where the record should have been made will have passed on under the glass

without the record having been made, showing the employee to have been negligent, and that he has not attended to his duty. The records show the exact time each dynamo was started and cut out, and the length of time each has been running; also the amperes, from which the average or total day or night load, or both, can be ascertained. The recorder can be fastened on the wall or laid on a desk, as preferred, as the clock has a marine movement and will run and keep accurate time in either position. This recorder can as easily be adapted to many other kinds of business where a half-hourly or hourly record is desired, the only change necessary being in the printing of the dials.

Automatic Multiple Drill.

A great advantage of keen competition from a mechanical standpoint is the stimulus it exerts on the faculties of inventors and designers. In no way has this result been more beneficial than in the production of labor and time saving machine tools, and as an example of these we illustrate an eight-spindle automatic drill press, manufactured by the Garvin Machine Company, Laight and Canal streets, New York City, adaptable to accurately drilling or counterboring a large variety of small articles where two or more holes are desired to be drilled close together on opposite sides or ends



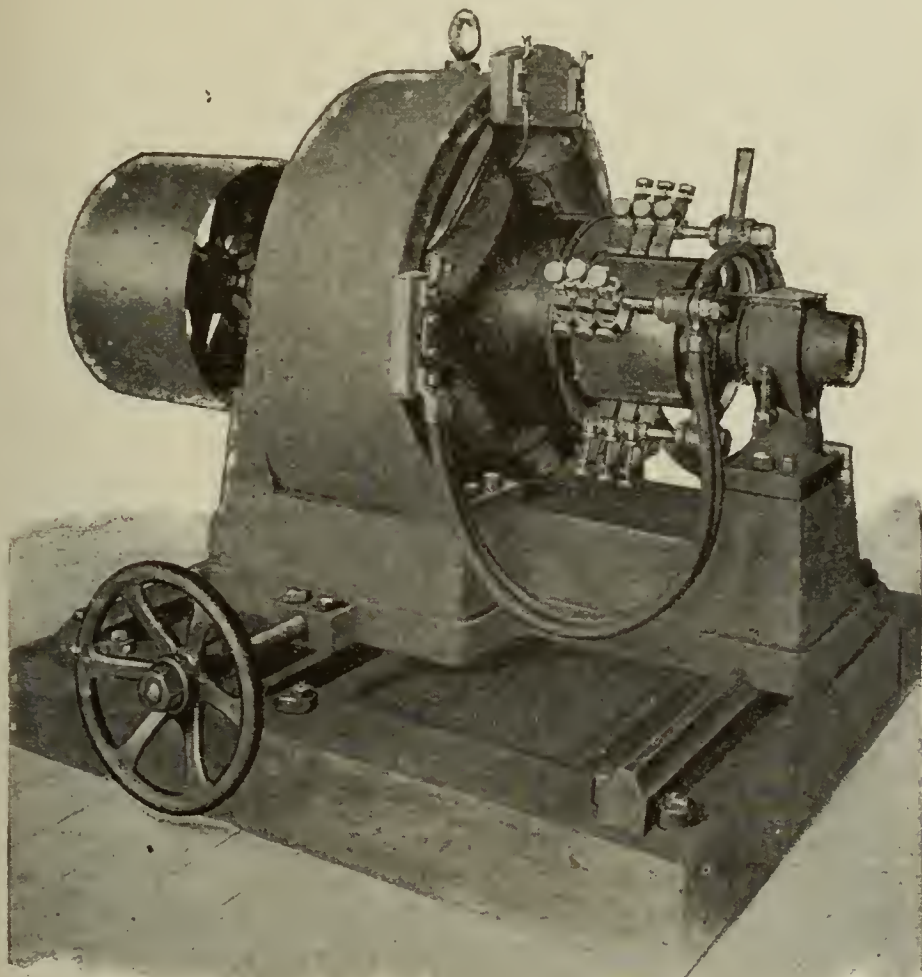
AUTOMATIC MULTIPLE DRILL.

of the piece. The spindle heads are mounted in opposite pairs on the planed surface of an inclined frame, on which they are adjustable as to their centre distances. Thus the several pairs of spindles may be set so as to drill two holes in exact line from opposite sides of the work, or parallel holes in each end of a piece at one operation. The spindles have an automatic feed trip and reverse motion, and can be made to feed up to the work one at a time, in pairs, all simultaneously, or in other combinations as the work may require. They are driven by pulleys, having a feather in the outer end of the hub engaging a spline in the spindle, and running on independent hollow studs which take the belt pull, thus leaving the spindles free and sensitive. For each of the two sets of spindles on opposite sides of the machine there is an endless driving belt, passing over idler pulleys, one of which is adjustable to provide for taking up the slack in the belt. The fixtures for holding the work are mounted between the spindle heads on a rail, beneath which is a cast iron trough for conducting the oil and chips to a tank under the machine, where the oil is strained and returned to the drills by an automatic pump. The weight of the machine complete is about 850 pounds, and with 3-16-inch drills it will produce about 5,000 pieces per day, only requiring the

attention of a boy to drop in and remove the work and throw the starting lever.

A New Multipolar Dynamo.

The dynamo shown in the accompanying cut has just been placed upon the market in sizes from 10 to 100 kw. by the Riker Electric Motor Company, 45-47 York street, Brooklyn, N. Y. As ordinarily constructed, this machine is de-



RIKER MULTIPOLAR DYNAMO.

signed for an incandescent generator working at the standard pressure of 125 volts. The base is made of cast iron, very heavy and thoroughly braced to prevent springing of the bearings. The field magnet is built of cast steel with salient poles projecting radially inward. In sizes up to and including 20 kw. high speed and 6 kw. low speed the field is cast in one piece, while in larger sizes the field is split to facilitate the handling of the armature. The section of the poles in all machines of this type is square, thus requiring a minimum length of wire without the necessity of making separate cores and pole pieces, as is the case in round core magnets of this general description. The field coils are wound on heavy metallic thimbles or spools, which serve the double purpose of holding the coils securely in place, and by their action as closed secondaries of absorbing the destructive induction sparks that result from breaking the field circuit.

All these generators are compound wound to maintain practically a constant potential, a slight rise of 1 or 2 per cent. being allowed to compensate for a fall in engine speed.

The armature is of the drum type, the plates being mounted directly upon, and keyed fast to, the shaft. The plates are clamped between heavy cast iron flanges, which are threaded on the shaft. No bolts pass through the core plates, thus obviating the trouble and expense of extensive insulation in the armature. The wires are laid in milled grooves, and all insulation on the armature between the core and the wire is either micanite cloth or pure mica. The coils of these armatures are all cross connected in parallel grouping, in order that the electrical balance shall be maintained, even when one or two sets of brushes are removed. The commutator is very heavily built, the bars being clamped between steel cones and insulated throughout with mica.

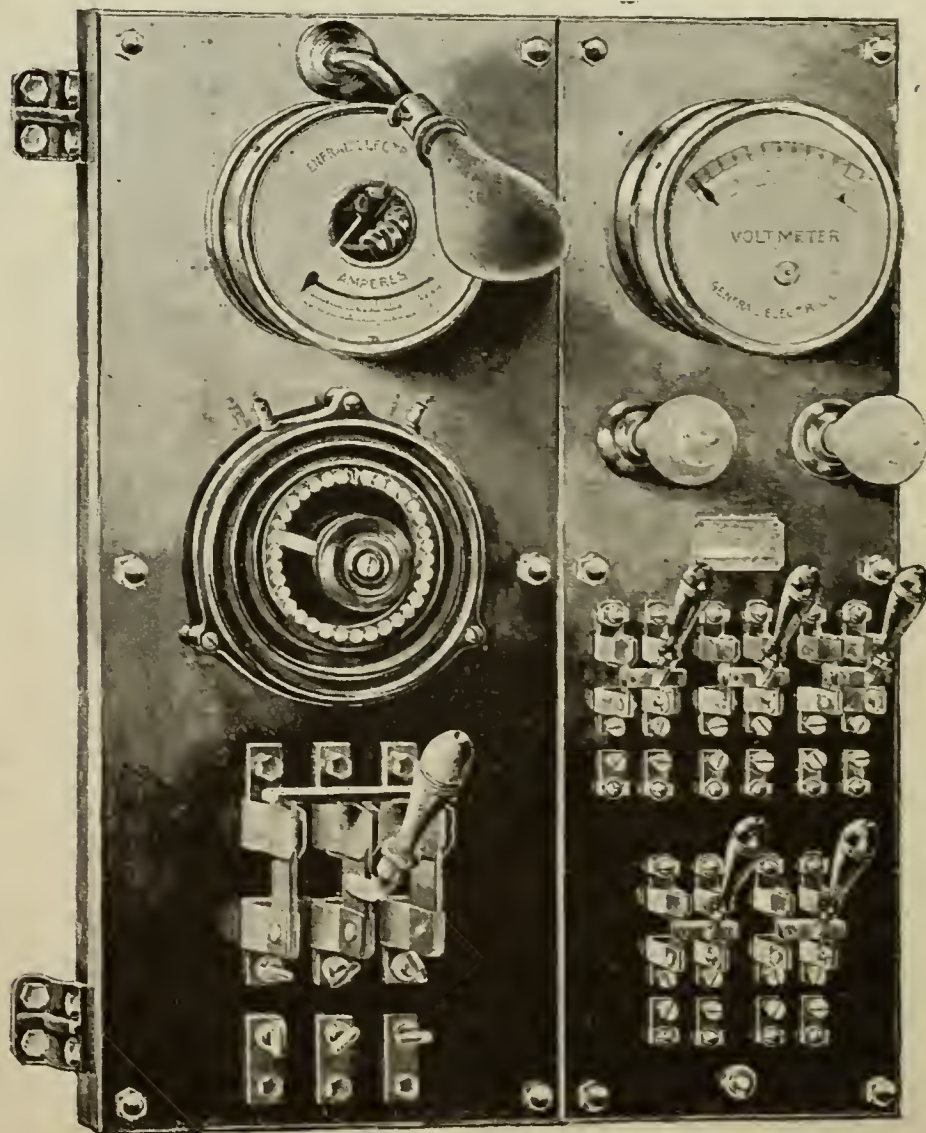
While the machines run without undue heating, they are not built unnecessarily heavy, a good wide working margin being allowed. The armatures under long runs at full load are allowed to rise in temperature about 40 to 50 degrees Fahr. above that of the surrounding atmosphere.

Five hundred circular mils per ampere at full load are allowed in all armatures, and 1,000 circular mils in the shunt and series coils. All resistances are kept as low as possible, thus reducing internal waste and maintaining efficiency.

All the fittings and connections of these dynamos have been designed to facilitate installation and at the same time to present an artistic appearance. The machines are thoroughly high grade, both as regards build and performance, and in every particular embody the principles of the best modern practice. From a theoretical point of view they are designed to a nicety, due regard being had for practical considerations.

A Compact Switchboard.

Much ingenuity has been expended in the improvement of the switchboard to bring it down to convenient proportions and yet to have upon it all the necessary instruments within easy reach of eye and hand. We show one lately designed by the General Electric Company for isolated plants in which convenience seems to have reached a high expression. The complete board comprises a panel for each generator and one for each set of five feeders. The generator panel is equipped with newly designed switches of high conductivity and durability, each of which has its own fuse holder. The rheostat and ampere meter are of the latest and most compact type. Each feeder panel carries an improved voltmeter and two-lamp ground detector, the push button being shown in the lower part of the panel. The advantage of this arrangement of switchboard lies in the possi-

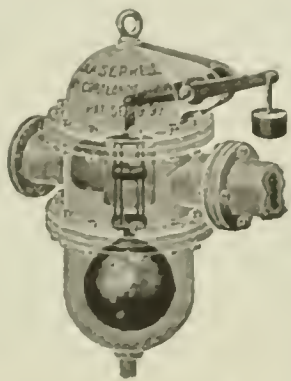


A COMPACT SWITCHBOARD.

bility of uniformly enlarging the board by adding panels. They can be set side by side and be connected with tie bars, and are furnished ready for installation and receipt of the generator and feeder connections.

Automatic Safety Receiver.

A large number of engines are constantly being wrecked by the accidental admission of water with the steam, from priming, condensation and overfeeding of boilers, and to obviate this danger John A. Serrell, 39 Cortlandt street, has designed an automatic safety receiver, which we illustrate.



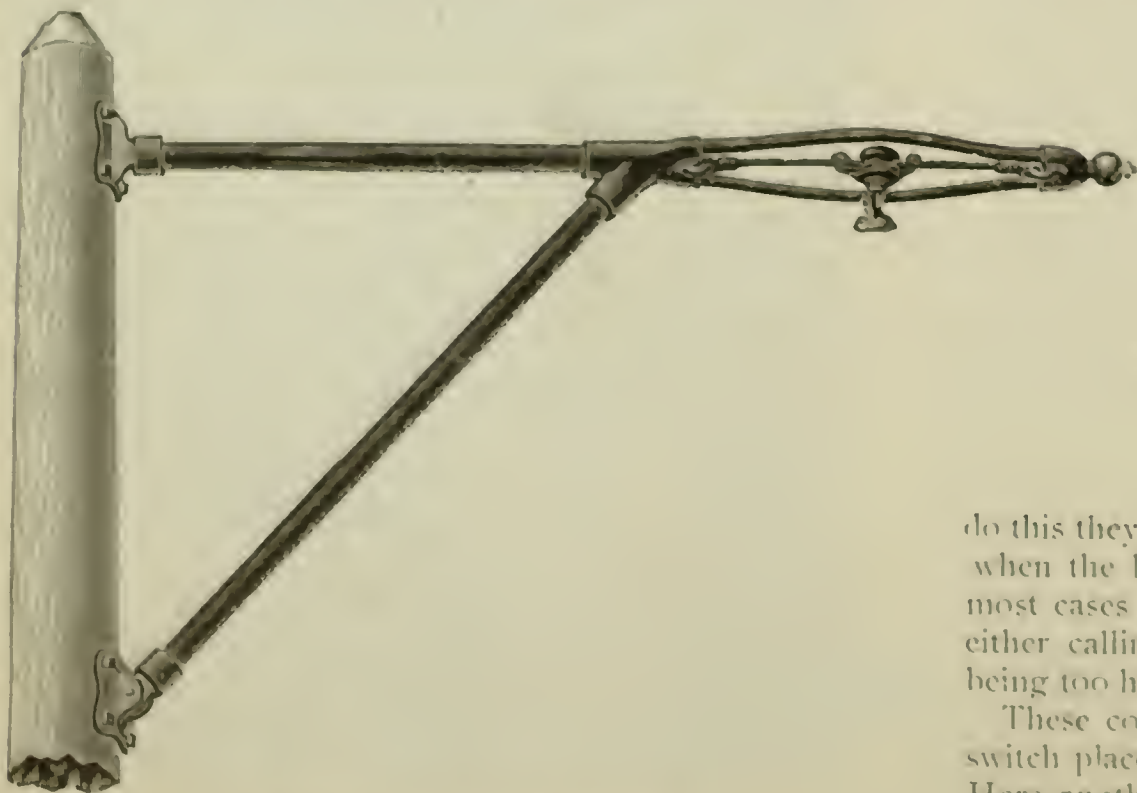
AUTOMATIC SAFETY RECEIVER.

This receiver will divert as much entrained water from the steam pipes as will accumulate under ordinary conditions. If, however, a larger quantity of water passes suddenly into the receiver, the balance valve and float will prevent its passage to the engine, and automatically reopen the steam line, as soon as the drip has sufficiently drained the receiver. In practice these receivers will seldom shut the engine down entirely, even for a moment. They are designed to withstand modern high pressures. The float and balance valve feature have been thoroughly tested, and there is no danger of collapse of the ball, or from the valve sticking. To those who have had experience with water in the cylinders of engines, the utility of this invention must be apparent.

A Combination Pole Bracket.

On account of the rigid construction and the consequent hammering effect of the trolley with bracket and centre pole line construction, the maintenance and reconstruction are very much greater than with inside pole suspension on account of the flexibility of the latter.

The bracket recently placed upon the market by the Wallace Electric Company, Chicago, Ill., and known as the Wood combination bracket, embodies improvements which



COMBINATION POLE BRACKET.

tend to make it a practical, simple and durable device, and was designed to overcome the difficulties experienced in bracket suspension, both in single and double track work.

This device, it is claimed, obviates the continual hammering effect received from the trolley wheel, which is not only detrimental to the trolley, trolley wheel and line, but tends to loosen and twist the bracket and increases the arcing and burning.

By referring to the cut it will be seen that a straight line hanger is used for supporting the trolley wire instead of the ordinary bracket hanger. The hanger is held in place by a piece of 1-4 or 5-16 span wire about three feet long, which affords a flexible support for the insulator. This bracket is similar in construction to the ordinary bracket now in use, differing only in the fact that the two curved arms which support the span wire extend over the brace casting. The span wire is easily adjusted by means of an eyebolt at the extreme end of the bracket. The objections to rigid construction have been overcome by the use of this bracket and the liability of breakage is reduced to a minimum.

Trolley Cord.

A trolley cord is so exposed to all sorts of weather and subject to such very sudden strains that it is good economy, as well as much safer, to use only the best grade of such cord that can be obtained, and one that will withstand moisture. The Samson braided cord, manufactured by the Samson Cordage Works, of Boston, Mass., is claimed to furnish the

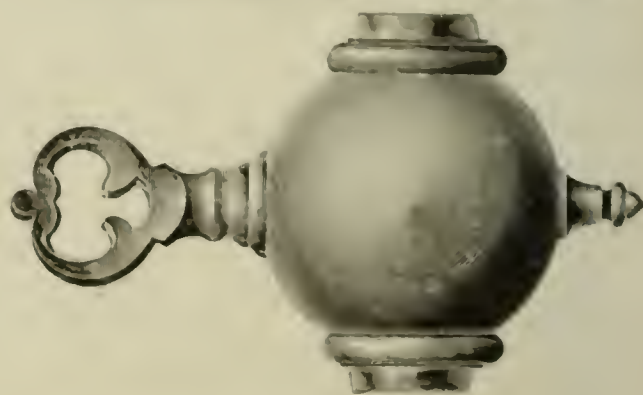


SPOT TROLLEY CORD.

desired qualities and to be waterproofed by a special process, which, besides, makes it extremely durable. To distinguish Samson cord from lower grades of similar cord which have been placed on the market in competition, and in order that purchasers may be able to recognize it at a glance, the manufacturers have adopted the expedient of marking it with a succession of spots of a different color from the body of the cord, as shown in the accompanying illustration.

Fixture Switch.

There is a growing tendency to turn the lights upward by the makers of the better class of fixtures. In endeavoring to



FIXTURE SWITCH

do this they have been hampered considerably by the fact that when the lights are turned up the key of the socket is in most cases practically inaccessible, the design of the fixture either calling for an ornamented socket cover or the key being too high to be reached readily.

These conditions called for a keyless socket, and a small switch placed in a handy position in the arm of the fixture. Here another obstacle was met, as no switch of good appearance and yet reasonable price was obtainable. The Newton Electric Company, of 39 Cortlandt street, New York, to meet this want has gotten up the switch shown in the accompanying cut, which fills the bill admirably, being small and neat in appearance.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, May 14, 1894.

ANNUAL REPORT OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.—The annual report to the stockholders was presented by President George Westinghouse, Jr., at the meeting at Pittsburgh, Pa., May 16, 1894.

Notwithstanding the fact that there was a general paralysis in industrial affairs throughout the United States during the last nine months of the past fiscal year, your board is able to present herewith a financial statement for the year ending March 31, 1894, which it believes will prove satisfactory in every particular.

From the balance sheet it will be noted that the net profits from manufacturing and other sources amounted to \$1,640,809.11 after charging to operating expenses, as heretofore, large sums for alterations and additions to buildings, for maintaining the machinery and tools in the highest order, and all sums paid for interest and discount, excepting interest on bonds and scrip, which has been charged off direct to surplus.

It will be seen that a large reduction in accounts payable, bills payable issued for merchandise, and those discounted with collateral has been made from the profits of the company, which further illustrates the careful manner in which the officers of your company have conducted its business. By the recent sale at par of the preferred stock which was in the treasury of the company, the bills payable have been further reduced since the 31st of March, so that on May 9 there were outstanding only \$560,982.64 of bills payable of all kinds, of which \$37,869.04 were issued for merchandise.

WORLD'S FAIR LIGHTING CONTRACT AND EXHIBIT.

All the apparatus used in connection with the World's Fair lighting contract and for exhibition purposes has now been returned to the warehouses of the company, and the final payments have been made by the World's Columbian Exposition Company.

The amount of the contract for lighting was \$399,000, and for extras under the contract \$88,704.47, making the total received by the company \$487,704.47. All goods shipped to the Fair were charged at the cost of labor and material with 20 per cent. added. After charging the account with all costs of every nature in connection with the running of the plant and of the exhibition, and crediting it upon the return of the material with the net cost of labor and material, it shows a net cost to the company of only \$16,013.03 for a grand display of the company's apparatus, the advertising effect of which has been invaluable. The price at which the lighting apparatus used at the World's Fair, and the apparatus used for exhibit has been sold, will yield a handsome profit to the company.

It is gratifying to state in connection with this subject that the entire contract was carried out without friction of any character, and without a single deduction of any kind being made from the bills rendered by the company, and that the experience gained by the company in constructing such large apparatus was an important factor in the securing of the contract for the three 5,000-h. p. generators now being constructed for the transmission of power from Niagara Falls for the Cataract Construction Company.

NIAGARA FALLS POWER TRANSMISSION.

The awarding to your company by the Cataract Construction Company of the contract for three 5,000-h. p. generators for the transmission of the power of Niagara Falls to Buffalo and other points was an event of more than ordinary importance. The officials of the Cataract Construction Company had employed the most renowned electrical engineers of the world, and had spent some years in a full investigation of the subject, and finally contracted with your company because of a belief in its ability to successfully carry out such an important undertaking. The transmission of power by means of these generators involves the use of your company's Tesla patents, covering the system of multiphase motors, and therefore the successful starting of this plant cannot fail to have a great influence in the development by your company of other plants for the transmission of power from waterfalls to remote points, by reason of the experience gained in this instance, and by reason of the ownership of the controlling patents. The three generators contracted for will soon be completed and put in operation.

INCANDESCENT STOPPER LAMP.

The successful use at the World's Columbian Exposition of the stopper lamps manufactured by your company, and their large use in general lighting, have fortunately placed the company in a position to protect all of its customers from the aggressive action of the owners of the Edison patent, covering the all-glass globe form of lamp. A steady advance has been made in the method of manufacture, so that your company is to-day producing a lamp which has no superior, and the use of which your officers expect to extend with great rapidity during the coming season on account of its quality and low cost of manufacture.

It may be fairly stated that the peculiar methods pursued by the owners of the Edison patent in their efforts to obtain a

monopoly of the sale of incandescent lamps have resulted in a disastrous failure, for the price of incandescent lamps to the public at large has been greatly reduced in consequence of the success of your company in the production of non-infringing lamps. Your officers believe that they will be able to sell stopper lamps to the company's customers at a price not exceeding the manufacturing cost of the all-glass form, and thereby greatly promote the company's electric lighting business.

COMPETITION AND PATENTS.

Our competitors have continued to copy our plans and infringe many of our patents, and in one instance the company's officials were reluctantly compelled to have indicted and arrested the agents of a large corporation who had entered into a conspiracy and had thereby succeeded in robbing your company of valuable drawings and information. It is believed that the action of your officers in this matter will have the effect of preventing the unlawful appropriation of your drawings and other information in the future.

NEW WORKS.

In the last annual report your directors announced that they had accepted a proposition of the East Pittsburgh Improvement Company to erect, according to the plans of your company, a new manufactory, upon a site of 23 acres. In consequence of the general depression in business, the letting of the work was deferred until January, when contracts were awarded at very low rates for the erection of a two-story machine shop 750 feet long and 230 feet wide, a two-story warehouse 750 feet long and 75 feet wide, and a boiler and power house, the whole having a floor space of over 10 acres. To these buildings there will be added in time a foundry, a blacksmith shop and one or two other unimportant buildings, making the whole plant when completed a most comprehensive one in every respect. The above buildings will be of steel and brick, arranged with reference to the manufacture of modern electrical apparatus of the heaviest character, and will be so equipped with electric cranes, machinery and improved machine tools as to enable the company to manufacture its product so much below the cost in existing competing establishments that the company will, at the prevailing competitive prices, enjoy a very satisfactory margin of profit.

Pittsburgh is exceptionally well located with reference to the material required for the construction of electrical machinery, and has unrivalled facilities for the shipment of freight in all directions; and, being centrally located with reference to the consumption of electrical apparatus, your officers have full confidence in their ability to secure enough work at profitable rates to fully occupy the entire establishment.

In conclusion, we call especial attention to the exceptionally favorable position of your company with respect to the electrical trade. Its capital stock in proportion to its operations is small, and it has no contracts of any character with local lighting or other companies, which can in any manner interfere with the sale of its apparatus. It has a harmonious management, and has an unequalled reputation with respect to the design and character of its apparatus; so much so that the company's standard apparatus is purchased and paid for without special guarantees of any kind.

The new works of the company will be completed and occupied during the present year, so that all of the manufacturing will be concentrated, and large savings thereby effected.

GEORGE WESTINGHOUSE, Jr., President.

BALANCE SHEET, MARCH 31, 1894.

ASSETS.

Cash in banks	\$325,694.55
Bills receivable	373,445.51
Accounts receivable	2,345,161.20
Material in stock and in process of manufacture (at cost of labor and material)	1,545,472.22
Advances to leased companies	109,124.68
Bonds (par value, \$249,800)	237,397.15
Stocks (par value, \$6,489,490.16)	3,988,992.26
Real estate and buildings	464,403.48
Machinery and tools	\$86,452.67
Miscellaneous	66,339.67
Charter, franchises, patents, etc.	4,379,821.69
Total assets	\$14,722,314.48

LIABILITIES.

Accounts payable	\$311,749.75
Bills payable issued for merchandise	116,933.85
Discounted with collateral	697,300.00
Contract and Contingent Liabilities	
Scrip dividend	194,560.00
Stock subscriptions	13,125.00
U. S. E. Ltg. Co.'s 6-per cent. 15-year bonds, \$50,000 payable annually	550,000.00
(Bills receivable under discount, \$528,550.65.)	
Capital Stock	
Preferred, 73,439.31 shares	\$3,671,965.50
Assenting, 103,309.62 shares	5,165,481.00
Common, 3,583 shares	179,150.00
	\$9,016,596.50
(In treasury 6,560.69 shares preferred and 13,107.38 shares assenting.)	

THE BROWN ELECTRIC AND MACHINERY COMPANY, Little Rock, Ark., has been incorporated with J. T. Brown, president; W. G. Brown, vice president, and T. J. Bryan, treasurer. This company is a reorganization of the Arkansas Electrical Supply Company.

THE CHESLEY ELECTRIC COMPANY, Hoboken, N. J., capital stock \$100,000, has been formed to manufacture electrical machinery and appliances and to sell same. Wm. S. Chesley, E. E. Warner, W. B. Gillmore and C. J. Donohue, all of Jersey City, N. J., are the promoters.

THE MILWAUKEE ELECTRIC LAUNCH COMPANY, Milwaukee, Wis., capital stock \$10,000, has been formed to do a general transportation business on the Milwaukee River. The promoters are W. Goltz, A. Menseck, Jr., O. M. Rau, A. F. Stern and D. R. Brigham.

THE CENTRAL ELECTRIC COMPANY OF PHILADELPHIA AND DELAWARE COUNTY, Philadelphia, Pa., capital stock \$60,000, has been formed to construct, maintain and operate an electric street railway. Wm. Bradley, L. G. Dutton, and Wm. Neville, of Philadelphia, are interested.

THE BLOCK HEAT AND LIGHT COMPANY, Camden, N. J., capital stock \$100,000, has been incorporated to build and maintain electric and other plants or stations to supply light, power and heat. A. H. Gillingham, J. D. Ely, Philadelphia, Pa., and S. K. Robbins, Moorestown, N. J., are interested.

THE WIRELESS ARMATURE DYNAMO AND MOTOR COMPANY, Jersey City, N. J., capital stock \$100,000, has been formed to manufacture, buy, sell, etc., electrical machines, contrivances and devices of every nature. Benj. Blum, C. S. Cowan, New York, and Jos. de Levy, Lakewood, N. J., are the organizers.

THE ESMOND ELECTRIC TRACTION COMPANY, New York, maximum capital stock \$1,000,000, has been formed to employ electricity in every manner, and to use and sell machinery that may be useful in the same. M. Strong, I. C. Chase, Montclair, N. J., and T. C. Esmond, Brooklyn, N. Y., are interested.

THE BUTTONWOOD STREET AND FAIRMOUNT PARK STREET RAILWAY COMPANY, Norristown, Pa., capital stock \$30,000, has been formed to construct and operate an electric street railway. H. L. Everett, Philadelphia; W. H. Richardson, Norristown, and Robert Everett, Jr., Malvern, Pa., are interested.

THE AKRON AND CUYAHOGA FALLS RAPID TRANSIT COMPANY, Akron, Ohio, capital stock \$300,000, has been incorporated to construct and operate an electric railway from Ravenna to Barberton, and to furnish light, heat, power, etc. R. J. Randolph, T. F. Walsh, W. E. Hall, E. F. Voris and E. L. Babcock are the promoters.

THE AUTOMATIC ELECTRIC COUPLER AND TRAIN SIGNAL COMPANY, Portland, Ore., capital stock \$100,000, has been formed to deal in patent rights covering electrical and other train signaling devices, and other electrical and mechanical inventions and appliances. W. E. Wamsley, G. W. Simons and B. L. Eddy, all of Portland, Ore., are interested.

THE MOUNT PLEASANT STREET RAILWAY COMPANY, Mt. Pleasant, Iowa, has been incorporated with Dr. George E. Smith as president, J. M. Ross vice president, and J. C. McCord secretary and treasurer. The company has not decided as to the motive power, and electricity may be adopted. Work will be commenced as soon as the franchise is granted.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
273 Broadway, New York, May 12, 1894.

THE SCOTT ELECTRICAL COMPANY has removed its offices from 89 to 126 Liberty street, New York.

MESSRS. J. W. PARKER & CO., of 30 Cortlandt street, New York, have recently closed several large contracts for the installation of steam plants for electric lighting purposes.

MR. JOHN McCORMICK has severed his relations as agent for the Heine Safety Boiler Company, and associated himself with the Sterling company, with offices at 126 Liberty street.

SEALED PROPOSALS will be received at the mayor's office, Brooklyn, to noon, May 17, for gas and electric fixtures and electric wiring for the armory of the Fourteenth Regiment, as per plans in the office of the architect, W. A. Mundell, Room 28, Phoenix Building, Brooklyn.

THE E. S. GREELEY & CO., 5 and 7 Dey street, New York, in the course of altering their warerooms and removing their New York factory from Fulton street to above their warerooms, are offering great inducements in job lots of supplies, etc. "Knowing ones" are taking advantage of these bargains.

CHARLES E. CHAPIN about two years ago opened an office at 136 Liberty street, New York. He began business representing the manufacturers of Packard lamps, Perkins sockets, switches and cut-outs, as well as electrical supplies in general. An important addition to the line has the porcelain manufactured by the R. Thomas & Sons Company, and carbon brushes made by the Partridge Carbon Company. Mr. Chapin reports recent sales, viz.: 535 T.-H. wattmeters, 10,000 incandescent lamps, 6,000 sockets,

6,000 rosettes, 15,000 yards lamp cord, 6,000 bushings, 40,000 feet of weatherproof wire, 8,000 porcelain shades, 5,000 2½-inch shade holders, 2,300 feet wood moulding, 10,000 feet interior conduit tubing, besides many thousands of porcelain insulators, porcelain tubes, etc.

MR. G. S. WOOLMAN, for many years engaged in the sale of scientific instruments at 116 Fulton street, New York, has sold his entire business to Queen & Co., of Philadelphia, with whom he was connected in earlier years. Queen & Co. have found it necessary, on account of the increasing volume of their business in New York, to establish a branch there, and they have secured Mr. Woolman's services as their New York manager. From the Philadelphia staff of the electrical department Mr. O. T. Louis, formerly in charge of resistance standardizing in Queen & Co.'s laboratory, at Ardmore, has been detached and stationed at the New York office. The establishment of this branch will undoubtedly prove to be a great convenience both to Queen & Co. and their customers.

New England Notes.

FRANCH OFFICE OF THE ELECTRICAL WORLD }
Room 91, Hathaway Building 620 Atlantic Ave., }
Boston, Mass., May 2, 1894.

NEW BRITAIN, CONN.—B. E. Baker is reported interested in the organization of a \$100,000 stock company for the manufacture of electrical appliances.

MR. FRANK WATERHOUSE, of the Perkins Switch Company, has received a contract at a good figure, though after severe competition, for 200 Waterhouse arc lamps, to be installed in the Boston and Maine Railway depot.

THE BOSTON PARK COMMISSIONERS have accepted a proposition for taking charge of the entire boating service of all the Boston parks which have water privileges, furnishing as many boats as may be required, in charge of careful and experienced men in uniform. It is proposed that some 250 boats compose the fleet for the present year. Various kinds of craft will be employed, from electric launches to row boats and canoes. This proposition was made by H. P. Partelow, the well known boat builder, and Gen. C. H. Barney, who had charge of the system of electric passenger launches at the World's Fair. It is understood that these gentlemen have the support of men prominent in Boston yachting and financial circles.

Canadian Notes.

OTTAWA, Ont., May 12, 1894.

OTTAWA.—The Canadian Pacific Railway Telegraph Company has started the construction of a line from Kingston to Ottawa, via the Rideau Canal route.

FENLON FALLS, ONT.—The Fenlon Falls Electric Light Company has secured a charter with power to produce and sell electricity for heating and lighting purposes.

TORONTO.—The city authorities have decided to make a contract with the Toronto Street Railway Company to water the track allowance in the city, 40 miles, four times a day during the summer months for 65 cents a mile, or \$26 a day. The company will do the work with an electric watering cart. The city will save \$7,000 annually by this plan in the cost of watering the streets.

MONTREAL.—The destruction of the Royal Electric Works in this city is being investigated. The insurance carried was as follows: Royal Insurance, \$10,000; North British and Mercantile, \$15,000; Liverpool and London and Globe, \$15,000; Commercial Union, \$15,000; Insurance Company of North America, \$15,000; Western, \$15,000; United Fire, \$12,500; Quebec, \$10,000; Phoenix, of Hartford, \$10,000; Atlas, \$10,000; Union, \$10,000; Hartford, \$7,000; British America, \$5,000; Queen, \$5,000; Eastern, \$5,000; Norwich Union, \$5,000; Albion, \$5,000; Manchester, \$2,500; Atlas Mutual, \$27,500; Massachusetts Lloyds, \$20,000; Mutual Lloyds, \$20,000, and Lloyds, England, \$40,000.

English Notes.

(From Our Own English Correspondent.)

LONDON, England, May 2, 1894.

THE NATIONAL TELEPHONE COMPANY.—This company now formally announces to its subscribers that it has decided to introduce the complete metallic circuit system. At the same time that this welcome announcement is made, subscribers are informed that their exchange numbers will all be altered, which alteration is likely to give rise to considerable complaint.

THE ELECTRIC CONSTRUCTION CORPORATION.—Mr. Thomas Parker, the founder of the Electric Construction Corporation, has just severed his connection with that concern, and taken with him some of the leading members of the staff, and will, it is said, form a company on his own account. The Electric Construction Corporation is among the three largest electrical manufacturing concerns in this country.

THE SUBMARINE DUPLEX TELEGRAPH PATENT.—The action which was recently brought by Messrs. Muirhead against the Commercial Cable Company for payment of arrears of royalties due to them for the use of their American patent No. 234,490

of 1880, which claim was contested by the company, who alleged that the American patent had lapsed owing to the expiry of the English patent of 1876, which they alleged to be similar to the American one, has been decided in favor of Messrs. Muirhead.

CITY LIGHTING.—The death is announced of Colonel Haywood, engineer to the city commissioners of sewers. Colonel Haywood had occupied that post for 48 years, and had superintended the carrying out of most important improvements. Colonel Haywood took a very early interest in the introduction of the electric light for the purpose of lighting the city streets, and his reports on the subject have been numerous and exhaustive. He had, however, a strong aversion against the city authorities themselves undertaking to generate and supply the electric current.

NEW ATLANTIC CABLES.—The cable ship "Faraday," belonging to Messrs. Siemens Bros. & Co., has just left the Thames with the first portion of the Commercial Cable Company's new cable aboard. The new cable for the Anglo-American Cable Company, which is to be laid from Valencia to Heart's Content, will also be submerged during the summer. It is interesting to note that 8 of the 18 Atlantic cables (including the 2 earliest, not now working) have been made and laid by the Telegraph Construction and Maintenance Company, and the remaining 7 by Messrs. Siemens & Co., both English firms.

AN IMPORTANT LEGAL DECISION AFFECTING ELECTRIC LIGHTING COMPANIES.—An important decision affecting electricity supply companies has just been given by Mr. Justice Kekewich. It is to the effect that electricity supply companies, notwithstanding their statutory powers, are not exempt from actions at common law for nuisance caused by noise and vibration necessarily arising from the exercise of their statutory powers. This decision was given in an action brought against the City of London Electric Lighting Company, which resulted in an award of damages to the plaintiff, though the injunction applied for was not granted.

ACTIONS FOR NUISANCES AGAINST ELECTRIC LIGHTING COMPANIES.—An action, brought by a combination of lodging-house keepers against the Metropolitan Electric Lighting Company for the purpose of obtaining damages, and an injunction, owing to the nuisance said to be caused by the working of their central station at the back of Manchester Square, has resulted in a judgment adverse to the company. The issue of the injunction has been suspended for three months to give the company time enough to complete their arrangements for mitigating the nuisance, and the amount of the damages is to be settled by arbitration. This is the second action within two weeks which has gone against electric lighting companies on this point.

THE COST OF ELECTRICAL ENERGY.—On Thursday last a paper was read by Mr. Crompton on the all important subject of the "Cost of Electrical Energy." Mr. Crompton's paper is without doubt the most valuable paper of the kind that has been read before the Institution of Electrical Engineers since it came into existence. Mr. Crompton commenced his paper by stating that he was confident that before many years had elapsed the total cost (including profit to the company) of generating and supplying 1 kw. hour to the consumer would come down to 3d., at which price electric light would be all things taken into consideration cheaper than gas. The larger part of Mr. Crompton's paper was devoted to the unqualified praise, supported by cogent arguments, of Babcock & Wilcox boilers and high speed direct-coupled engines. The author also showed by figures obtained from the companies themselves the great superiority of the continuous system over the alternating current system, so far as economy was concerned. Generally speaking, the efficiency of distribution of the alternate current system in England is about 66 per cent., whilst that of the continuous current system is more nearly 80 per cent. By efficiency is meant the ratio of the units metered to the units generated. Concluding his paper, Mr. Crompton stated that the standard which he had laid down was no impossible one, but whether attained or not, it should serve the useful purpose of holding before English electrical engineers the goal which they should all strive to reach, and which they could reach without the necessity of bringing out any one revolution in present practice, or, in fact, doing anything but perfect their present appliances.

MUNICIPAL ELECTRIC LIGHTING.—The accounts of the St. Pancras Municipal Electric Lighting concern for the year 1893 are fairly satisfactory. Briefly speaking the gross revenue has increased 36 per cent., whilst expenses have only grown 45 per cent. There is, however, some ambiguity about these figures, since a large proportion of the increased income arises from the growth of the public lighting, the revenue of which is, more or less, a bookkeeping item. Perhaps the most satisfactory feature is the fact that a 26 per cent. increase in the revenue has only raised the coal bill by 142, whilst the wages account has actually been reduced by over £200. The net result of the St. Pancras undertaking for the year 1893 is that a profit of over £6000 has been made, and this has been devoted to the payment of all the current interest on loans, the wiping off of arrears of interest, and the repayment of a small portion of the electric lighting debt. It has always been argued in this country that until English conditions of working and living were radically altered, the demand for motive power must ever remain an "unlimited trifle." Some curves published by the St. Pancras electric lighting committee show this to be the case. For nearly two years the St. Pancras Vestry has endeavored to obtain an appreciable

day load by supplying current during the day time at 3d. per Board of Trade unit; the idea being that it would not only encourage the use of the electric light in basements, but also foster the use of electric motors. How little this has been the case is evident when I say that whilst 55,000 kw. hours were supplied after dark during December at 6d. per unit, only some 3,500 kw. were supplied during the day at 3d.

ELECTRIC SUPPLY BUSINESS IN LONDON.—The meeting of the Metropolitan Electrical Supply Company took place on Monday, and in the course of the lengthy statement of the chairman, some interesting facts were illustrated. At every gathering of shareholders this year the same complaint of the persistent absence of foggy and dull weather during the past winter has been made, but it was reserved for the chairman of the Metropolitan Electric Supply Company to estimate exactly the money value to shareholders of good London fogs, and the dull days which usually adorn an English winter. Had the past winter been of the ordinary character, the Metropolitan Electric Supply Company would have been able to pay an extra 1½ per cent. dividend. To illustrate the evils of there being no electrical storage system comparable with the gasometer, the chairman pointed out that if all the company's existing machinery were to go to work for a couple of months, the power generated by it would, if stored, suffice for the entire year. Bemoaning the smallness of the dividend (2½ per cent.), the chairman pointed out that the company had been formed upon a basis of an income of £1 per 8 c. p. lamp connected, whilst the economical tendencies of the British householder had reduced this hypothetical income to the modest sum of 8s. 9d. Perhaps the most important announcement was that the directors were of opinion that the time had now come for the alteration of the company's system from that of house transformers to transformer sub-stations. The largest of our metropolitan companies, both in revenue (£69,000), area (4½ square miles), lamp connections (166,000) and main mileage (70), the progress of the Metropolitan Electric Supply Company is naturally watched with considerable interest both by capitalists and investors and electrical engineers, and its small dividends are to them all somewhat of a disappointment, and this disappointment was voiced at the recent meeting by more than one shareholder who, however, being non-technical, were only able to make vague comparisons with continuous current companies; comparisons which were rightly deprecated by the chairman. Such complaints are of no value in face of the fact that the Metropolitan company, for good or for evil, has committed itself to alternate currents, and in order to secure a lamp connection slightly larger than the biggest company's current concern, has been obliged to spend over 50 per cent. more money than its biggest continuous current rival.

News of the Week.

Telegraph and Telephone.

OCALA, FLA.—H. H. Birdsey is forming a company to construct a telephone system.

MILWAUKEE, WIS.—The National Telephone Construction Company has been incorporated.

RALEIGH, N. C.—A company is being organized to erect a telephone line from Raleigh to Durham and Henderson.

EASTON, PA.—The Pennsylvania Telephone Company states that the entire plant will be reconstructed and improved.

CUMBERLAND, TENN.—The Citizens' Telephone Company is to establish a telephone line to connect with the five surrounding mining towns.

HAGERSTOWN, MD.—C. B. Nestor is organizing a company to establish telephone systems in Hagerstown, and in Winchester, Va., also in other places.

LOUISVILLE, KY.—The Cumberland Bell Telephone Company, it is stated, will extend its telephone line from Louisville to Nashville, Tenn., and thence by way of Jackson to Memphis.

BROOKLYN, N. Y.—The Board of Aldermen of Brooklyn have granted a franchise to the New York and Eastern Telephone Company, subject to conditions approved by the city works commissioner.

NEWBURGH, N. Y.—The West Shore Telephone Company has been incorporated to construct a line between Newburgh and Saugerties, and Newburgh and the towns of Marlboro, Lloyd, Esopus, Kingston and Saugerties and Walkill Valley; also connecting Rosendale, New Paltz, Marbletown, Gaidner, Shawangunk and Patekill; also from the town of Lloyd, across the Hudson River to and through Poughkeepsie. The capital is \$35,000 and the directors are Wm. S. Ramsley, J. H. Crook, Wm. V. Snow and others.

Electric Light and Power.

SPARTA, TENN.—An electric light plant is to be built.

BRUNSWICK, ME.—An electric light plant is to be erected.

CRISFIELD, MD.—An electric light plant will soon be established.

GAITHERSBURG, MD.—An electric light plant for the city is to be erected.

CHESTERTOWN, MD.—The Chestertown Electric Company has been organized.

DODGEVILLE, WIS.—Residents are discussing the matter of waterworks and electric lights.

CLARKSVILLE, TENN.—The Clarksville Electric Light Company is arranging for liquidation.

NANAIMO, B. C.—The power house of the Electric Light and Power Company has been destroyed by fire.

DURAND, ILL.—There is talk of electric lights. W. E. Fyler has an engine which will be ample to supply power.

BRANCHVILLE, N. J.—C. H. Crisman has agreed to furnish light for the village, to be 30 lamps of 32-c. p. each.

McKEESPORT, PA.—The water and light committee has decided to call for bids for the electric lighting of the city.

MILWAUKEE, WIS.—The Gibbs Electric Company has filed an amendment, increasing the scope of its business to \$30,000.

OWINGS MILLS, MD.—An electric power plant is to be built by the Pikesville, Reistertown and Emory Grove Electric Railway.

MONTROSE, PA.—The special committee on electric lighting has reported in favor of an electric light plant, to be owned by the borough.

MARTIN'S FERRY, OHIO.—The Council is discussing the matter of an electric lighting plant, but no definite steps have yet been taken.

EVERETT, MASS.—An order has been adopted for the appointment of a special committee in the matter of a municipal electric light plant.

FORSYTHE, GA.—An electric light system is under consideration, which will cost about \$7,000. City Clerk R. G. Anderson will give information.

NANTICOKE, PA.—A New York firm has offered to erect an electric light plant for Nanticoke for a sum of \$50,000, to be paid for at \$5,000 per annum.

YORK, PA.—The Westinghouse Electric Light, Heat and Power Company is reported in the hands of the sheriff. The liabilities are \$25,000, the assets \$50,000.

SPRINGVILLE, ERIE COUNTY, N. Y.—The taxpayers, at a special election have voted in favor of a bond issue of \$12,000 for a municipal electric light plant.

HARRODSBURG, KY.—Harrodsburg is to have another electric light plant, to be put in by Riker & Lafen, to include both incandescent and arc lighting.

FREDONIA, N. Y.—The Fredonia Light and Power Company, recently incorporated, will soon begin the construction of an incandescent lighting plant in the village.

LEIPSIC, OHIO.—O. W. Irish has presented a proposition to the Council, asking for the right to light the town by electricity. The petition was laid on the table for one week.

HOLLIDAYSBURG, PA.—The Hollidaysburg Light and Power Company has submitted a proposal to light the streets, and the matter has been referred to the light committee.

WILLIAMSPORT, PA.—The Beacon Lighting Company, of Chicago, Ill., put in the lowest bid for lighting the streets, and the bids were referred to the committee on light.

OVID, MICH.—Sealed proposals will be received to noon, May 15, for furnishing an electric light and power plant for Ovid, as per specifications from the village recorder, A. S. Rose.

KANSAS CITY, KAN.—Thos. Wolf proposes that the city shall issue \$200,000 in 5-per cent. 20-year bonds, and turn the proceeds over to him, that he may establish an electric light plant.

WEST POINT, MISS.—Messrs. Whipple & Bell, of La Crosse, Wis., who have opened foundry and machine shops in West Point, intend installing and operating an electric lighting plant.

WATER VALLEY, MISS.—A contract has been made with Memphis parties for an electric light plant. The plant is to cost \$10,000 and is to be installed by the Western Electric Company.

ATHENS, GA.—The city has awarded the Athens Gas Light and Electric Company the city lighting contract for another year. This settles the question of a municipal lighting plant for the present.

HOUSTON, TEX.—The Consumers' Electric Light and Power Company is trying to secure a franchise for the erection of an electric light plant. Among the interested parties are J. W. Jones, J. J. Ryan, E. J. Peitzoker and others.

THE CITY OF HAWARDEN, IOWA, is to put in a 1,000-light incandescent municipal plant, and has adopted plans and specifications prepared by Wm. H. Bryan, consulting engineer, St. Louis. The city will receive bids up to May 25.

BLOOMFIELD, NEB.—Pierce Wright & Co., owners of the Bloomfield Mills, are making arrangements to put in an electric lighting plant for the use of the city, providing citizens will take 200 lights. The scheme is being well received.

MILWAUKEE, WIS.—President Rauschenberger, of the Common Council, has introduced a resolution authorizing the appoint-

ment of a special committee to act with the board of public works in the matter of a municipal electric light plant.

BALTIMORE, MD.—Sealed proposals will be received at the office of the fire commissioners to May 18 for one direct current incandescent dynamo and searchlight, to be erected on the fire boat "Catarnet." J. Alex. Preston is president of the board.

PHILADELPHIA, PA.—Sealed proposals will be received to May 15, at noon, by the bureau of water, department of public works, 1321 Filbert street, for a quantity of supplies, including an electric traveling crane. Details may be had of Director Jas. H. Windrim.

CHICAGO, ILL.—Mayor Hopkins and Superintendent of Streets McCarthy have decided to reduce the number of wires in the Hyde Park streets, and the companies interested have been advised that they must either reduce the number of poles or put the wires underground.

WYOMING, PA.—Councilmen Mullen, Stocker and Marsh have been appointed a committee to select an electrician, who will submit estimates for an electric light plant for lighting the streets of Wyoming, consisting of 50 arc lights, 500 incandescent lights and one 150-h. p. engine.

ALLEGHENY CITY, PA.—Sealed proposals will be received at the office of the city comptroller to 3 P. M., May 22, for the erection of an addition to the electric lighting station on Braddock street, as per plans at the office of U. J. L. Peoples, Room 611, Times Building, Fourth avenue. Robert McAfee is director.

A CORRECTION.—In The Electrical World of May 5 it was stated under this head that Frank J. Raë had been employed to prepare specifications and plans for an electric light plant for the city of Hamilton, Ohio. We are informed by Mr. C. L. Cornell that this is a mistake, as Mr. Cornell is employed by the city as electrical engineer.

CHARLOTTE, N. Y.—The contract for lighting the village with electricity has been awarded to Michael Doyle. The electric company in which he is interested will be known as the Charlotte Electric Light and Power Company. It will begin business with a capital of from \$18,000 to \$20,000. It will also extend its lighting area to Summerville and Windsor Beach.

The Electric Railway.

ROCKFORD, ILL.—An electric railway line will probably be established between Rockford and Dixon.

WASHINGTON, D. C.—The Washington and Arlington Electric road will be in operation in a short time.

EMMETSBURG, MD.—The Gettysburg Electric Railroad Company will extend its line through to Emmetsburg.

ATLANTA, GA.—The Consolidated road and the Traction company have a rate war in progress for Atlanta-Decatur traffic.

HARTFORD, CONN.—Engineers of the Hartford Street Railway Company have begun surveying for its proposed line to Windsor.

JACKSONVILLE, FLA.—The Jacksonville Street Railway Company is to change its line to an electric road and build extensions.

BALTIMORE, MD.—Contracts will soon be let for the Pikesville, Reistertown and Emory Grove Electric road, which is to be 10½ miles long.

LYONS, N. Y.—The Lyons Railway, Land and Improvement Company is securing right of way for the construction of an electric railway.

YOUNGSTOWN, OHIO.—A bill has passed one branch of the Legislature authorizing the county to issue \$12,000 in bonds to build an electric road.

OSHKOSH, WIS.—The Oshkosh City Council has granted a franchise to J. R. Tollotson, of Toledo, Ohio, to build and operate an electric railway.

LOCK HAVEN, PA.—The Lock Haven Electric Railway Company has accepted the ordinance offered to it last November, and will at once begin work.

PIKESVILLE, MD.—Dr. H. J. Hebb is interested in a movement looking to the construction of an elevated electric railroad between Pikesville and Randallstown.

PHILADELPHIA, PA.—The Central Electric Elevated Street Railway Company is reported as incorporated by W. J. Hamilton and others with a capital stock of \$200,000.

KANSAS CITY, KAN.—The Quindaro Park Electric Railway Company is the name of a proposed electric road. Isaac P. Moore, W. H. Huffaker and C. C. Dail are directors.

BRADFORD, PA.—The ordinance granting a franchise to the Bradford and Kendall Street Railway Company has been taken from the table and referred to a joint committee.

YOUNGSTOWN, OHIO.—The Youngstown Falls and Park Company has at last succeeded in drawing up a franchise the terms of which are agreeable to the county commissioners.

HANNIBAL, MO.—It is proposed to extend the electric line to McMastine Pastures, a natural park two miles from the city, and the necessary amount has been subscribed, less \$5,000.

PITTSBURGH, PA.—The Knoxville and Fair Haven Land Companies are moving in the matter of a scheme to build an electric road to Castle Shannon. Another meeting will be held May 10.

BROOKLYN, N. Y.—A franchise has been granted to the South Brooklyn Terminal Railway Company, giving it the right to build

a surface railway through the Twenty-sixth ward of Brooklyn.

CONNELLSVILLE, PA.—It is the intention of the Connelville, New Haven and Leisnering Railway to extend its line from the present terminus at Leisnering to Uniontown, a distance of eight miles.

RAYMOND, FLA.—Articles of incorporation have been filed for the Raymond Electric Railway to build an electric line from Raymond to Auburndale, a distance of nine miles. G. Bert Raymond is chief promoter.

KANSAS CITY, KAN.—The Eighteenth street railway is asking for a franchise for an electric street car line from Eighteenth street to Storch avenue, in Chelsea place. The company is an independent corporation.

BOSTON, MASS.—The committee on transit of the Senate reported leave to withdraw on the petition of Reynolds T. White for authority to build, equip and maintain an electric elevated railway in Boston, Mass.

SPENCER, N. Y.—The Spencer "Town News" is again agitating the building of an electric line between Ithaca and Owego, to be called the Tompkins and Tioga County Traction Company. Nothing definite has been done.

FORT WAYNE, IND.—The Centlivre Bros. will greatly improve their line this summer. It will be double tracked, new rails will be put down and a new power house built for the operating of the line by electricity.

WHITE PLAINS, N. Y.—The following have been appointed a committee to draft a charter for the company which proposes to build an electric railway in White Plains: Jas. B. Lockwood and Sylvester L. H. Ward, who will report at the next meeting, May 17.

FREEPORT, ILL.—The Freeport Electric Light and Street Railway Company, which was purchased by an Eastern syndicate, among whom are Speaker Crisp and other members of Congress, will expend \$100,000 in converting the street railway into a first-class electric line.

WHITE PLAINS, N. Y.—Residents have decided to form a company to be known as the Elmford, White Plains & Mamaroneck Railway, and the following are interested: Merwin Safflin, Jas. B. Lockwood, S. H. Gainsborg, Samuel J. Barnes and S. L. H. Ward. Wm. B. Sutherland is secretary.

FRANKLIN, PA.—A. H. McKelvey, Sheriff Roy and Jas. H. Dondy, of Warren, Pa., are interested in the proposed electric road for Franklin, to be called the Franklin Electric Street Railway, to build a line from Franklin to Oil City, via the river. D. P. A. Wheelock is engineer, and work will be begun at once.

GLOVERSVILLE, N. Y.—Civil Engineer W. L. Dugan, of Troy, N. Y., has been engaged to make a survey for the proposed line of electric railway to run from Gloversville to Mountain Lake, about five miles north. Alvah J. Zimmer, Wm. C. Mills and Elmer Hilt, of Gloversville, N. Y., are interested in the scheme.

THOMPSONVILLE, CONN.—The papers for subscriptions to the proposed electric railway from Thompsonville to Springfield are in the hands of L. A. Upson, of Thompsonville. George H. Fowler is one of the promoters of the scheme. Owing to plans not having been perfected, no definite action has yet been taken.

BENWOOD, W. VA.—The new railway between Moundsville and Benwood will be built. It will be called the Southern Electric Railway Company. The company has accepted an ordinance from the Benwood City Council to lay a double track through that place, which is five miles below Wheeling. The road will be about 10 miles long.

NEWBURGH, N. Y.—The Newburgh and Orange Lake Railway Company, capital stock \$100,000, has been incorporated to build a street railway $4\frac{1}{2}$ miles long between these points. The incorporators are Jos. M. Wickey, Wilbur H. Weston, Benjamin B. Odell, of Newburgh, and Benjamin Norton and Henry Newkirk, of Brooklyn.

RALEIGH, N. C.—The Raleigh Street Railway has been sold to J. H. McAden for \$4,000, who purchased the property as trustee for himself, Maj. R. S. Tucker, Col. A. B. Andrews, the General Electric Company and others. The road will be immediately put in order, and operated in connection with incandescent electric lighting.

BROOKLYN, N. Y.—The Nassau Electric Railway Company is to begin work on the 100 miles of new trolley line to run from the various ferries to Fort Hamilton, Bath Beach, Hensonhurst, Manhattan Beach, Sheephead Bay, Coney Island and Flatlands. Over \$5,000,000 are said to be involved in the deal, and over a year will be required to complete the system.

RANGOR, PA.—Messrs. Young & Pearson, of Easton, have begun surveying for the proposed line from East Rangor to Wind Gap, about eight miles. The Rangor Electric Light and Power Company has offered to furnish power, and its offer is being taken under advisement. The officers of the company are Thos. H. Seem, president; Chas. N. Miller, treasurer; Chandler A. Oakes, secretary, and George W. Mackey, solicitor.

BURLINGTON, VT.—The Queen City Park Association has decided to give the Electric Street Railway Company the right to carry passengers to the park for five years, and the road will be extended there as soon as right of way can be secured. The grounds are to be lighted by electricity. Dr. E. A. Smith, of Brandon, Vt.; B. F. Rugg, of St. Albans, Vt., and John Eastwood, of Winooski, Vt., are the committee on Queen City Park.

Miscellaneous Notes.

STORAGE BATTERY LITIGATION.—The argument on the motion for a preliminary injunction made by the Consolidated Electric Storage Company, of New York, against the Electric Storage Battery Company, of Philadelphia, came on for hearing before Judge Green, at Trenton, on Tuesday last, the 5th inst. It will be resumed on May 29.

THE ROSEL POLYTECHNIC INSTITUTE, Terre Haute, Ind., is especially fortunate in its thoroughly modern equipment and plan of instruction. It lays a special emphasis on the practical side of technical education, which it is enabled to do throughout the whole course of four years by its ample shops and laboratories and exceptionally complete outfit, especially in electricity.

THE FIRST ELECTRIC RAILWAY.—A friend of the late Prof. Moses G. Farmer writes to the New York "Tribune" contesting Dr. Cotton's claim of having exhibited the first electric railway. It is claimed that Professor Farmer laid tracks and operated an electric car during 1846 and 1847 in public halls of Dover, N. H., and Saco and Portland, Me., the car being large enough for children to ride on.

THE BURLINGTON, CEDAR RAPIDS AND NORTHERN RAILWAY has just finished fitting its switchlights at Estherville, Iowa, with electric lamps. On each switch stand is placed a signal globe containing a 16-c. p. incandescent lamp. This is thought to be the first case on record where electric light is used for switch signals, and the advantage of the electric light over the old oil lamp can be easily imagined. The glass never gets smoked up, thus destroying the effect of the signal, nor does the lamp ever go out from the jar of a passing train, nor freeze out or blow out. It can also be seen at a much greater distance. The company owns its own plant, and lights its roundhouse and general offices in addition to the numerous switches in the yard.

Personal Notes.

MR. FREDERICK BATHURST, of the General Electric Company, who returned to America in June from Europe, where he has recently made an extensive tour inspecting notable electrical applications, particularly for the transmission of power.

MR. CLINTON E. WOODS was born in Massachusetts in 1863.



Being left an orphan at 10 years of age, he was obliged to obtain his livelihood and education as best he might. Serving in miscellaneous employments until 1886, he drifted into steam and electrical work, being first identified with the local central station at Pittsfield, Mass., and afterwards at Peekskill and Newburgh, N. Y. From this he worked at general construction and engineering until 1889, when he entered the employment of the National Electric Manufacturing Company, Eau Claire, Wis., as its inspecting engineer. He served in this capacity until 1892, when he was made its chief electrician, which position he held until the spring of 1895, when he pooled issues with the Standard Electric Company, of Chicago, Ill. It is here that his work has won for him reputa-

tion and prominence in the electrical field, he having designed for this company a complete line of arc, alternating and constant potential dynamos, motors, etc., including such accessories as transformers and instruments. In the short space of 12 months, thus demonstrating the possibility of producing a commercial product without passing through the experimental stage. Mr. Woods is not only an electrician, but a manufacturer, having introduced methods of manufacturing dynamo-electric machinery which have greatly enhanced the value of his work from an artistic and mechanical standpoint.

Trade and Industrial Notes.

THE F. P. LITTLE ELECTRICAL CONSTRUCTION AND SUPPLY COMPANY, Buffalo, N. Y., has transferred its Western agency to the Metropolitan Electric Company.

MR. E. G. SALTER, 123 St. Aubin avenue, Detroit, Mich., claims to have devised a process by which copper can be tempered sufficiently hard to make boiler plate, firearms and other things requiring great strength and toughness.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, has opened an office in the Aldrich Court Building, 45 Broadway, where cells of the chloride accumulator, which have been so rapidly forging to the front, may be seen by those interested.

THE H. M. LOUD & SONS LUMBER COMPANY, 39 Cortlandt street, New York, is sending to its friends and patrons a card to which are fastened two miniature poles of the pattern supplied by them for electric lines, one of which is painted and the other carbolined.

MR. W. H. BEATTY, who has been identified with the Novelty Electric Company, of Philadelphia, for the past five years, acting in the capacity of salesman, is now connected with the Hubley Manufacturing Company, Lancaster, Pa., manufacturers of electrical specialties.

THE GENERAL ELECTRIC LAUNCH COMPANY, of Morris Heights, N. Y., sold four of its launches last week: One to Lord Aberdeen, Governor General of Canada, for use at Ottawa; two to A. Meinecke, Jr., of Milwaukee, and one to the Altoona and Logan Valley Railroad Company, for use at Altoona.

SHERBURNE MORSE, Arkansas City, Kan., has the contract for a 25-light arc plant complete, to be installed at Ponca City, Oklahoma; same to be in operation June 1. The Great Western Manufacturing Company's machinery will be installed. This is the first electric light plant to be installed in the Cherokee Strip.

MR. E. V. BAILLARD, formerly superintendent of the Equitable Manufacturing and Electric Company, has opened a factory of his own at 106 Liberty street, New York, where, with new and improved machinery, he will manufacture electrical instruments, and will also make a specialty of experimental and model work.

CHARLES A. SCHIEREN & CO, 47 Ferry street, New York, have received an order for 75 feet of 34-inch double perforated electric belting from the Metropolitan Street Railway Company, San Francisco, Cal. It had tried different kinds of belting, we are informed, and give the electric perforated a decided preference over all other makes.

THE CHICAGO ELECTRIC WIRE COMPANY, of Wilmington, Del., of which the Goodyear Hard Rubber Company and the India Rubber Comb Company, 9 Mercer street, New York, are the sole agents, is now manufacturing a flexible conduit tubing having a lead covering. The tubing can be easily bent to a curve of small radius, and the end joints soldered, thus enabling an entire conduit system to be hermetically sealed between its outlets.

THE HUBLEY MANUFACTURING COMPANY, Lancaster, Pa., has received a contract for furnishing the Hanover (Pa.) Electric Light, Heat and Power Company with all the material for, and building, its lines, and will also furnish the arc lamps. The same company has furnished the Citizens' Light, Heat and Power Company, of Lancaster, with more than 70 miles of insulated wire, as well as the bulk of supplies required by it to build its new lines, now approaching completion.

THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 De Kalb street, St. Louis, Mo., has issued a 24-page catalogue describing and illustrating the well known batteries manufactured by it, as well as various battery material. Several pages are devoted to directions for setting up and caring for cells, and recipes for making battery and amalgamating solutions. Much information is given in regard to Hayden carbon porous cup cells, including useful hints for the selection of the one most suited for a given use.

THE BUSINESS OF J. GRANT HIGH & CO., of 123 North Third street, Philadelphia, has increased to such an extent that Mr. High has been forced to enlarge his executive staff, and has taken in with him Mr. George T. Eyanson, M. E. On April 30 Mr. Eyanson severed his connection with the Meyer-Sniffen company, Limited, New York, after having been with them for four years as manager of their Philadelphia branch, controlling all of the Southern trade of that firm, where he is well known among the profession. The firm name will remain the same, Mr. High acting as president and Mr. Eyanson as secretary and treasurer.

THE BILLINGS & SPENCER COMPANY, Hartford, Conn., is sending out two unique advertising cards, samples of the materials to which they refer being attached. On one card is a sample 5-16 inch wrench with the opening milled, but otherwise unfinished, and attention is called to the fact that wrenches are now furnished with milled openings at the same price previously charged for rough forgings. To the other card is riveted a small drop-forged commutator bar, which serves as an exhibit of the excellent line of these manufactures, for which the Billings & Spencer company has established such an enviable reputation. The card states that all Billings' patent commutator bars are drop-forged from pure, unalloyed wrought copper, and guaranteed to be free from blowholes and porosity, and are made accurate to gauge, so as to require no milling on the sides.

THE FITCHBURG STEAM ENGINE COMPANY, Fitchburg, Mass., is now building two large cross compound condensing engines of 300 h. p. each for a power plant which is being erected in Boston; an engine was built for the same party last year; also a 250-h. p. high pressure for Wilmington, Vt., for a customer who already has nine Fitchburg engines; a 90-h. p. for a paper mill in Turner's Falls, Mass.; two 135-h. p. high speed engines, and one 40-h. p. for St. Louis, Mo.; two 100-h. p. for the new Medfield Insane Asylum, Medfield, Mass.; a 50-h. p. for Philadelphia. A 400-h. p. tandem compound condensing engine has just been started for parties who have used a 300-h. p. Fitchburg engine for a number of years. This speaks well for the quality of the work of this firm, and much of which for the past years has been for old customers. The company has so far been able to keep its large new shop running full time and with nearly a full complement of hands.

BARNARD & HOOPES is the firm name of a new electrical company recently established, and located at 916 Arch street, Philadelphia. This firm are selling agents for that vicinity for the Dahl alternating current motor, Western Telephone Construction Company and Great Western Manufacturing Company; also dealers in electrical supplies. A full line of dynamos and motors, gas and electric fixtures will be kept constantly on hand. This firm will also do construction work, but will make a specialty of selling electrical supplies and electric light and power machines. A small plant has been installed in its office for the purpose of showing the Dahl alternating current motor in actual operation to intending purchasers. Mr. Hoopes was formerly connected with the Fort Wayne and Edison Electric companies, and more recently superintendent of the Balla and Merion Electric Company, Cynwyd electric light station, Cynwyd, Pa. Mr. Barnard is a well known Philadelphia business man.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

THE CONSOLIDATED ELECTRIC STORAGE COMPANY has issued two new pamphlets, one (No. 9) on isolated lighting by the aid of storage batteries, and the other (No. 10) devoted to the various types of batteries, their capacity at varying rates of discharge, etc. They may be procured at the company's office, Edison Building, New York, or Drexel Building, Philadelphia.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MFG. CO., 2140 DeKalb St., St. Louis, Mo.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED MAY 1, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

518,939. ELECTRIC CONDUCTOR FOR UNDERGROUND CONDUITS; D. E. Conner, Covington, Ky. Application filed Jan. 23, 1893. A stringer containing an insulated live conductor having a downwardly extending slot in its lower edge, and a contact chain composed of links loosely supported in the slot.

518,944. DYNAMO ELECTRIC MACHINE; G. Forbes, Niagara Falls, N. Y. Application filed Aug. 7, 1893. The combination of a field magnet outside the armature, rotated by means of a spider attached to the shaft, the spider and field forming a bell shaped revolving field magnet, with a stationary armature.

518,945. DYNAMO ELECTRIC MACHINE; G. Forbes, Niagara Falls, N. Y. Application filed Aug. 17, 1893. The combination of an armature having parallel notches with two types of coils having corresponding parallel sides, the ends of the coils of the second type being bent over the ends of the armature and passing within and clear of the coils of the first type.

518,946. CONSTRUCTION OF SOLENOIDS OR COILS OF WIRE USED IN ELECTRIC MACHINERY; G. Forbes, Niagara Falls, N. Y. Application filed Aug. 17, 1893. This comprises a coil having a close fitting casing and an inlet for oil, with means for maintaining a forced circulation of oil.

518,952. TROLLEY FOR ELECTRIC RAILWAYS; G. W. Hooper,

Rochester, N. Y. Application filed June 1, 1893. A yoke for a trolley wheel provided with lubricant receptacles having bushings to form bearings for the axle of the trolley wheel, the interior of the bushings communicating freely with the receptacles and the bushings abutting against the trolley wheels about the axle.

518,959. TELEPHONE; E. V. Kolbassieff, Cronstadt, Russia. Application filed Sept. 21, 1893. This comprises a plurality of horseshoe magnets converging to the centre of a containing casing, a central pole piece structurally connected to one arm of each magnet, a cylindrical pole piece surrounding the central pole piece and connected to the opposite arm of each magnet, and a conductive coil interposed between the two pole pieces and surrounding the central piece. (See illustration.)

518,966. STORAGE BATTERY; W. A. Phillips and J. B. Entz, Bridgeport, Conn. Application filed June 20, 1893. The combination with a battery plate, of two loops, one on each face of the plate, and clamped together at top and bottom.

519,043. ELECTRIC HEATER; S. B. Jenkins, Boston, Mass. Application filed March 31, 1893. This comprises a pair of discs riveted together by a central core, and an insulated electric conductor wound about said core between the discs, the edges of the disc being turned one over the other to complete the inclosure of the conductor.

519,045. **ELECTRIC ARC LAMP**; J. B. McKeown, Cleveland, Ohio. Application filed Feb. 23, 1894. This comprises a tubular rod suspended in the chimney by cords attached to the top end and passing over pulleys in the top of the chimney, a counter weight attached to the ends of the cords, guide wheels secured to the casing, an armature suspended inside the tube, and an electromagnet outside the tube and connected in the electric circuit.

519,076. **SYSTEM OF ELECTRICAL DISTRIBUTION**; E. Thomson, Lynn, Mass. Application filed Aug. 5, 1889. This comprises a system of distribution having high potential mains and low potential secondaries, a vault beneath the ground, a converter, high potential wires passing to the primary of the converter, low potential wires passing from the secondary of the converter and a converter case.

519,077. **STORAGE BATTERY SYSTEM**; J. Trumphy, Hagen, Germany. Application filed Nov. 22, 1893. In a circuit changing switch the combination of a main brush and a series of auxiliary brushes carried thereby and connected with each other and with the main brush by resistances.

519,097. **FIELD MAGNET FOR ELECTRIC MACHINES**; A. Schmid, Allegheny, Pa. Application filed Dec. 7, 1889. This comprises field poles composed of laminae of sheet iron, a frame for the poles of cast iron, cast about the laminated pole pieces, certain of the laminae projecting into the cast iron frame a greater distance than the others.

519,098. **SELF-EXCITING CONSTANT POTENTIAL ELECTRIC GENERATOR**; A. Schmid, Allegheny, and B. G. Lamme, Pittsburgh, Pa. Application filed Feb. 20, 1890. This comprises an armature having main and supplemental coils, regulating coils connected in series with the main coils, regulating coils connected in series with the supplemental coils, and a conductor through which the connections are made from the supplemental coils with the field exciting coils.

519,099. **INCANDESCENT ELECTRIC LAMP**; F. S. Smith, Pittsburgh, Pa. Application filed Nov. 29, 1892. This comprises a glass globe and leading-in wires, the glass around the wires having substantially the following composition: Silica, 50 to 60 per cent.; boracic acid, $3\frac{1}{2}$ to 6 per cent.; sodium oxide, 10 to 20 per cent.; barium oxide, 30 to 40 per cent.; zinc oxide, 5 to 6 per cent.

519,115. **ELECTRIC RAILWAY CONDUCTOR SUPPORT**; J. C. Henry, Westfield, N. J. Application filed Sept. 27, 1889. The combination of two working conductors, one being divided and the other yieldingly supported normally above the point of division so as to pass through and below the division on the passage of the trolley.

519,116. **ELECTRIC MOTOR**; F. E. Herdman, Indianapolis, Ind. Application filed July 19, 1892. This consists in giving to the fields excessive strength at the time the current is thrown on the motor, the armature thereby revolving much quicker and speed being obtained in much less time than if the fields were not strengthened.

519,117. **ELECTRIC ELEVATOR**; F. E. Herdman, Indianapolis, Ind. Application filed Oct. 20, 1892. This comprises, in combination with the elevating car and power controlling mechanism, an operating shaft, a governor operated thereby, means to control the adjustment of the governor, and intermediate connection between the governor and the power controlling mechanism.



NO. 519,188. COMMUTATOR BRUSH.

519,120. **REGULATOR FOR ELECTRIC MOTORS**; F. E. Herdman, Indianapolis, Ind. Application filed April 16, 1892. This comprises a drum, plates wound around the same, one end of each plate being bifurcated, a source of current supply, brushes adapted to convey the current to the solid portions of the plates, and brushes adapted to convey current from the bifurcated ends of the plates to the desired points.

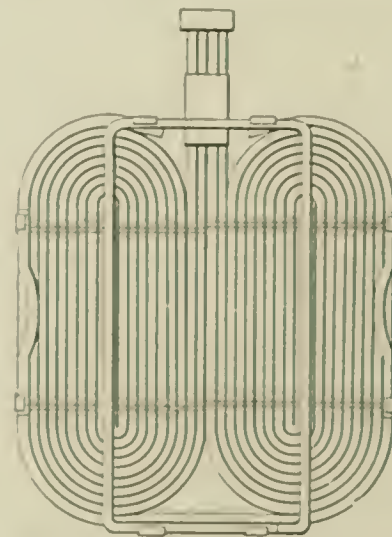
519,121. **CONTROLLING DEVICE FOR ELECTRIC MOTORS**; F. E. Herdman, Indianapolis, Ind. Application filed July 19, 1892. This comprises a switch arm operated by a solenoid, a motor, and electrical connection between the armature thereof and the switch.

519,122. **CONTROLLING DEVICE FOR ELECTRIC MOTORS**; F. E. Herdman, Indianapolis, Ind. Application filed July 19, 1892. This consists in admitting current to the regular winding of the field in a circuit parallel to the armature circuit and to the

regular field circuit, initially admitting current to the armature through resistances, and throwing resistances into the extra winding as the resistances are cut out of the circuit to the armature.

519,123. **CONTROLLING DEVICE FOR ELECTRIC MOTORS**; F. E. Herdman, Indianapolis, Ind. Application filed Oct. 20, 1892. The combination of a motor, armature circuit controlling switch, resistances, resistance arm and resistances adapted to travel over the resistances, a motor the shaft of which operates a worm meshing with a gear on the end of the arm, and an operating bar to operate the switch.

519,124. **ELECTRIC MOTOR CONTROLLING APPARATUS**; F. E. Herdman, Indianapolis, Ind. Application filed Oct. 20, 1892. The combination with a source of current supply and an electric motor of an armature current controlling switch, an arm in circuit with the armature of the motor and adapted to travel over the resistances, a solenoid, the core of which is connected to the arm, an independent solenoid controlling switch, electrical connection between the switch and current supply, and between the switch and solenoid, and independent operating devices for each of the switches.



NO. 518,966.—STORAGE BATTERY.

519,142. **RELAY**; H. S. L. Verley, Hoboken, N. J. Application filed Jan. 13, 1894. The combination with the primary contact actuating magnet of an auxiliary magnet arranged in the line circuit to act upon the contact arm and provided with a contact for the arm.

519,171. **MEANS FOR INTRODUCING INSULATING MATERIAL INTO CONDUITS**; D. Brooks, Jr., Philadelphia, Pa. Application filed Nov. 23, 1892. This comprises a conduit having a manhole in combination with a flexible receptacle open at top and communicating at bottom with the conduit, and means connected with the receptacle for suspending the latter within the manhole.

519,188. **COMMUTATOR BRUSH**; R. Kersberg, Hohenlimburg, Germany. Application filed Jan. 8, 1894. A commutator brush formed of a metallic cloth or fabric composed of wire spirals screwing one into the other. (See illustration.)

519,212. **AUTOMATIC ELECTRIC FIRE ALARM AND SIGNAL**; L. A. and C. J. Werner, Boston, Mass. Application filed Feb. 7, 1894. This comprises a burner carrying an electric lighting device, a circuit therefor, a fusible bar, a signal plate and a trip for holding the plate, which is itself held by the fusible bar, whereby when the bar is severed the plate is released.

519,272. **ELECTRIC MOTOR**; E. E. Ries and G. J. Scott, Baltimore, Md. Application filed July 27, 1893. An alternating current motor composed of several groups of sectional laminated and interlaced circularly arranged field magnets, a concentric sectional laminated armature and circuit connections, and a commutator for shifting the polar lines of the field of force.

519,280. **ELECTRIC GENERATOR**; W. Baxter, Jr., Baltimore, Md. Application filed May 12, 1891. In a brush holder, the combination of a hanger having a lower brush socket and an upper guide sleeve, a presser rod adapted to bear with its lower end above the socket and working in the guide sleeve, and a spring for forcing the presser rod downward.

519,281. **ELECTRIC MOTOR OR GENERATOR**; W. Baxter, Jr. Application filed May 12, 1891. The combination of a spider having projections on its arms, and field magnets supported on the spider through the medium of the projections.

519,282. **ELECTRIC ARC LAMP**; J. C. Fyfe, Chicago, Ill. Application filed Dec. 29, 1893. The combination with dependent supports, of horizontal supports carried thereby and projecting beyond the depending supports at one end, with disc carbons secured on the projecting ends at angles to each other.

519,291. **ELECTRIC RAILWAY**; W. B. Purvis, Philadelphia, Pa. Application filed April 14, 1893. A tube composed of insulated sections, inside and outside tubes formed of non-conducting material and slotted, and a loose electric wire within the inside tube.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., 253 Broadway, New York.

The Electrical World.

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NEW YORK, MAY 26, 1894.

No. 21.

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Established 20 years ago THE ELECTRICAL WORLD is the Pioneer Electrical Journal of America, and has well maintained its lead. It has the Largest Circulation of any electrical periodical in the world, and is the Best Advertising Medium.

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1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 289 " "
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The first issue of 1894 contained 320 different Advertisements.

No announcements of the publisher are included in this list.

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are a special feature of THE ELECTRICAL WORLD. Position Wanted small advertisements cost but \$1 an insertion; Help Wanted and For Sale small advertisements cost but \$1.50 an insertion. Remit in advance for the number of insertions desired.

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THE ELECTRICAL WORLD,

253 Broadway, New York.

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NEW YORK, MAY 26, 1894.

NO. 21.

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PRACTICAL DYNAMO CALCULATION.

In the present issue we print a second section of a series of "Practical Notes on Dynamo Calculation," by Mr. A. E. Wiener, in which will be developed a complete practical treatise on dynamo calculation intended for actual use and not as a theoretical contribution to the subject. The treatment is based upon results obtained in practice, and will include numerous original tables derived from the data and tests of almost two hundred modern dynamos of all types and of both European and American make. The articles are written in a simple style and will be devoid of the mathematical abstractions which so frequently accompany writings on similar subjects and destroy their value to those to whom they should prove most useful. They will form a notable departure from time honored electrical practice in this respect and more nearly follow the methods used by writers in the older branches of engineering. While primarily intended for the designer and the student of electrical engineering, every one interested in electrical pursuits will find the vast fund of practical information of interest, not only directly, but as furnishing concrete illustrations of the principles concerned both in the theory and operation of dynamos.

HONORS TO FRENCH ELECTRICIANS.

The current number of the "Bulletin de la Societe Internationale des Electriciens" announces that the President of the French Republic has conferred merited rewards upon a number of French electricians for their services in connection with the Chicago World's Fair. MM. Barbier, Carpentier, Lippmann and Violle have been promoted to the grade of officer in the Legion of Honor and MM. De La Touanne, Milde, Picou and Richard awarded its decoration of Chevalier. Most of these names, particularly Lippmann, Violle, Picou, Richard and Carpentier, are doubtless familiar to our readers, but the absence will probably be noted of those of two Frenchmen eminent in electrical science who honored the Chicago Electrical Congress with their presence, and whose writings are almost as well known in America as in France—Mascart and Hospitalier. Of these, Mascart has already reached the highest place on this distinguished roll, his splendid abilities having long since exhausted the official honors which France delights to lavish on her great savants. Without presuming to criticise the omission of the name of Hospitalier, perhaps the best known in America of all the eminent Continental electricians through the wide circulation secured for his works by their distinctively practical character, yet the gratitude which American electricians feel for his generous services in behalf of the henry, both in France and at Chicago, will give rise to a regret that he has not received a recognition which would also have been considered a compliment to the cause in which he labored.

INDUCTANCE AND REACTANCE.

The Institute, at its annual meeting last week, took another important and creditable step in the direction of the good work which it started nearly two years ago when it made the important suggestions to the recent International Congress, most of which, though meeting with no action there, have nevertheless borne good fruit. As the comparatively new term "inductance" was being used with two entirely different meanings, the Institute, at the suggestion of its Committee of Units and Standards, has now decided that,

at least in this country, as far as the great weight of its authority extends, the term is to be used only in the sense of a coefficient of induction, the cumbersome expressions "coefficient of self-induction" and "coefficient of mutual induction" to be consequently replaced by "self-inductance" and "mutual inductance." As the other quantity for which this term was sometimes used was thereby left nameless, the term "reactance," upon the motion of Mr. Steinmetz, was adopted for it, the reactance being the spurious or wattless component of the resistance, which, when properly combined with the true ohmic resistance, gives the impedance. The definitions of these two quantities as adopted by the Institute will be found in another column, and we urge all Americans to aid the Institute in this good work by adopting these terms in their writings. The English will undoubtedly join us, at least in adopting the term "inductance" in this sense, as it originated in their own country with that meaning. It is quite likely, too, that the Germans will at least not use these terms in any other sense and they may even adopt them. The French, we fear, will not be as easily persuaded, as their leading society has already expressed itself as being satisfied with the present terms. It may be added, however, that the adoption of the term "reactance" has been strongly advocated by no less an authority than M. Hospitalier. The usual objections to the introduction of new names will doubtless be raised by some, especially by those who do not understand these terms and quantities, or who do not appreciate the advantages of uniformity and simplicity in our international electrical language. Such persons may continue to use the older and longer expressions for inductance and replace the simple term reactance by its cumbersome definition every time they refer to this important quantity; the loss is their own.

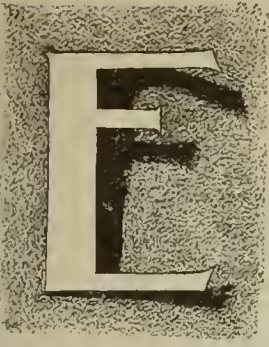
ANNUAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The growing vigor of the American Institute of Electrical Engineers and the professional influence which it exercises were most gratifyingly manifested at the recent annual meeting at Philadelphia, which was pronounced by all to be the most successful in its history. Not only was the attendance the largest—in numbers but little short of 150—but the interest in its proceedings was the most sustained as shown by the manner in which the attendance kept up. The assembly room of the Engineers' Club, though having a seating capacity of about 100, was so well filled that few vacant chairs were seen at any time, while at several of the sessions the room proved entirely too small, many members being unable to obtain admittance. A praiseworthy recognition of the national character of the body was shown by the spirit in which a measure affecting the Chicago meeting was received. The success of the first local meeting, it may be added, was a frequent subject of remark among the members present, and our Chicago brethren would have felt gratified at hearing the pleasure expressed on all sides at the success of their efforts. The social features of the meeting were not less successful than the professional ones, and all of those in attendance doubtless carried away a feeling that not only in name but in deeds the Quaker City is truly the "City of Brotherly Love." The annual dinner proved a most agreeable relaxation. We doubt if any other professional body in the country is as fortunate in the possession of graceful speakers at its social gatherings, for besides those who did honor to this occasion, the list of those present who possessed the envied gift of post-prandial oratory was far from being exhausted. The address of President Houston at the opening of the general meeting, besides its appropriateness for the occasion of the meeting of the Institute at its birthplace, is a valuable addition to the Transactions, covering as it does the interesting period of the childhood and youth of the Institute; for that body can now

be considered to have passed to a stage when its future is secure, and henceforth its deeds will furnish their own record.

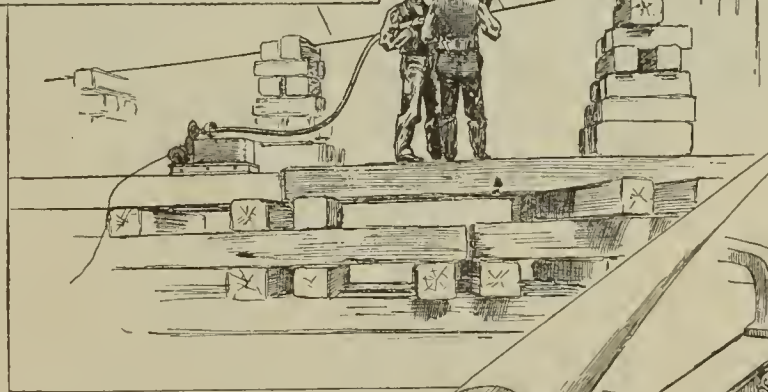
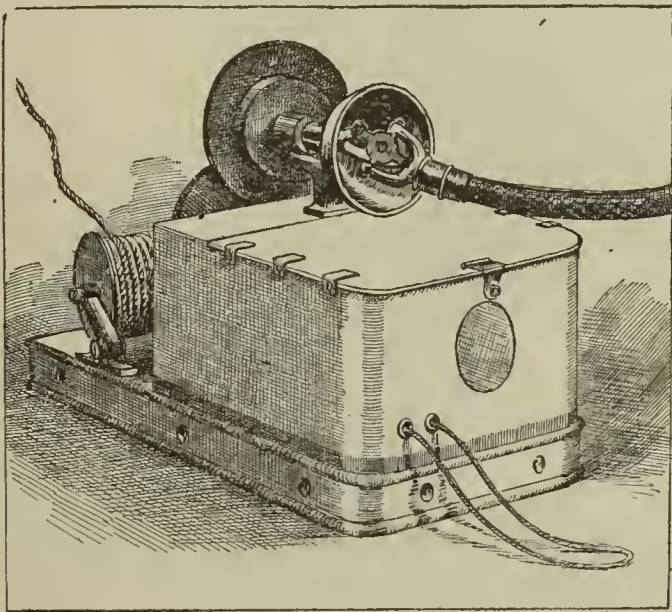
The programme of papers was an unusually satisfactory one, covering a wide range in which the highest theory and the most practical applications were equally represented. Of the fourteen papers read, the most notable were perhaps those of Messrs. Pupin, Steinmetz, Duncan, Crocker and Crehore. The paper of Dr. Pupin in a sense is an extension and application of the principles developed in his paper read before the annual meeting of last year, and relates directly to the analysis of alternating current curves by means of the resonance principle, and investigations into the origin of harmonics. An interesting result of the method outlined was the proof it furnished of the constant intensity of a rotary magnetic field, which has so often been doubted. In the paper of Mr. Steinmetz, which is a continuation of his classical researches in hysteresis, it was shown that the results of investigations by others have confirmed those arrived at by him as contained in the previous sections of the same paper. Among the points of interest in the paper are a discussion of the distinction between hysteresis and molecular magnetic friction, and data showing that much better iron can now be commercially obtained from a hysteretic standpoint than existed but a few years ago. The paper by Dr. Duncan contains a description of another application of his elegant method of alternating current analysis, this time to induction motors, including the study of their armature currents. Dr. Crehore described a beautiful method devised by him for the study of magnetic induction, based upon the change in the coefficient of refraction of a material in a field of induction. By this method, unlike others, there is no inertia to mar the results, and a ray of light is employed as a pointer in the apparatus described. Relating to new apparatus are the papers of Messrs. Willyoung, Wurts and Bedell. The commercial character which sometimes attaches to papers of this kind is in the present case relieved by the very full manner in which the principles concerned are illustrated, while the very complete experimental demonstration by Mr. Wurts of the physical facts relating to his subject was one of the successful features of the meeting. The phase indicator of Dr. Bedell, while apparently possible of only a limited application, is, nevertheless, a device as ingenious as it is simple. The paper of Mr. Griscom is particularly appropriate at the present time in view of the renewed interest being taken in storage batteries, and will doubtless result in some of the many points considered being taken up by others. An unusual amount of information and data is furnished in regard to obscure points in the theory of the storage battery, and the several problems left open for solution have their bearings most clearly indicated. The paper of Prof. Anthony is useful as bringing out the principles that should not be lost sight of in the consideration of the distribution of light, but perhaps it would have been well to have laid more stress upon the fact that owing to other important factors that enter into the case the one developed should rather be considered a guide than as capable of direct application. Messrs. Jackson and Ochsner by their experiments cast doubt upon the generally accepted principle that fuses are deteriorated by alternating currents, yet we should await further confirmation of their results before casting aside those of previous experimenters, with which they conflict. Dr. Bell brings forth some more hard facts in favor of induction motors, and shows that the power factor varies little within a very considerable practical range, while the reproach of the inefficiency of such motors at other than normal load applies with no greater force than to direct current series motors, which have no advantage whatever in this respect. The papers of Messrs. Adams and Owens deal with important points in dynamo design, and added to their intrinsic value by developing what was perhaps the most valuable discussion of the meeting.

Electricity at Cramps' Ship Yard.



VERY one is familiar with the name of the William Cramp & Sons Ship and Engine Building Company, of Philadelphia, but the important part which electricity in its yard plays in the construction and equipment of a modern vessel is not so well known.

Electricity was first introduced into this yard in 1890, and from a small plant of two incandescent machines and about one hundred lamps it has grown to an immense extent in the past four years, until now over 3,000 incandescent lamps and 125 arc lamps are in use. Recognizing the many advantages which the electric motor possesses, the general adaptability to every condition where power is required has led to the introduction of electricity where it was possible. Situated almost in the centre of the large yard is the electric light station, or, as it is commonly called, power house, and from its lofty cupola the numerous wires, for the trans-



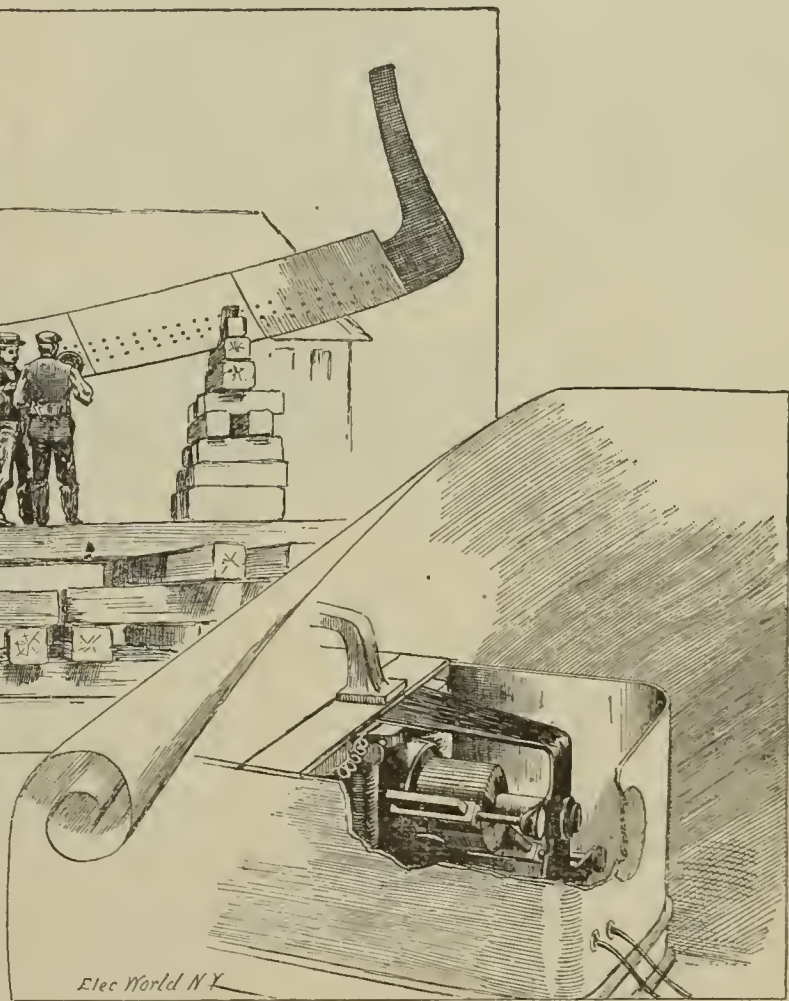
mission of power and light, branch out on all sides, forming a perfect network.

Within the station we can see the magnitude of the plant. A 200-h. p. New York Safety engine furnishes power to drive four Edison and three Thomson-Houston arc machines; a 50-h. p. Armington & Sims engine runs a 200-light Edison and 300-light United States dynamo; a 150-h. p. vertical compound engine runs the 400-light Electro-Dynamic Company's dynamo and the 110-kw. Eddy generator for power transmission around the yard.

Electricity is of much value in the large boiler shop, where there are two 50-ton and one 10-ton electric cranes, which do all the hoisting and transporting of the immense boilers for the ships, some weighing eighty tons and over, which, nevertheless, are handled with the utmost ease. Here we see that the electric motors possess advantages over any other form of power which could be used.

A useful tool in this shop is a machine for drilling and tapping marine boiler heads, made by Wm. Sellers & Co., and employing H. Ward Leonard's system of electric control. It has a spindle 4 inches in diameter, with a vertical range of 8 feet, a horizontal range of 14 feet, and a

stroke of 30 inches, and is driven by an electric motor carried upon the back of the upright, giving no less than 30 forward and 30 backward speeds. It also has a special feed for milling, and this feed is not dependent upon the spindle, is also entirely separate from the drilling and boring feeds, and yet has a range for the widest possible variation in diameter of milling cutter and pitch of cutting tooth. In short, it is suitable for all kinds of milling work. The drilling and boring feeds are in two series of fine and coarse, each with a wide range, and the total variation is from .002 to .3 of an inch. The centre of the spindle is only eight inches from the face of the upright, and the long bearing of the boring head insures a very stiff machine under cut. One very important feature of the whole arrangement is that the operator travels with the boring head, and he can therefore make any movement of the spindle, horizontally or vertically, at the head itself, promptly, at the rate of 20 feet per minute or less and with the greatest nicety. For instance, if the machine is at work at a height of, say, six feet from the floor, and it should be necessary to shift horizontally either a few inches or several feet, the man simply engages the necessary gears and the movement is promptly and accurately made, while in the usual constructions of such machines it would be necessary for him to either come down from the platform and make the manipulations himself as best he could, or call an assistant to make them while he saw that the adjustment was correct. The advantage of being



PORTABLE ELECTRIC DRILL.

able to make nice adjustments quickly, and thus keep the boring, drilling or milling tools under cut as much of the time as possible, is apparent, as well as the absence of the usual long shafts to transmit the power to the spindle and the great variety of speeds which is possible with the Leonard electric system of regulation.

Portable electric drills are used around the yard for drilling holes in the plates of the vessel, as illustrated in Fig. 1, which shows a 2-h. p. Electro-Dynamic Company's drill motor, with flexible shaft drilling holes in keel plates. These motors do all the heavy drilling through the thick protective deck sheets of the war vessels, saving much valuable time.

Passing from the boiler shop to the I. P. Morris foundry,

one of the best equipped in the country, it is surprising to see how much the foundry man depends upon electricity, yet not a single accident is recorded since the 50-ton electric crane was installed. This crane is one of the latest type built by William Sellers & Co., of Philadelphia, and is especially interesting from the fact that it is worked entirely by electric motors, every movement being controlled by a separate motor. Electricity is put to many other uses in the foundry; all the gib cranes are run by motors, and their speed can be varied as required by special resistance boxes close at hand. The centrifugal sand mixer receives its power from a 10-h. p. motor, as also the loam mill and sieve, and for lifting cores a small 10-ton crane performs the work. The 5-ton electric crane, which handles the plates in the ship shed and the brass foundry, with its 25-ton Snaw crane and numerous motors, completes the list of electric cranes now installed.

Perhaps the most useful electrical machine in the works is the electric hoist, consisting of a 30-h. p. Billberg motor directly connected by gearing to a Williamson hoisting engine, the motor of which is controlled by the White automatic switch. The switch is geared to the armature shaft, and consists of a rotating electric magnet separately excited and having a circular iron keeper attached to the switch lever, which, when the armature circuit is closed by throwing the hand switch, also closes the circuit on the electromagnets, causing the switch lever to rotate, which cuts out the sections of resistance successively, until the lever has reached the stop at the top switch circle; here the ring slides on the face of the magnet until the main circuit is broken, when the switch lever drops to the starting position by either weight or spring attachment. This useful machine has done all the hoisting of the steel plates on the International Navigation Company's new ship *St. Paul*, now in course of construction, requiring no repair and little attention since installed.

In the bending shed, the iron, white with heat, is drawn from the furnaces by aid of the 10-h. p. electric hoisting engine, a cut of which is given herewith, accomplishing in a few seconds the work of from forty to fifty laborers.

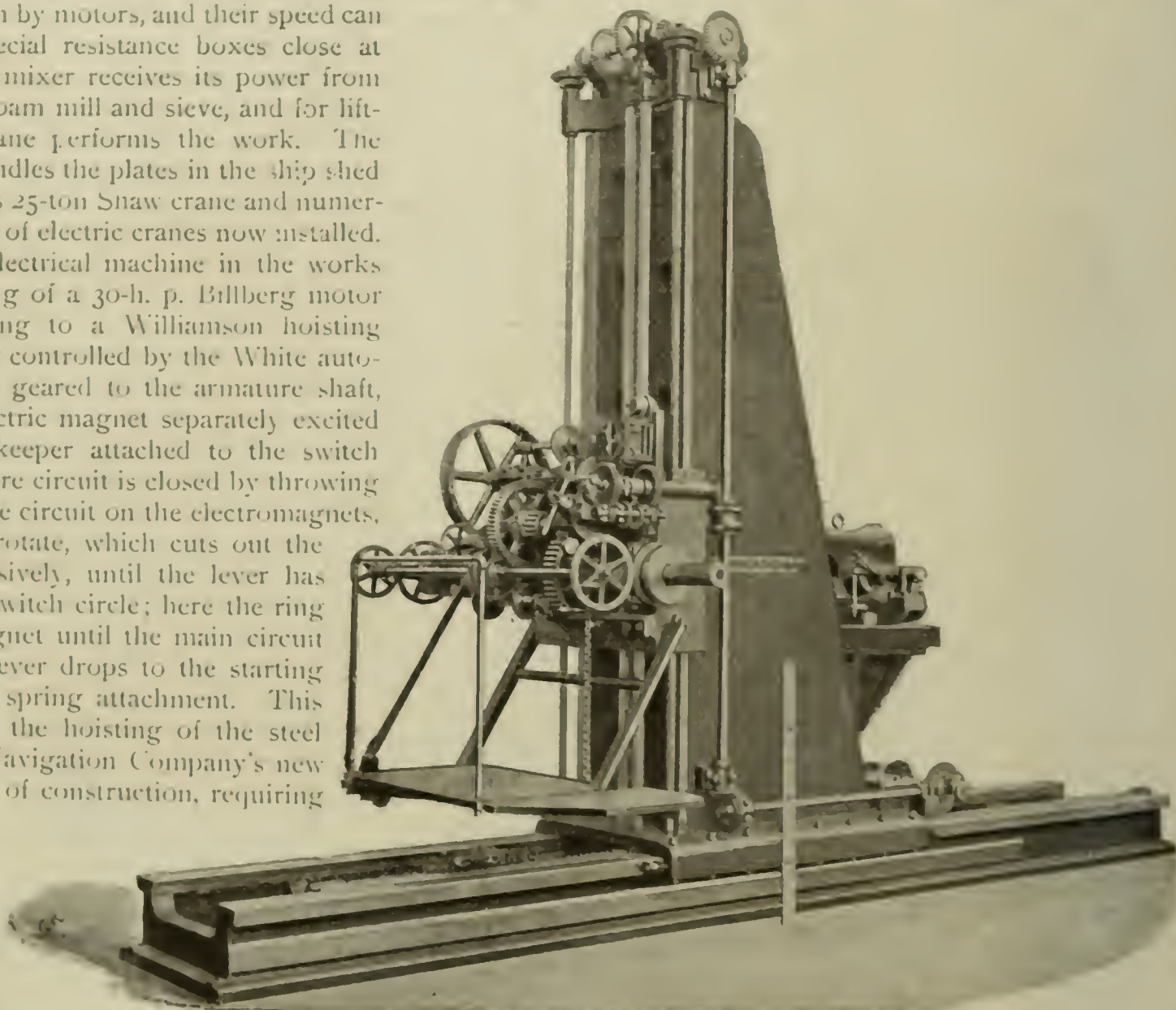
The incandescent light is an important thing, even a necessity in the construction of a ship. As soon as the plates are on the ship, and it becomes dark, it is necessary to light up the interior by some artificial light, and here the incandescent lamp has superseded the candle and the dangerous oil lamp for temporary lighting. In the ships under construction there are about 2,000 incandescent lamps, lighting them from stem to stern, and affording the workman plenty of light, even in the darkest corners, where candles would hardly be of any service.

Small motors furnish power for grindstones on the ships, while the portable electric drills are used for many purposes, saving time and labor.

The electric "deck planer," lately imported from England, planes with its sharp steel knives the rough decks, performing the work in one-quarter the time it would require to do it by hand and with greater accuracy. An electric elevator in the main office affords an easy means of communicating with the different floors; electric fans for cooling the offices, electric clocks, call bells and telephones sum up the many uses to which electricity is put within the works.

It is now well recognized what an important place electricity has in the equipment of a modern warship. In 1891 the electrical department was established in this yard, and since then the company has installed electric light plants in the following Government vessels: United States steamships *New York*, *Columbia*, *Minneapolis*, *Indiana* and

Massachusetts. Since the plants in the above vessels have been subjected to a severe Government test and passed all requirements, it shows conclusively that the electrical details are as carefully looked after as any other important feature in the construction of the ship. In the Government plants a standard type of generating set has been adopted, and the accompanying illustration gives the general view.



BORING, DRILLING AND MILLING MACHINE, WITH ELECTRIC CONTROL.

The engine shaft and armature shaft are directly coupled, the armature being secured with a feather and two set screws to the armature shaft. The engines are run without the use of lubricants in steam spaces, they are compact and light, and all parts are accessible for examination; they govern automatically, consequently the brushes on the dynamo are fixed for all loads. The dynamos are four-pole, compound wound, with a special resistance for series field directly on the headboard of the machine. The magnetic field is inappreciable at a distance of 15 feet. The engines make 400 revolutions with 80 pounds of steam.

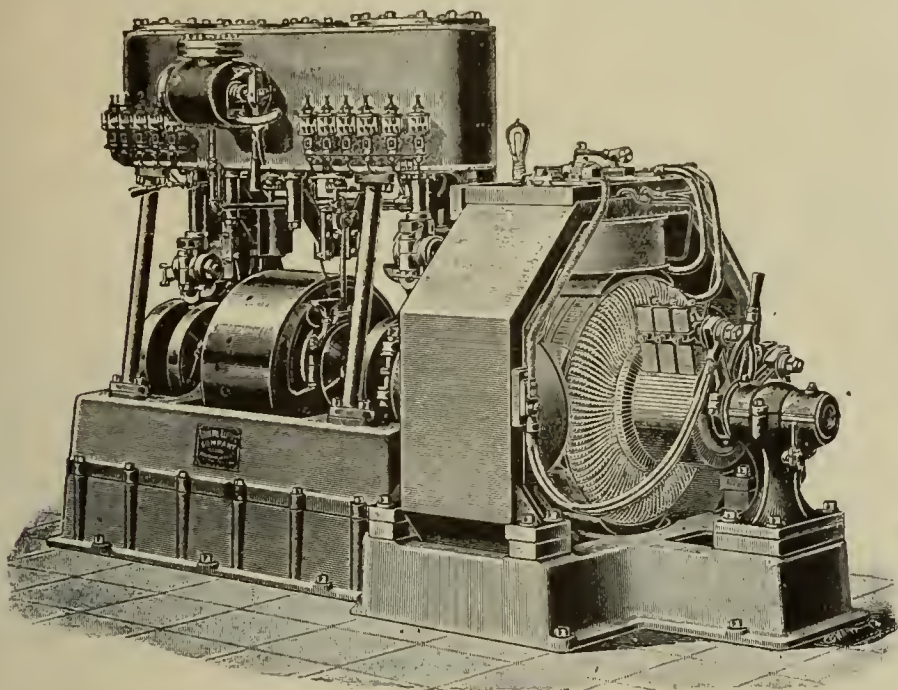
The dynamo room is located below the protective deck and as near as possible to the boilers. For ventilating the dynamo room an electric motor directly connected to an exhaust fan is used. This fan draws air from the deck and discharges it through the outlets, so placed as to give the best circulation of fresh air within the room. In some ships a blower for taking out the foul air is installed. Small portable ventilating fans are used for ventilating the double bottoms and such places, taking their current from an ordinary lamp attachment.

The switchboard adopted by the United States Navy is shown in the accompanying illustration. It combines small size and weight and simplicity in control. A section can be changed from one dynamo to another by simply shifting the knife switch seen in the illustration and any combination of dynamos can also be made.

The two-wire system is the one used, and the wires are

enclosed in wooden moldings, each wire having a groove by itself, and being separated from all others and from the deck or iron by at least one-half an inch of wood. The

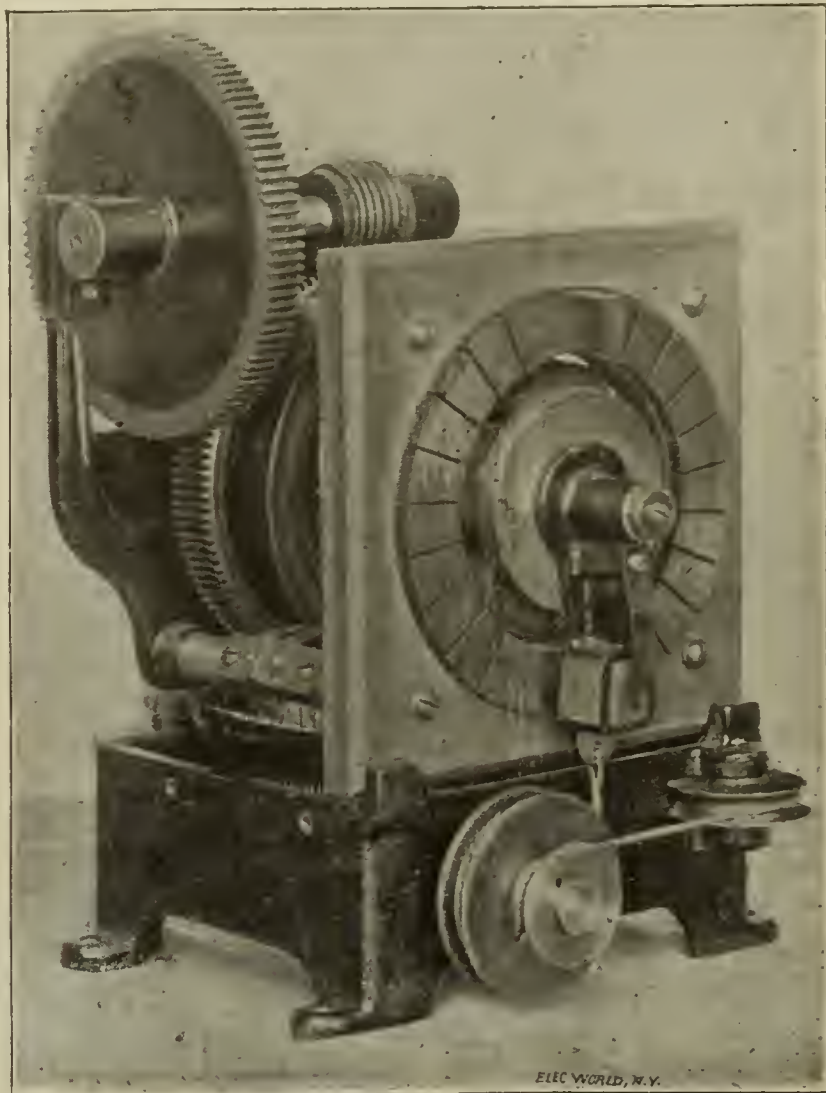
usually situated on the bridge. A series motor, placed in the pedestal of the lamp and geared to the barrel, trains and elevates the lamp. The armature of the motor revolves always



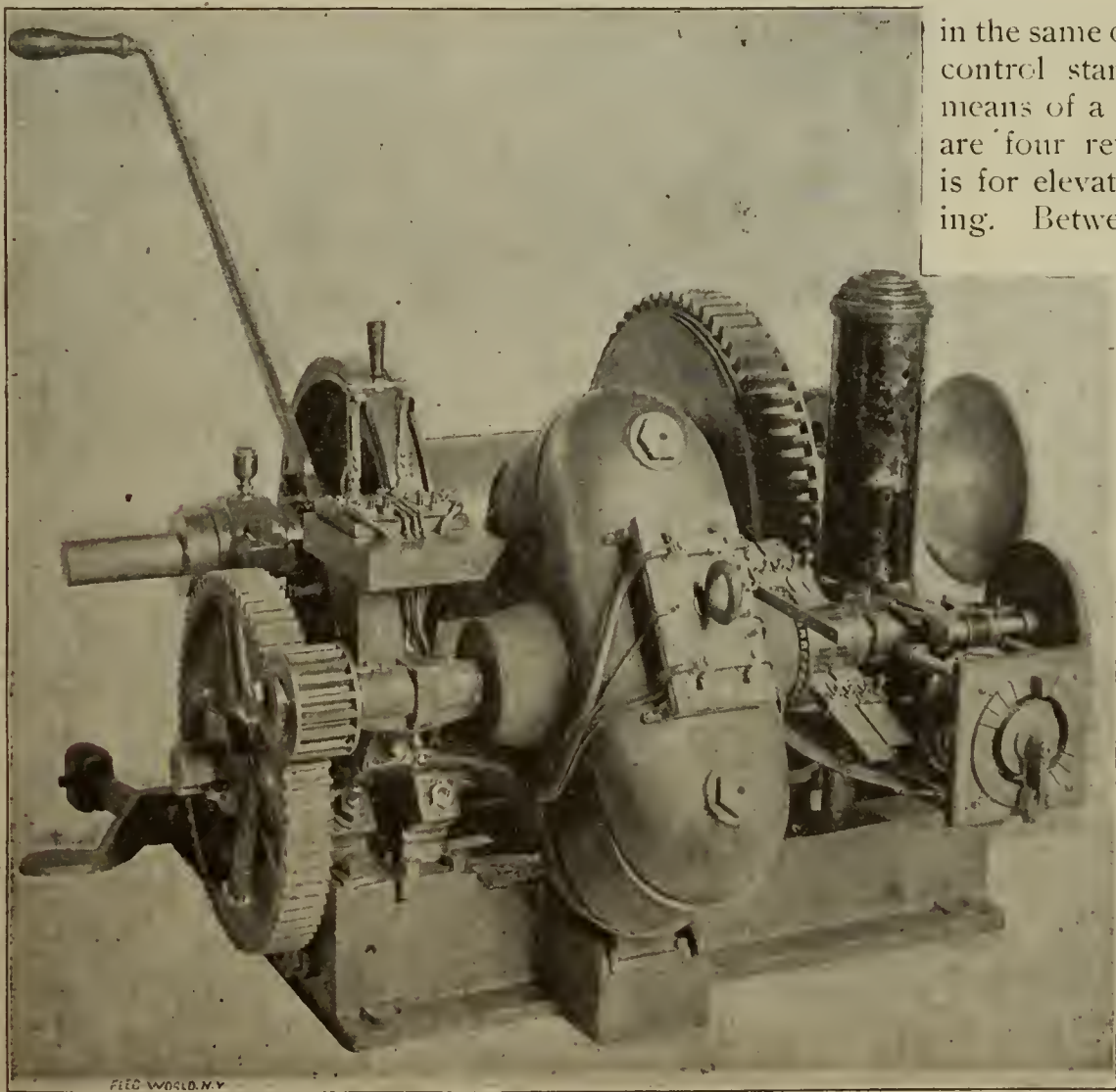
MARINE TYPE DYNAMO.

molding prevents short circuits and grounds when any injury has been done to the insulation of the wires.

The searchlights on the war vessels are of the latest type made by the General Electric Company. The accompanying illustration shows the automatic lamp. The lamps are run from the same dynamo that supplies the incandescent lamps, the voltage being reduced by means of dead resistance placed in the control stand mechanism. The dead resistance is required to steady the current in the lamp and also to prevent short circuiting while working. On the

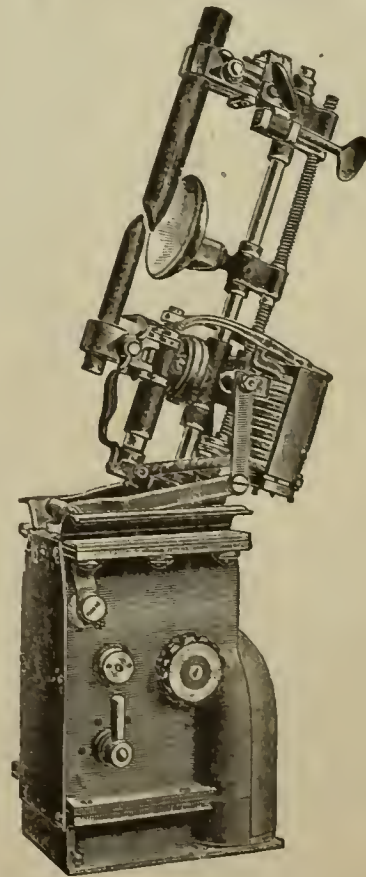


WHITE AUTOMATIC SWITCH.



ELECTRIC HOISTING ENGINE.

in the same direction, and is operated by switches placed in the control stand. The speed of the motor is regulated by means of a rheostat. Geared to the armature of the motor are four revolving electromagnets. One pair of magnets is for elevating or depressing the lamp, the other for training. Between each pair of magnets is a disc of soft iron



SEARCHLIGHT ARC LAMP.

United States steamships New York and Columbia the searchlights are electrically controlled. By this means the elevation and training of the light are placed under the control of the operator stationed in the control stand house,

secured to a shaft, which is connected by rods to gearing wheels. When one of the electromagnets is excited this disc is in motion, a slot engages with a pin on the magnet frame, making the disc revolve with the magnet and giving

the motion through the gearing to the lamp. The switches for operating the controlling mechanism are placed on the control stand and connected to the motor by means of an eight No. 14 B. W. G. stranded cable.

The lamps are adjusted to run on a current of from 85



ARDOIS KEYBOARD.

to 90 amperes at a pressure of 56 volts with a 1 1/4-inch cored Hardmuth upper carbon and a 1-inch solid lower carbon.

An interesting apparatus used on board the Government vessels for night signaling is the Ardois signal set. It con-

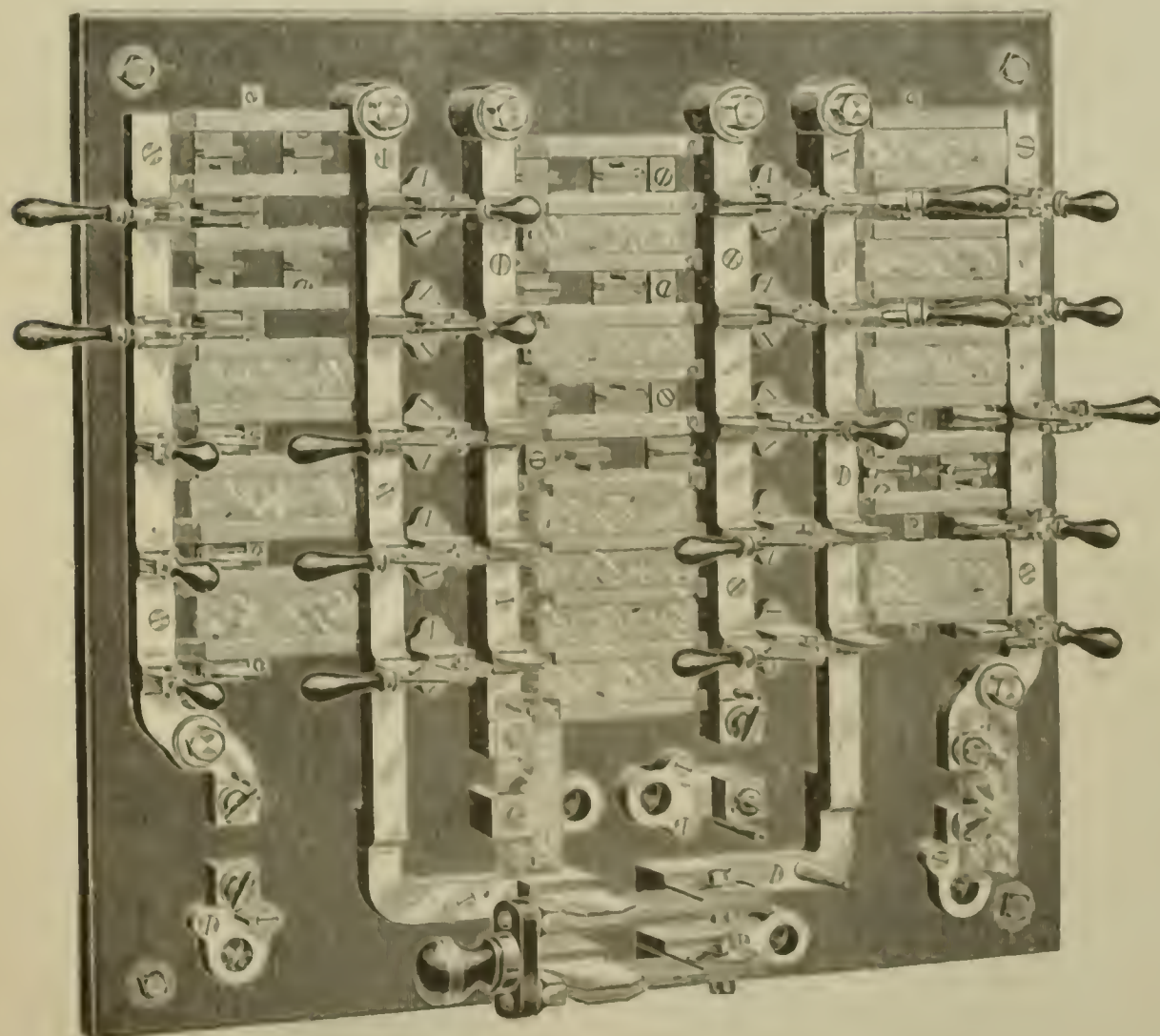
different combinations of lights can be made corresponding to a special code of signals.

The introduction of electric motors on board naval vessels has been quite prominent in the past few years. The many uses for which the electric motor is far superior to any other in convenience, weight and cleanliness recommend it for use on ventilating fans, rapid-firing guns, steering, ash hoists and workshop machinery.

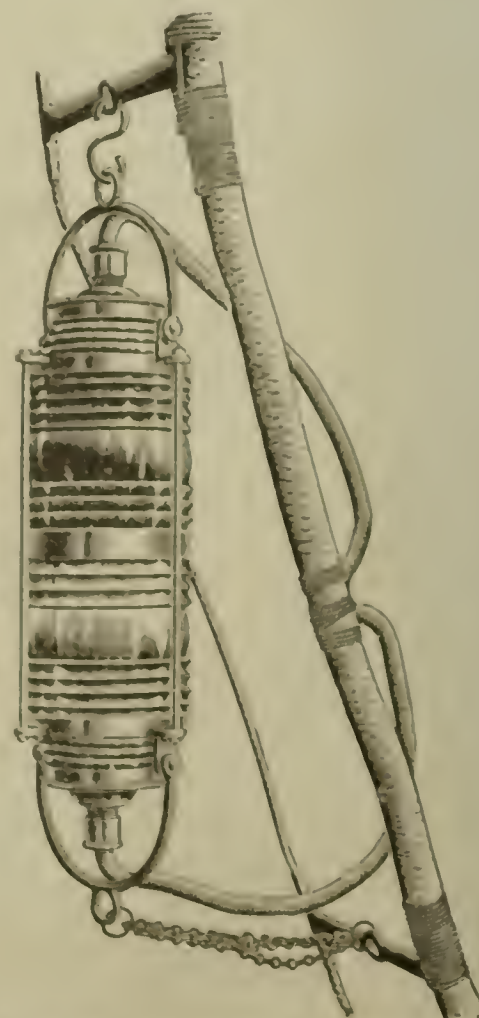
Aurora Borealis and Earth Currents.

To the Editor of The Electrical World :

Sir—There was a localization on the western half of the North American continent, not only of the fine aurora of Feb. 23, but also of the earth currents, affecting the telegraph lines, which, so far as is now known, after careful inquiry, were recorded only west of Chicago on that date. The day following, however, both the aurora and earth currents extended eastward, and were strongest along the Atlantic coast. This localization in longitude appears to depend primarily upon the development of a temporary magnetic system having its poles at a certain hour angle from the sun. Thus, there is concentration of effect at the meridians in the proper location to receive it at the time. Local terrestrial conditions may modify the distribution somewhat, but do not originate it, it depending upon the relative positions of sun and earth in relation to the temporary lines of force being developed at such times. The whole matter is being actively investigated by the aid of the concerted observations of the aurora which have been organized in connection with the Peary expedition, and which are proving to be successful. The authorities of the Western Union Telegraph system are



NAVAL SWITCHBOARD.



ARDOIS SIGNAL LANTERN.

sists of five double signal lanterns, similar to that shown in the illustration, each containing two lenses, one red and one white, and lighted by a 32-c. p. incandescent lamp. These lamps are connected by a stranded cable to the keyboard, an illustration of which is given, which is usually placed in the control stand house. By means of this keyboard 62

becoming interested in preserving more complete memoranda of the geographical distribution of earth currents on their lines for the purpose of comparison, especially with the distribution of auroras and thunderstorms, information respecting which is now to be had in greater detail than ever.

LYONS, N. Y.

M. A. VEEDER.

ANNUAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS



THE eleventh annual meeting of the American Institute of Electrical Engineers in Philadelphia last week was one of the most successful gatherings which that body has ever held, and marks in a fitting manner the close of its first decade of existence. The attendance was unusual, exceeding that of any previous meeting. The total number present approximated 150 and the large average attendance upon the daily sessions was especially gratifying. It has been too often the case in the past that the authors of the papers have been obliged to address empty chairs and the discussions have been participated in only by the faithful few. On this occasion the reverse was the case, and so many were present that a considerable portion of the audience were obliged to stand. The room where the meetings were held, unfortunately, proved much too small, but it had not been anticipated that so much interest would centre in the sessions. The discussions gave evidence of the spirit of the meeting and were so vigorously participated in that it was frequently found necessary to limit or postpone them.

The attendance was as strong in quality as quantity. There was a noticeably large percentage of the most prominent workers in the electrical field present, and the result was a series of discussions of rare importance and merit. It was unfortunate that at the close of the meeting the discussion of some of the most important papers read was necessarily cut short, but it is hoped that the printed Transactions may make amends for this loss.

The prosperity of the Institute is evidenced by the fact that the membership has now reached a total of 800, a net gain of 127 during the past year. The deaths, resignations, etc., during the past twelve months would increase this number by over fifty. The report of the council briefly reviews the progress made during 1893. For a long time the question of an official badge had been before the members, and this has been settled by the adoption of a design, which now appears upon all publications of the Institute.

The work of the Institute in connection with the International Electrical Congress and the establishing of headquarters at the World's Fair by voluntary subscription reflect great credit upon its officers and members. Arrangements are now also being made for the publication of the work of the International Congress. The adoption of a plan for local meetings and the establishment of a local branch at Chicago was perhaps the most important step taken, and promises to be crowned with success. The report of the treasurer shows an encouraging balance in the treasury with which to begin the new year.

The selection of Philadelphia as the meeting place was exceedingly fortunate, as those present can abundantly testify. Not only was this a merited compliment to the Institute's genial president, but the Quaker City proved to be a most satisfactory gathering place. The hospitality of the city is far-famed, and the members of the Institute found that it had not been overestimated. The many courtesies extended to them were fully appreciated and will be gratefully remembered.

A feature of the meeting was the presence of the ladies, this being the first time in the history of the Institute that they have graced the occasion with their presence. Not only did they add to the pleasure of the sterner sex, but they thoroughly enjoyed the experience themselves and are warm in their praise of the hospitable treatment accorded them.

President Houston is entitled to the thanks of the Institute for the able and impartial manner in which he presided over the meetings, preserving dignity and equanimity under all circumstances and asserting his authority, when necessary, with such tact and geniality that it might almost be counted a pleasure to

be called to order. Under his skilful guidance the programme was carried out in full, and this without sacrificing any of its essential features. All the papers were read with the exception of two, which were withdrawn by the authors, and all were given an opportunity to participate in the discussion. The proceedings will be found below in detail.



very sincerely,

Edwin J. Houston.



The eleventh annual meeting of the American Institute of Electrical Engineers was called to order by President Houston in the assembly room of the Engineers' Club, of Philadelphia, Tuesday, May 15, at 10:30 A. M., and immediately proceeded to the transaction of routine business. At 11 A. M. Mayor Stuart was announced, and in a few graceful words welcomed the Institute and its members to the City of Brotherly Love. In extending to the members the hospitalities of the city, the mayor laid stress on a visit to the Municipal Electrical Bureau, the efficiency of which he referred to with pride. President Houston appropriately thanked the mayor for his hearty words of welcome, and said that they would be held in grateful remembrance. Prof. Trautwine, president of the Engineers' Club, after a few words on behalf of the body which had so kindly placed its facilities at the disposal of the Institute, greeted the members.

The treasurer submitted his report, showing that the Institute is in an admirable financial condition. The report showed that the receipts for the year were \$10,454.60 and the disbursements \$10,047.06, leaving on hand \$407.54. The building fund, including accrued interest, now amounts to \$905.49. A committee, consisting of George H. Hamilton and William J. Hammer, was appointed to audit accounts.

A resolution was adopted directing the Committee of Units and Standards to memorialize Congress and urge the legalization of the electrical units adopted by the Chicago Electrical Congress.

The report of the Committee on the Revision of Election Rules was received, and after a long and tiresome discussion in regard to the phraseology of several minor amendments the report was adopted.

The chairman announced invitations to visit Girard College, the power house of the Philadelphia Traction Company, the Germantown Electric Light Company, the Athletic Club of the Schuylkill Navy, La Roche Electrical Works, Queen & Co.'s show room, the Historical Society of Pennsylvania, the Edison electric light station, the factory of the Chloride Accumulator Company and the University of Pennsylvania. As the counting of the ballots was not nearly completed and there was no other business to transact, the meeting adjourned.

AFTERNOON SESSION.

The meeting of the general session was opened at 2 P. M., and the president delivered an interesting address on "A Review of the Progress of the American Institute of Electrical Engineers."

President Houston referred to the fact that the Institute had its origin in Philadelphia ten years ago, having been organized by prominent electricians connected with and in attendance on the International Electrical Exhibition of 1884. The first step was the circulation in April, 1884, by Mr. N. S. Keith, of a paper requesting signatures for the purpose of organizing an electrical society. A preliminary meeting was called on April 15 of the same year in the city of New York, at which a series of resolutions was passed and a committee or organization appointed to call a meeting, which was subsequently held on May 13, 1884, when rules were adopted and officers elected. The first regular meeting of the Institute was held in Philadelphia, Oct. 7 and 8, 1884, in one of the buildings of the Electrical Exhibition.

The president sketched the growth of the Institute and referred to the preponderating influence which its members

have had upon the progress of electrical engineering, and called attention to the great and growing value of its Transactions. Stress was laid upon the valuable work of the Institute in connection with the preliminary arrangements for the Chicago Electrical Congress and its subsequent assumption of the unfinished work left by that body, on the adoption of the names of the magnetic units, and its more recent action in regard to the definition of inductance and reactance. A graceful tribute was paid to the electrical press and the affiliated professional electrical associations of Europe. It was pointed out that only in England, France and Germany are the electricians from all parts of the country concentrated in one central body comparable in importance to the American Institute of Electrical Engineers, and attention was called to the fact that the countries in which there has been so marked a progress in electrical invention and engineering are those which possess the advantages of this combined effort on the part of all its electricians. Among the benefits enumerated in the address which result from the existence of these various learned associations are the following: Concentration of effort, increased mentality excited by generous rivalry, systematic exploration into the domains of the unknown, the tacit agreement as to what shall be regarded as standards of good work, the practical establishment of a high court of last resort, by which all disputed questions in electrical engineering shall finally be settled, and the means of establishing a rapid communication of ideas between different parts of the country and the world.

The necessity of a central body for exercising the governing powers of the Institute is dwelt upon, and the evils pointed out which would be likely to follow from a neglect of this principle; on the other hand, owing to the great distances in our country the difficulty exists in all the members attending the meetings of a central body. The problem involved in these antagonistic conditions is, however, to a great extent, solved by encouraging simultaneous meetings in all parts of the country, where the same paper can be read and discussions held thereon, yet at the same time holding the governing body responsible for the proper direction of all the work of the Institute. The great success of the Chicago meeting is referred to and the hope expressed that there may soon be similar meetings held in other parts of the country where the membership will warrant it.

After referring to the bright future of the American Institute of Electrical Engineers, the advantages to be derived from co-operation are pointed out and the members reminded that it is only one of several such organizations in different parts of the world, and that the highest purposes of the science and art in which their interests are so closely centred can only be realized by the most cordial sympathy and hearty co-operation with all associated societies and their members wherever they may be.

Upon the conclusion of the President's address, which was most heartily applauded, the report of the Committee on Units and Standards, was brought up, recommending that the definition of the term "inductance" shall be identical with that of the coefficient of self or mutual induction, or L . The report stated that the opinion has been asked of the national electrical professional bodies of Great Britain, Germany, Austria and France, in regard to the definition of this term; that the two former were strongly in favor of defining it as being identical with the coefficient of self-induction; that the "Electrotechnischer Verein" of Vienna, expressed no opinion and was indifferent, and that the "Societe Internationale des Electriciens" expressed the opinion that the word should be defined as a coefficient of induction into an angular velocity. The discussion which followed was participated in by Messrs. A. E. Kennelly, C. P. Steinmetz and Dr. Bedell, the latter two favoring the French opinion, while Mr. Kennelly sustained the report of the committee. He

called attention to the fact that Mr. Oliver Heaviside originated the term to replace that of coefficient of self-induction and that the great consensus of American, English and German opinion was in favor of this view. He pointed out that at present confusion followed from the use of the term "inductance" in two senses and that this confusion would largely increase on account of the rapid extension which the branch of electrical science in which it occurs is taking. Upon a vote being taken, the report of the committee was adopted. Mr. Steinmetz then moved that the word "reactance" be adopted for that quantity in an alternating current circuit whose square added to the square of the resistance is the square of the impedance; that is, the quantity between brackets in the expression

$$C = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

This motion was warmly seconded by Mr. A. E. Kennelly and carried by a unanimous vote.

Prof. W. A. Anthony then read a paper "On the Subdivision and Distribution of Artificial Sources of Light."

room 40 feet square, with 16 lamps 10 feet apart, is fully as well lighted as a room 16 feet square with 4 lamps 8 feet apart.

Referring to arc lamps, it is pointed out that their efficiency is greatly overrated, and that instead of ten times it is rarely over three times as great as that of incandescent lamps, or only one and one-half times with opal globes. With bare arcs, it is shown that unless the area to be lighted is so large as to require about 500 incandescent lamps, the use of full arcs requiring the same power will leave some parts of the area less brilliantly lighted, while in street lighting the arc is at still greater disadvantage. The opinion is expressed that the location of arcs 1,000 to 1,600 feet apart is an entire waste of money, and that a far better illumination would be had with incandescent lamps 100 to 200 feet apart.

In the discussion several members expressed their surprise at the small average candle power, less than 500, which the author gave to arc lamps, but Mr. Steinmetz and others corroborated Prof. Anthony in this respect. Mr. Kennelly called attention to the fact that while the calculations of Prof. Anthony were undoubtedly correct, the effects of diffusion



THE PLANKED SHAD DINNER PARTY.

which discusses the distribution of light with reference to the minimum illumination of any part of the surface lighted. A given number of 16-c. p. lamps is taken, and the effect of their distribution in different ways on the illumination of various portions of a given surface calculated.

It is shown that to obtain a uniform distribution of light the lamps must be concentrated towards the outer boundary of the space instead of being equally distributed over it. The effect on the uniformity of illumination of grouping the lamps in clusters is calculated for different cases. Taking the illumination of the centre of an area as unity with a uniform distribution of 576 16-c. p. lamps, the illumination at the same place with 144 clusters of 4 lamps each is .813, and therefore if the illumination at any point in the second case is not to be less than in the first case, the number of lamps will have to be increased 25 per cent. It is also shown that the larger an area the less disparity will there be between the use of clusters and a uniform distribution of light; for example, a

and reflection would entirely change the results arrived at, and that these factors could never be neglected.

During the afternoon session the tellers, Messrs. F. R. Upton and Geo. R. Metcalfe, appointed to canvass the vote for officers, announced that the following gentlemen had been elected: President, Edwin J. Houston; vice-presidents, W. A. Anthony, F. B. Crocker, James Hamblet; managers, A. E. Kennelly, W. D. Weaver, C. S. Bradley, W. B. Vansize; treasurer, G. M. Phelps.

The secretary read a communication from the honorary secretary of the Chicago meeting, suggesting that the Institute make some provision for the expenses of reporting the discussions of the Chicago session. After some discussion as to the sum which should be authorized and of the wording of the grant, the Institute unanimously voted to allow a sum not exceeding \$10 per meeting for the expenses of a stenographic report, which amount is in excess of what was asked.

THE EVENING.

An informal reception to the members was given in the evening at the Manufacturers' Club, under the auspices of the Engineers' Club and the Electrical Section of the Franklin Institute. The handsome club rooms were thronged with members of the electrical fraternity, whose youthful appearance was evidently a surprise to more than one of the hosts. The occasion was particularly enjoyable, all of the guests being made to feel that for the time being the club was their own, and formalities of any kind were dispensed with. In one of the upper rooms ample opportunities were afforded for the refreshment of the inner man, particular care being taken that no one should suffer from the pangs of thirst. Nor were the ladies neglected and the dancing men had a free field for a display of their usefulness.



The session was opened by a paper on "Some Storage Battery Phenomena," by W. W. Griscom, which describes a number of experimental investigations of storage battery phenomena little understood. It was shown how the diverse chemical products formed at different stages of charge and discharge would largely account for the erratic form of the curves of E. M. F., and that the positive plate determines the characteristic curves of potential at times, while at other certain stages the negative plate asserts itself. The curious facts are stated that variations of capacities and even of E. M. F. exist in plates identical in history and position, and that one positive may discharge into its neighbor. It was shown that in a cell the rates of discharge of the different plates constantly varies in relation to each other. An actual decrease of temperature in a cell discharging was noted and explained as due to the simultaneous lowering of the specific gravity of the electrolyte, and it was pointed out that, contrary to usual belief, a positive plate has more capacity than a negative one. Several phenomena lacking explanations are referred to, including the changes shown in internal resistance, the simultaneous increase of internal resistance and potential, the tendency of a charged positive to buckle away from the light, and the sudden spontaneous discharge of a fully charged positive. The commercial aspects of the storage battery question are considered and the non-success in America ascribed to no allowance of a margin of safety in the weight and working of a battery, an observance of which factors has led to success in Europe.

In the discussion, Dr. Duncan referred to his experimental demonstrations of the considerable local action in plates, and to the impoverishment of the electrolyte in the plugs at high rates of discharge affecting the capacity of a cell.

The next paper on the programme was then read, that of Mr. Wurts on "Discriminating Lightning Arresters and Recent Progress in Means for Protection Against Lightning," which had been brought over from the programme of the day before. The paper is divided into three parts, the first of which describes some very interesting experiments made in Colorado, where the ordinary means of protection against lightning are entirely inadequate on account of the severity of the thunder storms. The apparatus employed was based upon the theory of "electrical surging," that disruptive discharges form nodal points in the system, and that choke coils form points of reflection where there will be a maximum tendency to discharge. A discharge gap therefore should be connected directly in front of a choke coil. The ap-

paratus used, consisted of choke coils and the familiar form of non-arcing metal arresters. The theory upon which this apparatus was based was substantiated by many beautiful laboratory experiments, some of which were given in the course of the paper before the Institute. The method of installation was described, and the satisfactory results obtained stated. The second section of the paper set forth a system of protection against lightning on circuits of any potential by the use of choke coils in series with the circuit. The theory of lightning discharges was taken up at considerable length. The third section was devoted to discriminating lightning arresters, two varieties being described, (a) the condenser lightning arrester; (b) the non-arcing railway arrester.

The discussion which followed was quite generally participated in, and proved to be of considerable interest.

Mr. Sachs suggested that if a considerable number of choking coils were used in series, there would be trouble from the resulting impedance. Mr. Stanley, however, stated that there would be no difficulty in this direction. Lightning discharges were of enormously high frequency, and the self-induction produced by the choking coils would hardly be appreciable. In the coil used in the experiments he estimated the choking effect to be equal to about two volts with a current of 50 amperes. He stated that the experiment shown illustrated in a beautiful manner the wave motion of the discharge and showed how it sifted off, as it were, from the various discharge points. In 1885 or 1886 he had constructed an alternating line, and as protection against lightning had put over the circuit a grounded wire. This had worked with perfect satisfaction, and he inquired if this device would not prove sufficient, at least in this section of the country. Mr. Wurts, in reply to this inquiry, stated that he knew of two cases in which such a grounded wire was used, one on Staten Island, which had worked satisfactorily, the other in Colorado, which had been a complete failure.

Mr. Charles Hewitt stated that the Edison company had used a grounded barbed wire for lightning protection, the wire originally being intended for a guard wire, but being found to serve a double purpose. In Philadelphia the traction companies had not only the problem of protecting the station, but the lead cables also.

Mr. Kennelly differed from Mr. Wurts as to the effect of additional turns to the choke coil above 17; he thought that impedance in the practical sense of what took place in that particular circuit under the particular conditions was meant. The impedance of the coil as actually represented in ohms would certainly increase in a continuous and marked manner. He also differed from Mr. Wurts in regard to reflecting points in the circuit. The impulse must travel along to the end of the wire unless met by some change or want of uniformity, and there is no piling up of pressure in the act of reflection. There will be no greater strains upon the insulation at the end of a wire than upon any intermediate point. In regard to an overhead wire for lightning protection, he stated that the instance cited by Mr. Wurts was the only case on record, so far as he was aware, where such a device had failed to offer protection.

Mr. Steinmetz stated that in the case of a direct lightning stroke the circuit is in the direct path of the disruptive charge, and the only thing to be done is to trust to Provi-



A. J. WURTS

dence and repair what is left of the station. The branch discharge, however, can be guarded against by a ground wire or arresters. If a highly charged cloud moving over the line is suddenly discharged, the potential of the line rises very high and no ground wire will protect against the discharge currents which result. Mr. Steinmetz also described the action of choke coils in the circuit and mentioned some tests made by him on discriminating lightning arresters.

Other remarks were also made by Mr. Jenks and Mr. Harrington.

AFTERNOON SESSION.

A paper on "Unipolar Dynamos for Electric Light and Power," by F. B. Crocker and C. H. Parmly, was then read by Prof. Crocker. The object of the paper was stated to be to show that unipolar dynamos and motors are much more practical and generally applicable than is ordinarily supposed. The name "unipolar" was pronounced unsatisfactory, and "continuous pole" suggested in its stead. It was pointed out that iron or steel is much better than copper for the armature, on account of its strength, while its specific resistance is no objection on account of the great mass of metal used. A type of unipolar machine was described and formula deduced for its design. It was shown that the armature of a machine of this type for 10 volts at 1,200 revolutions need be only 27.4 inches in diameter and for 130 volts and 200 revolutions 242 inches. The capacity of the latter machine is illustrated by the statement that if two were coupled to the shaft of a 100,000-h. p. engine, they would develop more current than at present is consumed in any two cities of the world, and if run even as low as 1,000-h. p. the loss in the armature would only be four or five per cent. The great advantage of the unipolar machine in extreme simplicity is pointed out. Its armature consists of nothing but a solid cylinder or disc of steel or other suitable metal firmly mounted upon a shaft, while the construction of the field magnet and the rest of the machine is also very simple. According to accepted theories there should be no hysteresis in these machines, no Foucault currents, and probably no armature reaction. The machines would be practically indestructible, not likely to be damaged mechanically, and it is impossible to conceive of one being burned out, or otherwise injured electrically.

Those who took part in the lively discussion which followed were incredulous as to the practical merits of the unipolar dynamo. Mr. Kennelly remarked that the Ferranti armature had the advantages claimed for the type proposed, though giving an alternating current, and none of the great advantages of speed and difficulty of collection. Mr. Stanley described a somewhat similar form of unipolar dynamo he designed some years ago, but did not think any form practicable. Mr. Steinmetz also described a unipolar machine of his design, in which he solved the problem of multiplying the voltage, but denied the practicability of the unipolar principle. Mr. Hering suggested a change of the form of the field proposed and thought armature reaction would not be absent.

Prof. R. B. Owens then read a paper on a "Test of a Closed Coil Arc Dynamo," in which the rise of voltage for each bar was measured and plotted for no load, and 5, 10, 15, 20 and 25 lights, the latter being full load, and the machine a Wood arc dynamo. The results obtained show that the total induction in the armature varied very slightly with load, and that the displacement of the neutral plane decreases with load angle, but varies less than 10 degrees from no load to the maximum load used. The conclusions were that it would never pay to run such machines underloaded, and that if a number are used in one central station, the connections of the external circuits at the switchboard should be so manipulated as to keep the machines actually in use always loaded to as near their full capacity as possible. Regarding the relative amounts of iron in field and armature,

no reason for the present practice for using so little iron in the armature, as compared with the field, is seen. The necessity of a very high field induction or a thoroughly stiff field is apparent; but why, when the lines are once generated by the field, it is not sought to collect and utilize them all by means of an armature, with a generous amount of iron, is not so easily seen. The number of commutator segments would of course have to be increased to prevent sparking, but the regulating qualities of the machine would, it is believed, be impaired. The result would be a larger output and greater efficiency. Regarding the rates of ampere turns on armature and field, such ratio will depend largely on the shape of the pole pieces and desired width of brush, but is in all cases much less than in constant potential machines.

In the discussion on Prof. Owens' paper, Mr. C. N. Black referred to the necessity of sufficient iron in the armatures of arc machines, and pointed out the error of using too high an induction there. If a sufficient amount of iron—say, to give 95,000 lines per square inch—were used in arc machines and the induction in the armature is not worked around the bend of the curve, an arc machine can be built which will be practically automatic.

Mr. Steinmetz said that he was at the same time of an opposite and the same opinion as the last speaker. He stated that the density of the iron should be very high and that 95,000 lines per square inch was such a density, though perhaps a low one in arc lighting. He referred to the fact that a good design for a constant potential machine is a bad design for an arc light machine, and that the principle of a successful arc light machine consists in having a large armature reaction; such a machine will, without shifting the brushes, keep the current practically constant under all loads.



C. P. STEINMETZ.

Prof. Anthony then read a paper by Mr. A. D. Adams on "Relative Advantages of Toothed and Smooth Core Armatures," which we print in full elsewhere. In the discussion which followed Mr. Wiener said it omitted one of the disadvantages of the toothed armature, namely, that the iron of the teeth causes a core leakage in the toothed armature, so that in such a machine, if otherwise well designed, the leakage about balances the gain, due to the reduction in the air gap. Mr. Steinmetz stated that the conclusions drawn in the paper are largely opposed to those he had derived from theoretical reasoning and practical experience. For machines like railway generators, a toothed armature is necessary, not only for mechanical reasons, but owing to the rapid changes in load, which in a smooth cored armature would cause excessive sparking. Commutation without shifting of brushes is in smooth cores out of the question. On the other hand, a smooth core machine is very desirable for lighting where a very large current is taken off at very low voltages but a railway generator cannot be made to work with a smooth core. It is in getting rid of the shifting of the field in which the advantage of the toothed armature really lies, and this enables a very much higher efficiency to be attained with them than with the smooth core. In general, the toothed core is somewhat cheaper than the other.

Mr. Dunn said that the magnetic reluctance of the gap in the toothed core armature was not a constant, increasing as the teeth became saturated, and that the effect of saturation of the iron teeth is similar to increasing the air gap at high loads, which accounts for the less liability of such machines sparking.

Mr. Stanley referred to the extra self-induction due to the

teeth of toothed armatures, which was a cause of sparking, and in reply to a question Mr. Dunn informed him that he considered this self-induction as the greatest disadvantage of toothed core armatures.

Mr. Kennelly referred to the greater density of current that could be carried by a toothed core armature, but Mr. Steinmetz said that in the large smooth core machines the question of ventilation was not a drawback.

Prof. J. P. Jackson then read a paper on "Alternating Currents and Fuses," by Prof. Dugald C. Jackson and R. J. Ochsner, describing experiments to determine if the alternating current had any disintegrating effect on commercial fuse wires. Under the conditions of the experiment, which were those of ordinary practice, no change in the properties of the fuse due to the action of alternating currents was noted, and it was suggested that when fuses on alternating circuits blow unduly, the cause will probably be found in mechanical shaking on account of not being tightly clamped.

THE ANNUAL DINNER.

At 8:30 P. M. the annual dinner was served at the Hotel Metropole, almost a hundred chairs being occupied, and the preponderance of dress suits was so large that it is probable that few will take any chances on this score at future meetings. President Houston, as toastmaster, with a few well chosen words, introduced the various subjects and speakers, who reflected in their happy remarks the spirit of fraternalism and the elevated professional thought which have been so marked a characteristic of the Philadelphia meeting of the Institute.

Mr. George M. Phelps responded to the toast of "The Electrical Press" in a witty vein, which also showed consideration for the other members of an estate which is noted the world over for its delicate professional susceptibilities.

Mr. H. Ward Leonard, in responding to the toast of "Commercial Electrical Engineering," laid stress upon the relations which should exist between supervising and constructing engineers, and deplored the spirit so often met through which the position of the latter is rendered not only uncomfortable by the unreasonable interpretations of the former, but at times unbearable by their unwarranted suspicions and exactions.

When Mr. A. E. Kennelly arose to respond to the toast of "Mathematics and Electricity" every one had pleasurable anticipations, and when he resumed his seat the hearty and prolonged applause was evidence that his audience was not disappointed. In the most felicitous and elevated terms, Mr. Kennelly spoke of the role of mathematics in electrical science, of its almost magical character in revealing the most carefully guarded of Nature's secrets, and of its yeoman's duty in the service of the engineer. He referred to the unmerited reflections frequently made upon mathematical science and offered an eloquent plea for a recognition of the great part mathematics has played, and will continue to play, in the theory and practice of electricity.

Mr. E. G. Willyoung, in response to the toast "The Philadelphia Committee," referred to the efforts of the committee in their local work preliminary to the annual meeting, to the satisfaction its members personally felt at the fruit of their labors, and paid a merited tribute to the other gentlemen associated with him for the efficient manner in which they had discharged their arduous duties.

Mr. James Hamblet, whose subject was "Electricity and Time," alluded in humorous terms to the slight attention Time thus far had bestowed on electricity and its devotees, but warned the youthful looking audience that even electricians could not ward off its whitening hand, as he could personally testify.

"Power Transmission" was the subject most appropriately assigned to Mr. C. F. Scott, and his response showed that even such a rugged theme could be clothed in graceful words. The speaker referred to what had already been accomplished in this latest development of the great industrial applications of electricity, and his predictions as to its future were warmly applauded by the audience.

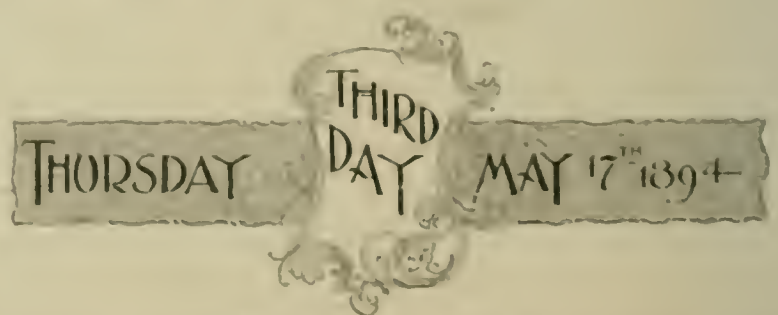
To the subject of "The Electrical Expert," Prof. W. A. Anthony did the justice expected of one of its most eminent and worthy representatives. He pointed out in words, as his practice has done in deeds, the responsibility which the electrical expert owes, not only to his client but also to the dignity of the science he represents, and condemned the misuse so frequently made of the vocation and of the name.

"Electrical Engineering Education" was the subject to which those present owed the witty and suggestive remarks of Dr. Pupin, who surprised many not only by his thorough command of an adopted language, but also by the literary art he displayed in its use. He sketched the immense progress made in the methods of electrical engineering education in recent years and referred humorously to the suspicions in regard to the utility of "a German professor with his mathematics," which existed five years ago. Since then, however, it had been recognized that mathematics is an inseparable part of an electrical engineering course and that if the engineer would take a standing in his profession, he must no longer be content with a mere manual and empirical knowledge of principles.

Prof. R. B. Owens, in responding to the toast "Electricity in the West," pointed out the great field there offered for the electrical engineer, and spoke of the use Western engineers were making of their opportunity and of the work of Western schools in fitting out the engineers of the future. He referred to the recent extension of the field of usefulness of the Institute by the inauguration of the Chicago local meeting and of the mutual benefit to both sections of the country which would follow from that action.

THE THEATRE PARTY.

A theatre party had been provided for the entertainment of the ladies, and they spent an enjoyable evening at the Broad Street Theatre, where Mr. John Drew was playing in the "Butterflies."



Mr. Elmer G. Willyoung opened the morning session by reading his paper on "Standardizing Electrical Measuring Instruments." The object of the researches upon which the paper was based was to devise a method by which the restandardizing of instruments could be done by central stations themselves. The first portion of the paper was devoted to a discussion of the potentiometer method, which, broadly speaking, consists in opposing some known proportion of the drop of an unknown E. M. F. through a given resistance to a definitely known E. M. F., the proportion being so chosen that no current is produced by the latter known source. The second section of the paper describes an improved direct reading potentiometer devised by the author, based on the form of potentiometer originally suggested by Dr. Fleming.

A paper by Prof. G. S. Moler and Dr. F. Bedell entitled "An Optical Phase Indicator and Synchronizer" was presented by Dr. Bedell. The instrument described consists of an ingenious device for measuring the angular difference in the position of two shafts running at the same speed. When

applied to a synchronous motor this instrument gives by direct reading the angle of lag of the armature of the motor behind that of the generator. It has, however, as the writers of the paper pointed out, wide application in other lines of work, as in the measurement of small speed-differences, in power-transmission between two shafts, and in work of all kinds where synchronous operation is required.

In the simplest form of apparatus described, the motor and dynamo are placed in line with ends abutting. A disc is placed on the end of each shaft. Each disc has a system of slits and when the slits of one disc cross over those of the other, a hole is formed by which light can pass through the two discs. When the discs are revolving synchronously, and a light is placed on one side of the discs, these holes appear as a ring of light. The slits in the discs are so constructed that this ring moves in or out if one disc is revolving more rapidly than the other. The distance of the ring from the centre is proportional to the angle of difference in the positions of the two discs. The apparatus is so arranged that this phase difference may be read directly.

Dr. A. C. Crehore then read his paper on "A Reliable Method of Recording Variable Current Curves." The paper proposes a method of taking current curves by means of a weightless vibrator, thus avoiding the difficulty which it seems must exist in other methods. The method of obtaining the vibrator is as follows: It is sought to influence a beam of light directly by means of the magnetic field produced by a current, so that the direction of the beam is changed proportionally with the current. The principle upon which the method depends is that discovered by Faraday, that a beam of plane polarized light has its plane rotated in passing through a magnetic field. The beam after passing the polarizer is passed through a quartz plate which naturally rotates the plane of all the rays, but the blue more than the red, according to the approximate law that the angle is inversely as the square of the wave-length. The light then passes through a tube containing carbon bisulphide, around which the coil for the current is wound, and after passing the analyzer and slit, it is resolved into the pure colors of the spectrum. The spectrum thus obtained is the complete spectrum without that color which the analyzer neutralized, that is, there appears a dark band in the spectrum which may be moved completely across it by rotating the analyzer. This band may also be moved by passing a current through the coil. This motion takes place back and forth in exact unison with the current, and it may be so arranged that its displacement is proportional to the current. The record of this motion is obtained upon a photographic plate exposed when in motion in the well known way.

Mr. Steinmetz complimented the author upon the result of his researches, and expressed the belief that the apparatus would prove to be of great practical value and would perhaps occupy a similar relation to electrical engineering that the indicator does to steam engineering. Mr. Anthony also stated that the idea had been very beautifully worked out and had undoubted practical value.

THE EXCURSION.

One of the most enjoyable events of the programme was the plank shad dinner at Gloucester. After the morning session a private steamer, on which a refreshing lunch was provided, took the members up the Delaware to Cramp's shipyard, where they were shown the large liners and the ships which are being constructed for our Navy, besides a number of tools driven by electric motors, showing the great adaptability of such motors in cases where the tools are brought to the parts to be worked instead of bringing the work to the tools. The trip was then continued down the Delaware to Gloucester; after an excursion on the electric road and a visit to the power station, the members and guests were introduced to that famous May delicacy, a Gloucester plank shad dinner. A certain wise provision of

the committee, without which the dinner and the speeches would have been dry, put everybody in a good and jovial humor, and the speakers were warned that any serious remarks would be ruled out of order. The speeches were all quite equal to the occasion and proved to be very entertaining, and it was with regrets that the members adjourned, even though it was fully an hour later than the time on the programme. A moonlight trip up the Schuylkill completed the most enjoyable day of the meeting.

THE LADIES.

The ladies were entertained at luncheon at the Manufacturers' Club and in the afternoon by a very pleasant trolley excursion.



A committee appointed to consider the advisability of the Institute adopting "the National Electric Light Association's standard rules for electrical construction and operation" reported that in the short time at its disposal it would have been impossible to make the examination and report on the rules necessary before placing the matter before the Institute for action.

Dr. M. I. Pupin read his paper on "Resonance Analysis of Alternating and Polyphase Currents," which, in some respects, is a continuation of his epoch making paper on resonance read before the last annual meeting of the Institute. The introduction points out the advantages of knowing the form of alternating current waves and states the method of resonance analysis offers a simple, sensitive and accurate method. A description of the method used is then given, with experimental tests, and the conclusion arrived at that a resonator of the type employed is quite capable of detecting all the frequencies that may exist in an alternating current wave, that its indications are in good agreement with the theory as far as the fundamental frequency is concerned, and that it gives a fairly approximate idea of the relative strength of the harmonics. Next is an account of experiments to determine the location of the origin of upper harmonics, and the conclusions arrived at are that a ferric self-inductance in circuit with an alternator which gives a simple harmonic E. M. F. distorts the current by introducing higher odd harmonics, principally the harmonics of three times the frequency of the fundamental, and that this and probably all other harmonics increase proportional to the excitation; with this ferric inductance as a transformer, the distortion appears slightly in the secondary if the transformer has an open magnetic circuit, but negligibly with a closed one; a practically simple harmonic E. M. F. is produced by alternators with smooth core armatures, even if the latter are worked at a high rate of magnetization: a slotted core armature produces a complex harmonic E. M. F. in which the upper harmonic of three times the frequency of the fundamental is by far the strongest, and the amplitude proportional to the excitation, or the magnetization of the armature; a ferric inductance in circuit with a slotted core armature introduces no new harmonics, and seems to strengthen the odd harmonics.

It is also shown that the odd harmonics are present undiminished at all loads, though sometimes masked. As to secondary circuits, it is pointed out that the primary corresponds to an alternator and the origin of the secondary's harmonics is therefore in the primary. An analysis of the rotary field is described, which showed that such fields pro-

duced by reasonably well constructed machines are not accompanied by fluctuations.

The view of the author as to the cause of upper harmonics is that they are not due to hysteresis, but will be generated whenever more or less abrupt changes of the magnetic state in any part of the magnetic field through which an alternating current flow occurs, as by the use of slotted armatures. The final conclusion is given that there is no cure against harmonics in circuits containing iron.

In the discussion Prof. Anthony said that he never could see any reason why the rotary field should be considered complicated, and that it followed as a matter of course from the principles concerned that its intensity should be constant. Mr. Steinmetz stated that the phenomenon of resonance can be explained from well known laws without considering it as a special phenomenon, and that it is not different from the well known action of the choking coil producing an E. M. F. 90 degrees behind the current and thereby, according to the phase relation between currents and impressed E. M. F., either reducing the E. M. F. if the current is lagging or increasing it if the current is leading.

Mr. Kennelly considered that the beautiful method described by Dr. Pupin is necessarily and fundamentally weak in one important particular, and that is that while it brings out the harmonics in any periodic wave E. M. F., it does not bring out, and cannot bring out, the phase relation of these harmonics; consequently you can have a large harmonic in an alternating E. M. F. and the shifting of the phase will produce an enormous difference in the shape of the wave whether it be in step or not, so that as you shift it along the consequence may be so great as to totally offset the conclusions based on observation. In reply to this Dr. Pupin said that it does not make any difference whether there is an infinite number of phase relations, and that no one cares for the exact shape of an alternating current wave and that we do not even care whether the harmonic is in phase with the fundamental or not, provided that phase directions will not affect our results and experiments, as has been shown.

Mr. A. E. Kennelly then read a paper by Dr. Louis Bell on "Some Facts About Polyphase Motors." Stress was laid upon the fact that a properly designed induction motor can be run like a continuous current series motor at different speeds, and also has a similar efficiency at such speeds. A misapprehension in regard to the power factor of polyphased currents was referred to, and it was shown that the

analyses of iron have given hysteretic losses much below that quoted by Ewing, and previously by himself. A chapter of the paper is devoted to defining the difference between molecular friction and hysteresis, and the conclusion stated



LOUIS DUNCAN.

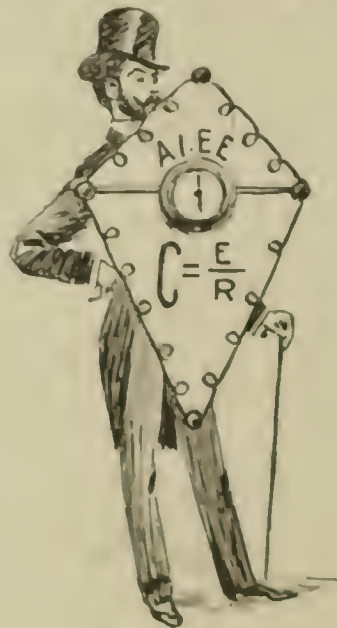


A. E. KENNELLY.

that magnetic hysteresis is not identical with molecular magnetic friction, but one of the phenomena caused by it.

Dr. Louis Duncan gave an account of some "Experiments with Two-phase Motors" illustrated by curves showing simultaneous values in the two circuits; in a future issue we will publish the paper in full.

A paper on "Reactance," by C. P. Steinmetz and F. Bedell was read by title. The meeting then adjourned.



HOME AGAIN.

The following is a list of those in attendance:

Philadelphia.

J. G. Biddle, C. Billberg, A. Braddell, Chas. A. Bragg, J. Martin Brill, W. I. Chesney, A. Childs, W. E. Culbertson, W. P. Dallett, F. W. Darlington, W. A. Drysdale, W. C. L. Eglin, H. P. Farington, S. G. Flagg, Frank R. Ford, J. E. Gaylord, F. W. Glading, W. W. Griscom, C. H. Harris, John Hoskin, Carl Hering, Chas. Hewitt, F. H. Hochrath, E. J. Houston, R. M. Hunter, J. D. Israel, A. Langstaff Johnston, E. R. Keller, A. E. Kennelly, R. H. Klander, F. L. Knight, E. K. Landis, Winford Lewis, R. McK. Lloyd, W. D. Marks, A. P. Mayers, L. K. Perot, C. W. Pike, G. B. Price, A. L. Register, A. J. Rowland, E. A. Scott, Franklin Sheble, L. N. Shultz, H. L. Snyder, Thom. Spencer, J. E. Stevens, E. S. Stewart, C. W. Swope, F. E. Swope, Jr., J. C. Trautwine, Jr., F. Uhlenhaut, H. P. White, P. Winands, E. G. Willyoung, C. P. Wilson, Peter Wright.

New York.

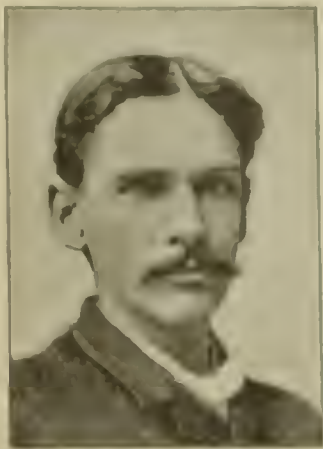
Harold Binney, C. S. Bradley, H. S. Chase, S. L. Coles, F. B. Corey, F. B. Crocker, H. M. Davis, Gano S. Dunn, C. E. Emery, Henry W. Frye, P. G. Gosler, Jas. Hamblet, W. J. Hammer, W. F. Hanks, W. R. Hewitt, Cary T. Hutchinson, W. J. Johnston, J. M. Knox, A. A. Knudson, N. W. Perry, Geo. M. Phelps, R. W. Pope, M. I. Pupin, H. Ward Leonard, W. B. Lester, O. T. Louis, J. C. Martin, Geo. Metcalfe, J. R. Moser, W. A. Mosscroft, J. W. T. Olan, Rich. Pfund, H. D. Reed, Chas. T. Rittenhouse, Joseph Sachs, L. Störinger, J. R. Taltavall, H. C. Townsend, F. R. Upton, W. D. Weaver, N. D. Webster.

Baltimore.

Louis Duncan, J. C. George, H. S. Hering, S. Riber, T. M. Thomas.

Schenectady.

T. V. Bolan, H. G. Reist, C. P. Steinmetz, F. W. Tischenderfer, A. D. Wiener.



WILLIAM STANLEY, JR.



W. A. ANTHONY.

power factor only varies slightly for large variations in load from full load, and becomes notably reduced only at small loads. The admirable regulating qualities of induction motors were illustrated by curves, and a great advantage of such motors pointed out in their immunity from being burned out.

Mr. C. P. Steinmetz gave a synopsis of a continuation (Part III.) of his classical paper "On the Law of Hysteresis," only a portion of which had been printed, and the remaining copy was at the printer's. He referred to the confirmation of his former conclusion by others, and stated that recent

Pittsburgh.

E. E. Keller, C. F. Scott, A. J. Wurtz.

Elsewhere.

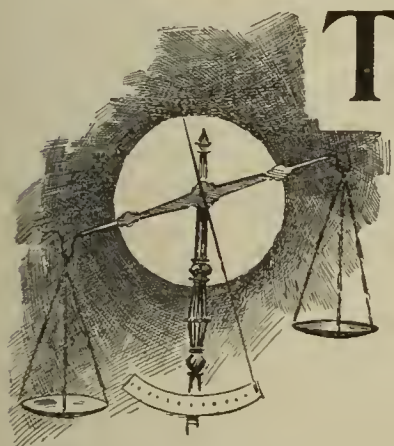
Ansonia, Conn.—G. G. Grover; Bridgeport, Conn.—Leonard Waldo; Brooklyn, N. Y.—P. G. Grulen; Camden, N. J.—W. E. Harrington; Cleveland, Ohio—C. N. Black; East Orange, N. J.—F. E. Jackson; Frankfort, Germany—Fred. Cornell; Hanover, N. H.—A. C. Crehore; Hartford, Conn.—F. G. Waterhouse; Ithaca, N. Y.—Fred. Bedell; Lincoln, Neb.—R. B. Owens; Manchester, Conn.—John Waring; Maywood, N. J.—C. O. Jaeger; Minneapolis, Minn.—Morgan Brooks; Newark, N. J.—E. A. Colby, R. O. Heinrich; Passaic, N. J.—S. D. Mott; Pittsfield, Mass.—Wm. Stanley; Rutherford, N. J.—Alfred Buys; St. Paul, Minn.—M. H. Gerry; Sharon Hill, Pa.—C. R. Arnold; State College, Pa.—J. P. Jackson; Troy, N. Y.—E. G. Bernard; Vineland, N. J.—W. A. Anthony; Westchester, Pa.—Arthur Hoops; West Hoboken, N. J.—F. Reckenzaum; Wilmington, Del.—J. A. Hall, C. R. Van Trump.

The Ladies.

Mrs. C. S. Bradley, New York; Mrs. W. E. Harrington, Camden, N. J.; Mrs. A. Langstaff Johnston, Philadelphia; Mrs. W. J. Johnston, New York; Mrs. A. A. Knudson, New York; Mrs. A. B. See, Brooklyn; Mrs. Franklin Sheble, Philadelphia.

Relative Advantages of Toothed and Smooth Core Armatures.*

BY ALTON D. ADAMS.



THE merits of different methods of construction in the manufacture of dynamo electric machinery, as in other lines, must evidently be decided by their comparative costs, all else being equal. Although questions concerning the relative merits of toothed and smooth core armatures have long been discussed, very little seems to have been written to show whether actual saving in cost may be effected by one construction over the other when employed to produce the same results.

The practice of dynamo builders in this country, and abroad embodies both types, and the history of the art records many changes from each to the other. In view of the above, the inquiry whether in the light of present facts any saving can be effected by the use of toothed core armatures seems of interest.

The limits of this paper do not permit consideration of this question in connection with all classes of electrical machinery, and its bearing on direct current constant pressure machines only will be taken up.

The principal disadvantages of toothed compared with smooth core armatures are greater first cost, large change of lead, excessive sparking when used with too short air gaps, and the production of heat in pole pieces; their advantages are, that inductors are positively driven, large solid inductors, protected from eddy currents, and that a reduction may be made in the length and consequent magnetic resistance of the air gap.

Change of lead may be fixed within any desired limits, and sparking abated by such proportions of air gap and teeth as give them sufficient magnetic resistance.

Heat in pole pieces may be reduced by their lamination, by the use of very narrow teeth and slots, by forms of teeth that present a nearly continuous surface of iron to the pole pieces, and still more, by the use of openings in core discs which do not cut through their outside surface, or a continuous magnetic sheath outside the teeth. For any given form of tooth, the heating is less the longer the air gap.

The mechanical strength of armature teeth, as usually employed, is far in excess of that required to hold inductors in position, even under conditions of short circuit, and driving pins inserted in the core, at proper intervals, are much cheaper and take up less valuable room on the armature circumference. Either teeth or substantial driving pins are,

of course, preferable mechanically to the slender bits of hard fibre which have been much used, and often give way under the heavy strains to which large generators are subject.

When large wires or copper rods are used as inductors, their protection from eddy currents is an important matter, but proper stranding of inductors reduces the eddy loss in them, when used on smooth cores to a very small amount, and has the further important advantage that inductors may be bent into the proper shape at armature ends, and the joints, necessary when rods are used, avoided.

The chief possible advantage, then, to be gained by the use of toothed armatures is through a reduction in the length of the air gap, and the consequent reduction in the ampere turns required on field magnet, weight of copper, or energy in winding, and the length and weight of iron core. To make this advantage available, it must be practical to use air gaps shorter than are required for insulation, winding and clearance.

As is well understood, the armature winding of a dynamo or motor, in operation, has a magnetizing action which is measured in ampere turns for a bipolar machine by one-quarter the product of all the inductors of the armature into the total armature current. The ampere turns on the armature evidently tend to set up a flow of magnetism, having a complete circuit through the armature core, twice across each air gap, and through the iron of pole pieces.

About half the ampere turns furnished by the inductors under pole pieces evidently act against the field ampere turns in each air gap at the polar tips, and the ratio between the armature and field ampere turns at this point, necessary to give sparkless reversal there, must determine whether the required magnetic resistance be greater or less than that of an air gap long enough for insulation, winding, and clearance with a smooth core armature.

As an armature coil in an operating dynamo or motor passes under the brush, the current flowing in it must stop, and one in the opposite direction be set up; and if this action is to be accomplished without sparking a sufficient electromotive force must be provided in the coil while in direct contact with the brush. In the ordinary dynamo or motor magnetism forced across the path of the coil, by the field ampere turns expended in air gap, must provide this reversing electromotive force.

The data of a number of smooth core armature machines of different make show ratios of field to armature ampere turns in air gap of from about one and one-half to one, to two and one-half to one, and the writer's experience is that a ratio of two to one will give sparkless operation at full load, with brushes set just outside pole corners.

It is a matter of common experience that the ratio between field and armature ampere turns in the air gap may be so reduced, even in machines with smooth core armatures, as to require excessive change of lead to secure even approximate freedom from sparking.

If it be desired therefore to build machines having an expenditure of field ampere turns in the air gap not much greater than those of the armature, we need not resort to toothed cores.

Take, for example, the case of a 260-ampere dynamo, with 120 inductors on its armature in one layer, an air gap induction of 25,000 lines per square inch, and 80 per cent. of inductors under the pole pieces. An air gap of .45 inch between the armature and each pole piece will be sufficient for insulation, winding and clearance, and the field ampere turns expended in each air gap will therefore be 3,500, while the armature ampere turns, active under each pole tip, will be 3,100. A considerable change of lead and sparking can be readily predicted for this machine.

In some types of small machines the room required by insulation, winding and clearance makes the air gap longer than necessary for sparkless operation, and in such machines

* A paper read at the eleventh annual meeting of the American Institute of Electrical Engineers.

the utility of teeth seems to depend on their cost compared with the saving to be effected by their use.

As the ampere turns furnished by the inductors under any pole piece grow less in a machine of given capacity when the number of poles is increased, very short air gaps may be used if the number of poles is sufficiently large.

As an increase in the number of poles usually makes a machine of given capacity more expensive, however, the question at once comes up to what extent the number of poles may be increased without a greater expenditure than the saving of iron and copper to be effected.

In large multipolar machines of four or six poles, such as are commonly used, the length of air gap required for sparkless operation is considerable, and those who have watched the development of these machines with toothed core armatures during the last four or five years have seen the air gaps gradually widen, until machines of this character are not hard to find in which the copper inductors between the teeth could be taken out, wound outside the teeth, and still leave room enough for good clearance.

Additional mechanical security, of course, furnishes a considerable argument for the use of teeth in very large slow speed machines.

A number of devices have been suggested from time to time to enable toothed core armatures to be used with short air gaps, and the consequent saving in iron and copper effected. No machines with these devices, however, have yet stood the test of time and competition with those of ordinary type, and have yet to prove their ability to produce results as at present attained at a less cost.

The seeming opportunity to save material by the use of toothed armatures is very attractive, and we cannot but hope it may some day be practical; in the light of present knowledge, however, there seems little to be gained by their use in medium and large bipolar machines.

Inductance and Reactance.

An important step was taken by the American Institute of Electrical Engineers at its general meeting last week in adopting definitions for the technical terms "inductance" and "reactance." The former has been in use for some time, but, unfortunately, has been subject to ambiguous usage, while the latter, although suggested about a year ago, had not received general acceptance.

Mr. Oliver Heaviside, finding that he had very frequently to employ the cumbersome terms "coefficient of self-induction" and "coefficient of mutual induction" in his writings, decided to adopt the word "inductance" for a "coefficient of induction" with the specification "self-inductance," or "mutual inductance," whenever distinction became necessary. This term was introduced consistently with his system of terminology, in which the suffix -ance, as in the word resistance, denoted a property of matter prescribed by the form of a body, and the suffix -ivity, or -ity, as in the word permeability, for a property of matter considered independently of the form of a body. According to Mr. Heaviside's original proposal, therefore, a coil of wire possesses a definite inductance expressible in centimetres or quadrants, or, as we now express it, in henrys.

Whether by misapprehension or by independent invention, it is now difficult to say, the word inductance subsequently found a new and different application. It was applied to the component of spurious, or wattless, resistance, which compounds rectangulary with the real or ohmic resistance in an alternating current circuit, to form the apparent resistance of that circuit. In this second sense of the word, the square of the resistance of such a circuit, plus the square of the inductance, gave the square of the total resistance. This made inductance a quantity of the same dimensions of resistance, except that it was a

resistance that did not dissipate the energy of a current. Most of the French writers employed "inductance" in the sense of a resistance of this nature. In England and America writers were divided, some using it in one sense and some in another. In German literature the term did not take root, possibly owing to this very ambiguity.

This was the state of affairs in this matter in 1893, when the Congress committee of the American Institute of Electrical Engineers drew up its report. In this report a definition for the word "inductance" was suggested as worthy of the attention of the Chicago International Electrical Congress. But the Chamber of Delegates did not pass any resolutions on the subject of nomenclature, so that the ambiguity in the use of this term still continued unchecked.

The American Institute, after the conclusion of the Chicago Congress, followed up the matter, and in order to avoid, if possible, the continuation of confusion until the next International Electrical Congress should be convened, appealed to four of the leading European electro-technical institutions for their views upon the meaning that should be given to this term. The London Institution of Electrical Engineers supported the original definition of Mr. Heaviside. The French Societe Internationale des Electriciens referred to the report of its committee that was appointed in 1893, to consider the Chicago Congress proposals, and in this report, although the word inductance was not mentioned, it was advocated that the older phrases, coefficient of self or mutual induction, should undergo no change. It also advocated, however, that the word "reactance" might suitably be employed for that wattless resistance in an alternating current circuit, to which the term inductance was frequently applied. The "Physikalisch Technische Reichsanstalt" in its reply to the American Institute appears to have gracefully accepted the meaning of the originator of the word inductance.

On the recommendation, therefore, of its Committee on Units and Standards, the American Institute of Electrical Engineers, at the annual meeting held last week, formally adopted the meaning of a coefficient of induction, in conformity with the English and German Institutions.

At the same time, the Institute has also adopted the recommendation of the French Societe Internationale concerning the word "reactance," which should therefore take the place of the rejected use of the term inductance. Reactance, in a circuit traversed by a periodic current, is therefore that quantity whose square, added to the square of the resistance, gives the square of the apparent resistance or impedance. A more accurate definition is to be submitted to the Institute for consideration by Messrs. Steinmetz and Bedell.

The dimension of inductance, in the electromagnetic system of units, is simply a length, and it is measured in henrys; the dimension of reactance is the same as that of resistance and the values of reactances may be expressed in ohms.

We sincerely hope that for the sake of conformity, the action of the Institute will be everywhere upheld; that all writers will now use the terms inductance and reactance with the meanings adopted and recommended by the Institute.

During the reading of a paper by Mr. Steinmetz, he suggested the use of the term "admittance" to represent the reciprocal of "impedance" just as "conductance" is the reciprocal of "resistance." As the total admittance of several circuits in parallel will be the sum of their separate admittances, the use of this term greatly simplifies the discussion of such circuits and avoids having to say that the total impedance of such circuits is equal to the reciprocal of the sum of the reciprocals of the individual impedances. Some writers are doubtless already familiar with this term, as it was suggested some time ago. No action was taken by the Institute, but if the term proves to be acceptable, something should be done to prevent the use of other terms for this quantity, or the use of this word in any other sense.

Practical Notes on Dynamo Calculation.—II.*

BY ALFRED E. WIENER.

4.—Field Density.

The specific strength of the magnetic field has to be chosen according to the size of the machine, the number of poles, the form of the armature, and to the material of the pole pieces. In general, the higher a density of the magnetic lines per unit of field area is taken, the larger the output of the dynamo, and in multipolar machines greater values of $\mathcal{H}$ are admitted than in bipolar ones. In dynamos with smooth core armatures the field densities are greater than in those with toothed armature bodies; for in the latter a portion of the lines enters the teeth and passes through the armature without cutting the conductors; for such armatures it therefore takes more lines per square inch of pole area to produce the same field density (per square inch of area occupied by armature conductors) than for smooth cores, and consequently smaller field densities are to be taken in order to prevent over-saturation of the pole pieces, and, eventually, of the frame. This leakage through the armature takes place in the higher degree the greater the width of the teeth compared to that of the slots, and therefore still smaller field densities are to be chosen in case of armature cores with tangentially projecting teeth, and of those with closed slots. Finally, in machines having wrought iron or steel pole pieces, the densities can be taken about 50 per cent. higher than in those with cast iron pole shoes.

TABLE IV.—PRACTICAL FIELD DENSITIES IN ENGLISH MEASURE.

Field Densities, in Lines of Force per square Centimeter													
Bipolar Dynamos							Multipolar Dynamos						
Smooth Armature Core		Toothed Armature Core					Smooth Armature Core		Toothed Armature Core				
		Straight Teeth		Projecting Teeth					Straight Teeth		Projecting Teeth		
Capacity in Kilo Watts	Cast Iron Polepieces	W'r't Iron or Steel Polepieces	Cast Iron Polepieces	W'r't Iron or Steel Polepieces	Cast Iron Polepieces	W'r't Iron or Steel Polepieces	Capacity in Kilo Watts	Cast Iron Polepieces	W'r't Iron or Steel Polepieces	Cast Iron Polepieces	W'r't Iron or Steel Polepieces	Cast Iron Polepieces	W'r't Iron or Steel Polepieces
.1	1550	2300	1250	1850	—	—	.1	2150	3100	1850	2800	—	—
.25	1850	2800	1550	2300	—	—	.25	2500	3700	2150	3250	—	—
.5	2150	3100	1850	2800	—	—	.5	2800	4200	2500	3700	—	—
1	2300	3400	2000	2950	1250	1850	1	2950	4350	2650	3850	1550	2300
2.5	2500	3700	2150	3100	1400	2150	2.5	3100	4500	2800	4000	1700	2500
5	2650	3850	2300	3400	1550	2300	5	3250	4700	2950	4350	1850	2800
7.5	2800	4000	2500	3700	1700	2500	7.5	3400	5000	3100	4700	2000	3100
10	2950	4350	2650	3850	1850	2800	10	3700	5400	3250	5000	2150	3300
25	3100	4700	2800	4200	2000	3100	25	4000	5900	3400	5400	2300	3500
50	3400	5100	3100	4700	2150	3400	50	4350	6400	3550	5900	2500	3700
100	3700	5600	3400	5100	2500	3700	100	4700	6800	3850	6200	2650	3850
200	4200	6200	3700	5600	2800	4200	200	5000	7300	4200	6500	2800	4000
300	4700	7000	4200	6200	3100	4700	300	5400	7750	4500	6800	2950	4350
500	—	—	—	—	—	—	500	5900	8200	4800	7200	3100	4700
1000	—	—	—	—	—	—	1000	6400	8700	5100	7500	3400	5000
2000	—	—	—	—	—	—	2000	7000	9300	5400	7800	3700	5400

TABLE V.—PRACTICAL FIELD DENSITIES IN METRIC MEASURE.

Field Densities, in Lines of Force per square inch													
Bipolar Dynamos							Multipolar Dynamos						
Smooth Armature Core		Toothed Armature Core					Smooth Armature Core		Toothed Armature Core				
		Straight Teeth		Projecting Teeth					Straight Teeth		Projecting Teeth		
Capacity in Kilo Watts	Cast Iron Polepieces	W'r't Iron or Steel Polepieces	Cast Iron Polepieces	W'r't Iron or Steel Polepieces	Cast Iron Polepieces	W'r't Iron or Steel Polepieces	Capacity in Kilo Watts	Cast Iron Polepieces	W'r't Iron or Steel Polepieces	Cast Iron Polepieces	W'r't Iron or Steel Polepieces	Cast Iron Polepieces	W'r't Iron or Steel Polepieces
.1	10000	15000	8000	12000	—	—	.1	14000	20000	12000	18000	—	—
.25	12000	18000	10000	15000	—	—	.25	16000	24000	14000	21000	—	—
.5	14000	20000	12000	18000	—	—	.5	18000	27000	16000	24000	—	—
1	15000	22000	13000	19000	8000	12000	1	19000	28000	17000	25000	10000	15000
2.5	16000	24000	14000	20000	9000	14000	2.5	20000	29000	18000	26000	11000	16000
5	17000	25000	15000	22000	10000	15000	5	21000	30000	19000	28000	12000	18000
7.5	18000	26000	16000	24000	11000	16000	7.5	22000	32000	20000	30000	13000	20000
10	19000	28000	17000	25000	12000	18000	10	24000	35000	21000	32000	14000	21000
25	20000	30000	18000	27000	13000	20000	25	26000	38000	22000	35000	15000	23000
50	22000	33000	20000	30000	14000	22000	50	28000	41000	23000	38000	16000	24000
100	24000	36000	22000	33000	16000	24000	100	30000	44000	25000	40000	17000	25000
200	27000	40000	24000	36000	18000	27000	200	32000	47000	27000	42000	18000	26000
300	30000	45000	27000	40000	20000	30000	300	35000	50000	29000	44000	19000	28000
500	—	—	—	—	—	—	500	38000	53000	31000	46000	20000	30000
1000	—	—	—	—	—	—	1000	41000	56000	33000	48000	22000	32000
2000	—	—	—	—	—	—	2000	45000	60000	35000	50000	24000	35000

* In the first section of this serial, on page 676, the symbol F has been used to denote the field density; hereafter, the symbol $\mathcal{H}$ will be employed for the field intensity, in accordance with the congress notation of 1893. All who intend to follow this treatise are advised to make the substitutions indicating this change of notation, as reference will be made to formula (1) in future sections.

The suitable values of $\mathcal{H}$ for all these various cases are tabulated in Table IV., which gives the average densities in lines of force per square inch, while Table V. contains the corresponding values of $\mathcal{H}$ in lines per square centimetre.

For very low potential machines (electro-plating dynamos; battery motors, etc.), about 3-4 of the densities given in Tables IV. and V. are to be taken.

5.—Length of Active Armature Conductor.

By means of the specific armature induction obtained from formula (1), the total length of active wire to be wound upon the pole facing surface of any armature can be readily determined. If E denotes the total E. M. F. generated in an armature, and L_a the total length of active wire wound on it, then E divided by L_a will give the specific armature induction V . The length of active conductor for any armature can therefore be obtained from the formula

$$L_a = \frac{E}{V}, \quad (2)$$

in which

L_a = total length of active conductor (on whole circumference opposite pole-pieces), in feet;

E = total E. M. F. to be generated in armature, i. e., volt. output + additional volts to be allowed for internal resistances (see Table VI.); and

V = specific induction of active armature wire, calculated by formula (1).

Introducing the value of V from (1) into (2), the formula for the length of active armature conductor becomes:

$$L_a = \frac{E}{\frac{v}{P} \times S \times \frac{\mathcal{H}}{20000}} = \frac{20000 \times P \times E}{v \times S \times \mathcal{H}} \quad (3)$$

To find the total electromotive force, E , to be generated by the armature, increase the electromotive force, e , wanted in the external circuit, by the percentages given in Table VI. The figures in the second column of this table refer to shunt wound dynamos, and, therefore, take into account the armature resistance only. The percentages in the third and fourth columns are to be used for series and for compound wound dynamos, respectively, and, consequently, include allowances for armature resistance as well as for series field resistance.

TABLE VI.—E. M. F. ALLOWED FOR INTERNAL RESISTANCES.

Additional E. M. F., in per cent. of output E. M. F.			
Capacity in kilowatts.	Shunt dynamos.	Series dynamos.	Compound dynamos.
Up to .5.....	20% to 12%	40% to 25%	30% to 20%
" " 1	12 " 10	25 " 20	20 " 15
" " 2.5.....	10 " 8	20 " 16	15 " 12
" " 5	8 " 7	16 " 14	12 " 10
" " 10	7 " 6	14 " 12	10 " 8
" " 25	6 " 5	12 " 10	8 " 7
" " 50	5 " 4	10 " 8	7 " 6
" " 100	4 " 3½	8 " 6	6 " 5
" " 200	3½ " 3	6 " 5	5 " 4
" " 500	3 " 2½	5 " 4	4 " 3
" " 1,000	2½ " 2	4 " 3	3 " 2½
" " 2,000	2 " 1½	3 " 2½	2½ " 2

6.—Size of Armature Conductor.

The sectional area of the armature conductor is determined by the strength of the current it has to carry. For general work, the current densities usually taken vary between 400 and 800 circular mils per ampere; in special cases, however, a conductor area may be provided at the rate of as low as 200 to 400 circular mils per ampere, or as high as 800 to 1,200 circular mils per ampere. The low rate refers to machines which only are to run for a short while at the time, as, for instance, motors to drive special machinery (private elevators, pumps, sewing machines, dental drills, etc.), while the high rate is to be employed for dynamos which have a 15 or 20 hours' daily duty, as is the case for central station, power house, and marine generators, etc.

Taking 600 circular mils per ampere as the average cur-

ent density (= 475 square mils, or .000475 square inch per ampere, or about 2,100 amperes per square inch), the sectional area of the armature conductor, in circular mils, is to be

$$\delta_a^2 = 60 \times \frac{C}{2P} \times \frac{300 \times C}{P} \quad (4)$$

where δ_a^2 = sectional area of armature conductor, in circular mils;

δ_a = diameter of armature wire, in mils;

C = total current generated in armature, in amperes; and

P = number of pairs of magnet poles.

The size of conductor may be taken from the wire gauge tables by selecting a wire, the sectional area of one or more of which makes up, as nearly as possible, the cross-section obtained by formula (4).

In this formula, as in equation (1), half the number of parallel armature circuits is to be substituted for P , in case the former figure should differ from the latter.

The total armature current, C , in shunt and compound dynamos is the sum of the current output, c , and the exciting current of the shunt circuit. The latter quantity, however, generally is very small compared to the former, and in all practical cases, consequently, it will be sufficient to use the given c instead of the unknown C for the calculation of the conductor area. A supplementary allowance may, then, be made by correspondingly rounding off the figures obtained by (4), or by selecting the wires of such a gauge that the actual conductor area is somewhat in excess of the calculated amount.

7.—Diameter of Armature Core.

If the speed of the dynamo is given, the proper conductor velocity taken from Table III. will at once determine the diameter of the armature. Let N denote this known speed, in revolutions per minute, and d'_a the mean diameter of the armature winding, in inches, then the cutting speed, in feet per second, is

$$S = \frac{d'_a \times \pi}{12} \times \frac{N}{60}, \quad (5)$$

from which follows:

$$d'_a = \frac{12 \times 60}{\pi} \times \frac{S}{N} \times 230 = \frac{S}{N} \quad (6)$$

From this mean winding diameter, d'_a , then, the diameter of the armature core, d_a , is found by making allowance for the height of the armature winding. For small armatures—under two feet in diameter—the coefficients given in Table VII. may be used for this purpose; for larger ones it is sufficient to simply round off the result of formula (6) to the next lower round figure.

TABLE VII.—RATIO BETWEEN DIAMETER OF BODY AND MEAN WINDING DIAMETER FOR SMALL ARMATURES.

Size of armature Up to 4 in. diameter	Drum armatures. $d_a = \frac{1}{2} d'_a$	Ring armatures. $d_a = \frac{1}{4} d'_a$
6 in.	$d_a = .5 d'_a$	$d_a = .25 d'_a$
8 in.	$d_a = .5 d'_a$	$d_a = .25 d'_a$
10 in.	$d_a = .5 d'_a$	$d_a = .25 d'_a$
12 in.	$d_a = .5 d'_a$	$d_a = .25 d'_a$
14 in.	$d_a = .5 d'_a$	$d_a = .25 d'_a$
16 in.	$d_a = .5 d'_a$	$d_a = .25 d'_a$
18 in.	$d_a = .5 d'_a$	$d_a = .25 d'_a$
20 in.	$d_a = .5 d'_a$	$d_a = .25 d'_a$
22 in.	$d_a = .5 d'_a$	$d_a = .25 d'_a$
24 in.	$d_a = .5 d'_a$	$d_a = .25 d'_a$

For dynamos with internal poles, the reciprocals of these coefficients are to be taken, or the result is to be rounded off to the next higher round figure respectively; and the dimension thus obtained is the internal diameter of the armature core. In the case of machines with internal as well as external poles, the mean winding diameter, d'_a , is identical with the mean diameter of the armature body.

If the speed of the dynamo is not given, the following Tables VIII., IX., and X., will be found useful. Table VIII. gives practical data for speeds, conductor velocities, and corresponding diameters of drum armatures. Table IX. contains similar information relating to high speed ring armatures,

and in Table X. the data for slow speed ring armatures are compiled.

TABLE VIII.—SPEEDS AND DIAMETERS OF DRUM ARMATURES.

Capacity in kilowatts.	Speed, in revs. per min., N .	Conductor velocity in feet p. sec., S .	Body diameter in inches, d_a .
.1	1,000	25	13 $\frac{1}{4}$
.25	2,700	30	21 $\frac{1}{4}$
.5	2,400	32	23 $\frac{1}{4}$
1	2,200	34	25 $\frac{1}{4}$
2	2,000	36	27 $\frac{1}{4}$
3	1,900	40	31 $\frac{1}{2}$
5	1,800	45	35 $\frac{1}{4}$
10	1,700	50	41 $\frac{1}{2}$
15	1,600	50	47 $\frac{1}{2}$
20	1,500	50	53 $\frac{1}{2}$
25	1,350	50	59 $\frac{1}{2}$
30	1,200	50	65 $\frac{1}{2}$
50	1,050	50	77 $\frac{1}{2}$
75	900	50	89 $\frac{1}{2}$
100	750	50	101 $\frac{1}{2}$
150	600	50	121 $\frac{1}{2}$
200	500	50	141 $\frac{1}{2}$
300	400	50	181 $\frac{1}{2}$

TABLE IX.—SPEEDS AND DIAMETERS OF HIGH SPEED RING ARMATURES.

Capacity in kilowatts.	Speed, in revs. per min., N .	Conductor velocity in feet per sec., S .	Body diameter, in inches, d_a .
.1	2,600	50	4
.25	2,400	55	5
.5	2,200	60	6
1	2,000	65	7
2.5	1,700	70	9
5	1,500	75	11
10	1,250	80	14
25	1,000	80	18
50	800	85	24
100	600	85	32
200	500	88	40
300	450	90	46
400	400	92	52
600	350	95	62
800	300	95	72
1,000	250	95	87
1,500	225	100	102
2,000	200	100	115

TABLE X.—SPEEDS AND DIAMETERS OF SLOW SPEED RING ARMATURES.

Capacity in kilowatts.	Speed, in revs. per min., N .	Conductor velocity in feet per sec., S .	Body diameter, in inches, d_a .
2.5	400	25	14
5	350	26	17
10	300	28	21
25	250	30	27
50	200	32	36
100	175	35	46
200	150	40	60
300	125	42	78
400	100	44	100
600	90	45	115
800	80	45	129
1,000	75	45	138
1,500	70	45	148
2,000	65	45	158

(To be continued.)

An Unpatented Improvement in the Magneto Telephone.

BY C. L. GIFFORD.

Mr. Ford's experiment, recorded in The Electrical World of May 5, is certainly of interest, but if he will refer again to my article of March 31 he will see that the closed secondary circuit, in the form of a metallic case with soldered joints, is recommended simply for overcoming self-induction—not induction from outside sources. If properly made, such a case will be found very efficient for the intended purpose.

The Bell people have recently placed upon the market a bipolar receiver, in which the coils are wound on solid metallic bobbins, or at least the heads are solid. These bobbins, whether designedly or not, have an action of the same kind as that of the exterior metallic case under discussion.

"Industries and Iron."

It appears that the English journal, "Industries and Iron," has changed hands, having been bought by the proprietors and publishers of "The Laundry News" and "Sugar."

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

COMPILED FROM
PRINCIPAL FOREIGN
ELEC. WORLD, N.Y.

ELECTRICAL JOURNALS
BY CARL HERING

ELECTRO-PHYSICS.

Bands in Geissler Tubes.—An article by Mr. Gulstein, from the "Wied. Ann.," volume 51, page 62, is abstracted in the "Elek. Zeit.," April 26; he shows that the three bands or layers in the cathode light in Geissler tubes are really three entirely different kinds of rays, having different properties and capable of being separated.

Induction and Inertia.—In the "Elek. Zeit.," April 26, Mr. Baumgardt shows that the analogy between self-induction and inertia is not only correct quantitatively but qualitatively also; he gives the theory and illustrates it with an apparatus made of a pivoted bar magnet, containing a flywheel in its centre, a strong current being passed through it from one end up to the flywheel and a galvanometer being placed in circuit between the other end and the middle contact, thus including the flywheel.

Electrical Interference Phenomenon.—A Royal Society paper by Mr. Barton on "An Electrical Interference Phenomenon Somewhat Analogous to Newton's Rings, but Exhibited by Waves along Wires," is abstracted briefly in the Lond. "Elec. Rev.," May 4.

Theory of Electric and Magnetic Phenomena.—A mathematical article by Mr. Ebert from "Wied. Ann.," volume 52, No. 2, is abstracted in "La Lum. Elec.," April 28.

MAGNETISM.

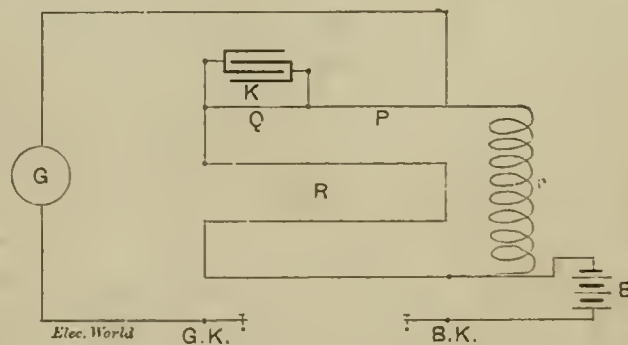
Magnetic Qualities of Iron.—The paper by Prof. Ewing and Miss Klaassen is continued in the Lond. "Elec. Eng.," May 4; a large number of hysteresis diagrams are given as determined by the magnetic curve tracer; in one case the cycles were produced slowly and in another comparatively fast, at the rate of 31-2 per second, in which case the rounded corners and increased wideness of the curves are noticeable, and the increased areas show that more work is being done, an effect probably due in great part to Foucault currents; the main part of the circuit was well laminated, but there were thick, solid pole pieces. Some of the curves were recorded by tracing the luminous line with a lead pencil and in others they were photographed; the latter gave good evidence of the constancy with which the movement repeats itself. In another test a small loop was superposed on a main cycle and also on a magnetization curve starting from zero, taken after the metal had been reduced to neutrality, showing the feature that in magnetizing from the neutral state the curve crosses the rising limb of the cyclic curve, which is in agreement with the fact that the extremity of one cyclic curve projects beyond the rising limb of a higher cycle; in another similar test with hard steel this magnetizing curve passes through the extreme points of the several cyclic curves which overlap one another. Another set of curves shows a study in superposed magnetizations in soft iron, there being a constant and a periodic magnetization at the same time; the experiments show that the reversal of a given

magnetizing current produces less and less change as the total magnetism is increased, also that a periodic change, in addition to a constant one, does not immediately produce cyclic effects and that during the accommodation period the mean value of the magnetism is rising, a consequence of the molecular shaking which is involved in the process of reversal.

Magnetism of Manganin.—Sir David Salomons calls attention in the Lond. "Elec. Rev.," April 20, to the fact that manganin may be regarded as non-magnetic, but that the filings are as magnetic as iron, a fact which may not generally be known; he suggests that fine manganin wire may possess magnetic qualities. In the issue of April 27, the makers of manganin state that they have repeated the test, but find a complete absence of magnetism; they suggest that possibly the other samples were extremely hard and might therefore have removed some particles of steel from the file, which would account for the observation. In a further communication in the issue of May 4, Sir David Salomons states that it could not have been the steel from the file, because the piece was entirely reduced to powder and the whole of this powder proved to be magnetic.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measuring Coefficients of Induction.—In the Lond. "Elec.," May 4, Mr. Russell describes two methods for measuring coefficients of self and mutual induction which are convenient in practice, as they do not necessitate a rearrangement of the apparatus for the two measurements. The first, which is capable of giving very accurate results, is shown in the accompanying diagram, consisting of a Wheatstone bridge



MEASURING COEFFICIENTS OF INDUCTION.

(in the form of a British post-office box), a mirror galvanometer and a condenser, which is preferably subdivided; r is the coil to be measured and Q , P and R the resistances of the various arms of the bridge, K being the condenser. First measure the resistance, r , of the coil; if the galvanometer key is pressed down before the battery key there will be a throw of the needle, and if the battery key be opened while the galvanometer key is down, there will be a throw in the opposite direction; if the resistance Q be shunted with the condenser K , these throws will be smaller; use two dif-

ifferent values of the condenser, one giving a deflection to the right and the other to the left, and find from the two deflections by the usual geometric construction (or by proportion), the value of the condenser which would give no throw, then L , the coefficient of self-induction, will be equal to this value of the condenser multiplied by Q , by r and by 10^{-6} , the result being in henrys, the condenser value being in microfarads and the resistances in ohms. For measuring mutual induction between two coils let L and N be the coefficients of self-induction and M that of mutual induction; then if the two coils be connected in series the mutual inductive voltage on each coil acts in the same way as the self-induction voltage, and if measured when so connected the total coefficient $A = L + N + 2M$; if B is the result when the terminals of one coil be reversed, then $B = L + N - 2M$, and therefore $M = \frac{1}{4}(A - B)$. The formulas are also given when the two coils are connected in parallel. This method gives correct values even when the coils are wound on brass cores or if there are closed circuits near them. The second method is not quite so accurate, as it assumes the harmonic law, but, on the other hand, requires only an ordinary alternating current voltmeter and ammeter; measure the voltage V and the current A with a direct current, and the voltage v with an alternating current of the same amperage; construct a right-angled triangle of which the voltage V forms the vertical side and v the hypotenuse, then the length of the third side divided by $2\pi nA$ is the coefficient of self-induction in henrys, when n is the frequency. For measuring mutual induction connect the two coils in the two different ways described above, make these same measurements and lay off the same triangles, which will have the vertical side in common and different hypotenuses; the difference between the lengths of the third sides of these two triangles divided by $8\pi nA$ will give the mutual induction in henrys; the method fails when the mutual induction is very small compared with the sum of the self-inductions, also when any closed circuits or masses of non-magnetic metal are near the coils. In conclusion, he states that it is very difficult to calculate the coefficients from the geometric dimensions of the coils, and as a general rule the formulas given in pocket-books are only rough approximations and are not safe to use unless one understands them perfectly.

Electrostatic Error.—Mr. Mather, in the Lond. "Elec.," April 27, gives a number of cases showing that the error produced by electrification of station instruments is a very important factor; he has produced a deflection of 80 volts in a 100-volt instrument by a single stroke of his finger across the glass.

Clark Standard Cell.—Further information about Mr. Kahle's paper is given in the Lond. "Elec. Eng.," April 27; he claims that the variation in the E. M. F. from the normal value can, with little difficulty, be reduced to 0.0001 volt, based on observations covering 1 1/2 years; the temperature coefficient between 10 and 30 degrees (presumably centigrade) was found to be $-0.000814 - 0.000007(t - 15)$.

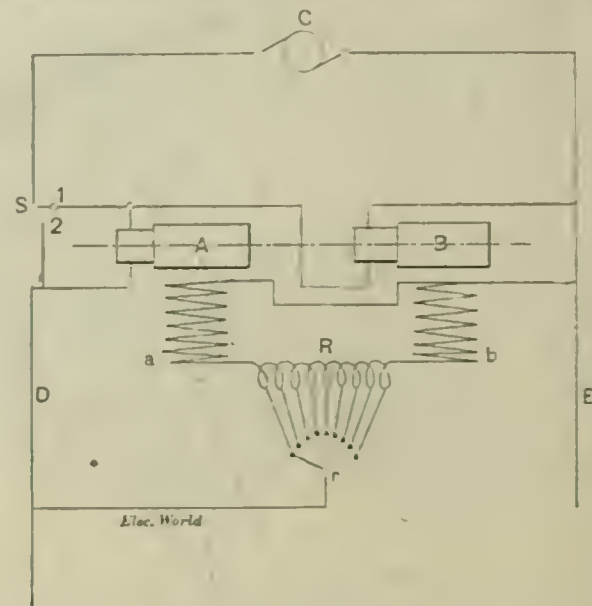
Meters.—The Schmehlik meter is described and illustrated in the "Elek. Anz.," April 15; the readings of the volts and the amperes are recorded on a strip of paper. The Fegs & Lorwa meter is illustrated and described in "La Lum. Elec.," April 21; it consists of an electro-dynamometer and electric clock for measuring and registering the deflections of the pointer. The conclusion of Mr. Wilson's paper on meters, together with the discussion, is given in the Lond. "Elec. Eng.," April 27.

Lightning Indicators.—See abstract under "Magnetic Property of a Static Discharge."

DYNAMOS AND MOTORS

Variable Speed Motors.—An alternative method to Mr. Leonard's system is described in the Lond. "Elec. Rev.," May 4, by Mr. Boulton; it is shown in the accompanying diagram

in which C is the motor and A and B the motor-generator, D and E being the line and R a resistance connected to the shunt field windings a and b , which are in multiple arc as



VARIABLE SPEED MOTORS.

shown, and S the main switch; for starting C the switch r is put into the position shown, so that a is fully excited and b is not excited, the switch S being placed as shown; the main current in passing through A loses voltage, say 460 out of 500 volts, and continues through C to E , while B is driven as a generator by A and supplies a low pressure quantity current to C ; as the speed of C is to be increased the switch r is moved to the right. For long runs without stops C is run directly from the mains; as A and B act in parallel to supply current to C , they need not be as large as in Mr. Leonard's arrangement.

The H. Ward Leonard system is also described in the London "Electrical Review" of April 27, where it is also discussed editorially, belief being expressed that the weak point lies in the fact that the efficiency of the working depends on the intelligent care of the motorman; it is also discussed in a communication in the same issue.

Variable Speed Motors.—In the "Elek. Zeit.," April 19, Mr. Baumgardt describes the following system to be used in factories and other like places where electric motors are required to run at greatly differing speeds. Two generators are used and are connected in series, one of 100 volts and the other of 50 volts, a wire being connected to their junction, thus making a three-wire system; the field and armature circuits of the shunt motors may then be connected variously to these three wires, producing a number of different combinations, resulting in different speeds; besides these combinations, resistances may be inserted in the field, thus producing intermediate speeds; by such a combination the relation of the lowest to the highest speed will be as 1 to 9; the theory is given and deductions made from it; the cost of the line wire is worked out and it is found that for variations of from 1 to 10 the copper required for the line is about twice as great as in the two-wire system of the same total voltage and for the same loss of energy, but as the cost of the wire in such an installation is a small part of the total, this factor is not of much importance.

Dynamo.—The novel shaped dynamo mentioned in the Digest May 12 (under Designing Dynamo Magnets) is described and illustrated in the Lond. "Elec. Eng.," May 4.

ARC AND INCANDESCENT LIGHTS.

Heavy Gases in Incandescent Lamps.—The Lond. "Elec. Rev.," May 4, abstracts Prof. Anthony's Institute paper, but emphatically maintains that, contrary to Prof. Anthony and other authorities, the carbon molecules do travel in straight lines and that shadows on the carbon deposits do occur in certain incandescent lamps where the conditions for the production are favorable.

Loading-in Wires.—According to "La Lum. Elec.," April

28, it has recently been found that an alloy of 95 parts of tin and five parts of copper may be fused to glass and will hold with great tenacity; the copper is added to melted tin; the melting point is about 300 degrees C.; by the addition of a little zinc or lead it may be made more or less soft and fusible; nothing is said about its expansion.

Small Arc Lights.—In "L'Ind. Elec.," April 25, Mr. Claude discusses the competition which electric light has to fear, calling attention to the more extended use of petroleum and concluding that in view of the fact that the solution of the problem of the cold light is still distant, the best direction of development of cheap lighting is the introduction of small arc lights to replace incandescent lights as much as possible; he mentions successful lamps of 1.5 amperes, or a total of 75 watts; also the use of reflecting diffusers as distinguished from semi-opaque globes; he encourages inventors to give their attention to small arc lights.

TRANSMISSION OF POWER.

Lauffen-Frankfort Transmission Plant.—The official report of the tests of this plant is abstracted in the "Elek. Zeit.," April 26; the results are as follows: The energy delivered by the second set of transformers averaged 114 h. p., with a mean voltage of 64.3 and a mean current of 440 amperes in each of the three branches, and the average total efficiency from the shaft of the dynamo to the secondary binding posts of the second set of transformers was 74.4 per cent.; experiments were made showing that the effect of the weather on the efficiency of such an installation is probably quite negligible; the efficiency of the dynamo at full load was found to be 95.4 per cent.; the efficiency of the transmission was tested by measuring the low tension current at the generator and at the distant end; the efficiency of the transformer at 100 kilowatts was 96 per cent., the maximum efficiency at which the iron and copper losses are equal was 96.1 per cent.; from half load to full load the efficiency varied from 95.7 per cent. to 96.1 and back to 96.0 per cent.; the mean efficiency of the whole transmission was 73.5 per cent., the total distance was 102 miles, the high tension voltage was 8,500 to 7,500 volts; the lowest efficiency of the whole system was 68.5 per cent. and the highest 72.5 per cent.; the only loss in the line was that due to its resistance, that is, to the $C^2 R$ loss; theoretical researches have shown that the influence of the capacity on the efficiency of such bare air lines for alternating currents of 30 to 40 to 50 periods is so slight that it may be treated as a very insignificant matter in the designing of such transmissions; in conclusion, it is stated that the electrical transmission at that voltage over air lines insulated on porcelain insulators with oil, for distances of more than 60 miles, is just as regular and reliable as with alternating currents of lower voltage and shorter lines. (Preliminary tests of this plant, in which the figures are given in greater detail, were described in The Electrical World July 2, 1892, page 8.)

Transmissions to Great Distances.—The "Revue de l'Electricite," March 31, contains an article on the cost of different forms of transmissions for great distances.

Series Transmission.—A translation of the paper by Mr. Schultz, mentioned in the Digest April 14, is given in an abstract in the Lond. "Elec. Eng.," May 4.

ELECTRIC RAILWAYS.

Heilmann Locomotive.—In a correspondence to the Lond. "Elec. Rev.," May 4, Mr. Sayers states that by using his winding there is no difficulty in constructing a generator to run without sparking at one-tenth its normal field, the speed and current being normal; he suggests that there would be none of the losses mentioned in a previous criticism in starting up the Heilmann locomotive if both generator and motor were series wound and permanently connected, the locomotive being started and stopped by the engine; the maximum torque would be applied at all speeds,

and there would be little or no trouble with commutators, even with an ordinary type of machine.

Combination Trolley and Accumulator Line.—According to "La Lum. Elec.," April 28, a line has been recently started in Sydney, Australia, in which, besides the overhead line, there are accumulators on the cars which are used at starting on grades; 40 to 50 h. p. can be developed by the accumulators; this combination increases the efficient working at the power station.

Accumulator Line.—According to the "Elek. Zeit.," April 26, a street railway in Berlin, to be completed in five or six weeks, is to be run with accumulators; no further information is given.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Consumption of Energy by Different Consumers.—In the paper by Mr. Hordern in Lond. "Lightning," April 19, he gives diagrams for a period of four quarters for each of different classes of consumers of the Westminster station in London; it was found that the difference of consumption of individuals in each class was much greater than that between the sections of the class, for which reason it becomes very difficult to forecast a new consumer's bill.

Lighting in Berlin.—The Lond. "Elec. Eng.," April 27, gives the kilowatt hours consumed since the year 1885 under the headings of "Private Lighting," "Street Lighting" and "Motors," from June, 1892, to June, 1893. These figures for 1893 are about 5,000,000, 22,000 and 238,000 kilowatt hours; there are 238 motors, representing a total of 785 h. p.; the net profit on last year's working was about \$250,000.

WIRES, WIRING AND CONDUITS.

Networks of Conductors.—In the "Elek. Zeit.," April 26, Mr. Muellendorff publishes an additional article to his paper mentioned in the Digest March 3.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Balloon Signaling.—The Lond. "Elec. Rev.," May 4, gives an illustrated description of the Bruce signaling balloon, mentioned before in these columns, in which a vertical row of six incandescent lamps is suspended in the inside of a semi-transparent captive balloon, 18 feet in diameter and having a capacity of 3,200 cubic feet; the lamps are of 16 c. p. and 55 volts, having spherical bulbs and thinner carbon filaments in order to avoid the afterglow; the signaling is done by means of a key having contacts of carbon; in an experiment the signals were visible at a distance of 16 miles; the balloon is the one constructed for the Italian Government.

Duplexing.—In a communication to the Lond. "Elec. Rev.," May 4, Mr. Bailey points out a "most striking point of incorrectness" of a statement made by Lord Kelvin and Prof. Bottomley, in the recent litigation, that where condensers are used in both arms of the bridge, the sum of the resistances used in combination in the arms of the bridge must remain constant.

ELECTRO-CHEMISTRY.

Purification of Sugar.—"La Lum. Elec.," April 21, abstracts a paper by Dr. Bersh describing the Schollmeyer-Behne and Dammeyer system (see Digest May 13, July 15, Dec. 9, 1893, and March 24, 1894), as applied in the Hoym factory in Germany. In addition to what has already been stated in these columns, the following may be of interest: Each of the two compartments has a capacity of 1,500 litres, each charge being treated for a period of ten minutes by a current of 50 or 60 amperes, being equal to a current density of 7 to 14 amperes per square metre of electrode (presumably of the zinc electrode); there are 7 electrodes of sheet zinc, having a surface (total?) of 6 square metres; the electrolysis produces a gelatinous material, which is difficult to filter, to obviate which a small quantity of chalk is added to the liquor; 1 per cent. of chalk will, in this way, produce better

results than 3 to 4 per cent. in the ordinary process; during the last year considerable trouble was experienced at this factory with a formation of froth in the ordinary process, due to the beets being of poor quality, but with the electrolytic process no froth is produced; there is also less destruction of the sugar. He states that in eight days the cost of the installation was paid for by the results obtained; the quantity of steam for generating the electricity is said to be of no importance; with 6 volts only 1-2 electrical horse power is required.

Pollak Accumulator.—According to a test recently made in an installation in Frankfurt, after running a year and a half, one battery had a capacity of 562.5 ampere hours, an efficiency of 97.5 per cent. in ampere hours and 83.6 per cent. in watt hours; in a second battery with a capacity of 725 ampere hours the efficiencies were 97.1 per cent. and 81.9 per cent. respectively; the capacities were respectively 25 and 61.1 per cent. greater than what was guaranteed; it is stated that since their installation no repairing whatever was necessary.

Accumulator.—Mr. Gruenwald makes an active mass by mixing pulverized lead with linseed oil and borate of manganese; electrolysis changes the oil into a resinous substance, which forms the binding material.

Aluminium.—According to "La Lum. Elec.," April 28, the installation to be established at La Praz will use 3,000 h. p., with 15,000 still available, and will produce three tons a day; it is questioned whether at the low price there will be sufficient demand for this quantity of material. It states that in the south of France bauxite of great purity is found, from which it is thought that aluminium at 4 francs per kilogram (37 cents per pound) may be made with the electric process.

MISCELLANEOUS.

Heating by Contact with an Electrolyte.—In "La Lum. Elec.," April 21, Mr. Hoho discusses this phenomenon at some length; in the phenomenon referred to a strong current is passed through a piece of metal immersed in an electrolyte, which causes the metal to be heated rapidly (see Digest April 29, July 8, Aug. 5 and 12, Nov. 11, Dec. 9, also May 6, 1893; March 17, April 7 and 14, 1894, and The Electrical World June 10 and July 15, 1893). He states that the phenomenon was described a long time ago by quite a number of physicists and gives references to their publications, dating back as far as 1841; he describes the researches of Plante referring to this phenomenon. In the early part of 1890 Messrs. Hoho and Legrange made exhaustive experiments, publishing their researches in the Bulletin of the Royal Belgian Academy in 1891, No. 9-10. He then describes in detail what takes place when the E. M. F. increases; first there is electrolysis, and after an increase in the voltage a crackling sound is produced and the liquid seems to boil; at still higher voltages luminous points appear on the electrode; after further increase these luminous points become more numerous, forming finally a luminous sheath, the color of which depends on the nature of the electrode, the electrolyte and the voltage, and the current, which before then was very irregular, now becomes steady and reduced in quantity; with a further increase greater heat is produced; the phenomenon manifests itself better at the negative electrode, the sheath at the positive electrode being less stable; it takes place with all conducting liquids and conductors, the voltage, however, being different for different materials; the nature of the electrode seems to have no appreciable influence on the E. M. F. necessary to produce the first appearance of the phenomenon, but it does seem to have an influence on its maintenance; it is greater for the negative than for the positive electrode; the tendency of the current is to remain constant for increasing voltages; the surface of the anode is a very important factor and the current increases

almost in proportion to this surface; the nature and form of the electrode have some influence; they found the same phenomenon with alternating currents, but with certain marked differences. He then discusses at some length the extended researches of Koch and Wueller published in 1890-'92.

The paper is concluded in "La Lum. Elec.," April 28; after summarizing his previous papers and giving references to them, he discusses the paper of Mr. Neher in The Electrical World, July 15, 1893, in which it is stated that the phenomenon does not take place if the metal is immersed before the circuit is closed; to this Mr. Hoho replies that if a slightly higher voltage had been used the phenomenon would have taken place; he shows in a table of results the effects of the temperature on the bath, from which it appears that with a constant E. M. F. the current diminishes as the temperature increases, and at near the boiling point the phenomenon no longer takes place. When carbonate of potassium is dissolved in glycerine he finds that less energy is required to form this luminous sheath, and the stability is greater than with water, the sheath is thicker, quieter and disengages less vapor; a given quantity of energy transformed into heat vaporizes a larger quantity of glycerine than of water and the resistance of the sheath will be greater; he discusses at some length the explanation of the phenomenon and believes that there is no question that it is simply due to the fact that this sheath introduces into the circuit a very great resistance.

In an article on this process by Mr. Ehrenfest in the "Elec. Tech.," April 15, he states that it has been found that the cost of welding by this system is half that of the ordinary forge system.

Electric Balloon.—"La Lum. Elec.," April 21, gives some further information regarding the electrically driven balloon to be operated at the Antwerp Exhibition (mentioned in the Digest Jan. 27). The oblong shape has been adopted, the length from point to point is 81.5 metres, the diameter of the central part 17.5 metres and the volume 14,000 cubic metres; with ordinary lighting gas an ascensional force of 0,800 kilograms is expected, enabling 25 to 30 passengers to be carried; the cage will be divided into three parts, the upper one for the navigator, the next for the passengers and the lower one for the machinery; the electric motor will have 125 h. p. driving a propeller 8 metres in diameter with four wings; a speed of 40 kilometres (24 miles) per hour is expected, the total distance being 1.8 miles; the electric cables are wound on a drum with special braking apparatus to allow for automatic winding and unwinding, according to the requirements; the trolley wire is composed of a cable 25 millimetres (about one inch) in diameter, made of galvanized steel wire, carried on an overhead structure 30 metres (100 feet) in height; the generator will consist of two gas engines, each of 200 h. p., supplied by power gas made specially for them, and two triphase current dynamos. (The abstract is taken from the "Revue Industrielle," the date of which is not given; as it will be seen, it is rather incomplete and probably some statements are not correct.)

Aerial navigation is discussed by Mr. Schoelfleuthner in the "Elec. Tech.," April 15, in which he concludes that a system like the above is the easiest solution of the problem.

The flying machine of Prof. Wellner, mentioned in the Digest Feb. 24, which is about being constructed in Austria, is described and illustrated in a paper by Mr. Bethuys in "Cosmos," March 31; peculiarly shaped, curved, paddle wheels are used, two of them being located above and on the sides of the balloon proper.

Mechanical Application of Electricity.—"La Lum. Elec.," contains a serial by Mr. Richard (mentioned several times before in these columns) containing short descriptions, accompanied by a number of well executed illustrations of various mechanical applications of electricity, taken apparently from patent specifications.

Suggestions for Transit Systems.—II.

BY S. D. MOTT.

The street system shown in the drawing is what may be called a sub-surface or sub-trolley line. It is not so very much of a departure from the overhead trolley system, the primary feature, of popular moment, being an absence on the street of poles and lines, and the features of practical moment being the ease and cheapness of converting the present cable roads into electric lines, and also the feature of depressing to

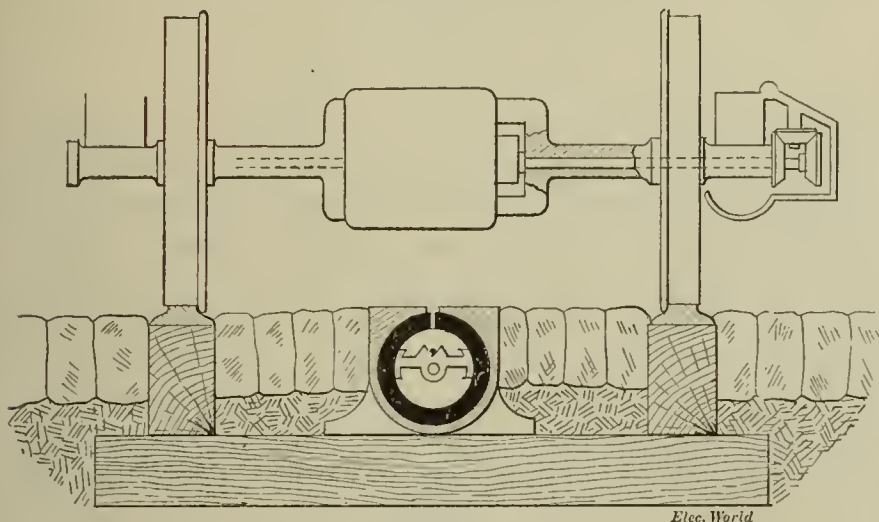


FIG. 1.

a sub-trolley line the electric suburban roads at points on the line where for any reason overhead construction is prohibited or undesirable. The trolley wire is carried down a supporting pole and continued, for a distance, it may be, sub-surface. The sub-trolley system (Fig. 2) consists of a trolley wire or cable of small dimensions—the size depending upon the E. M. F.—raised out of a conduit slot and travelling above the surface of the ground for about four feet underneath the cars as it progresses, there making electric contact to motors, thence trailing back into conduit as the car recedes.



FIG. 2.

It may be a single circuit, using the ground as return (Fig 1), or it may be operated on metallic circuit (Fig. 3). This line will take curves and switches with the same facility as overhead trolleys, and with greater facility and less expense than the cable systems. With ordinary electric roads the single trolley wire frequently carries current for all cars on the line. It will be observed here that the working conductor carries current for and to one car, the feeding conductor (Fig. 5) energizing the working conductor at all points;

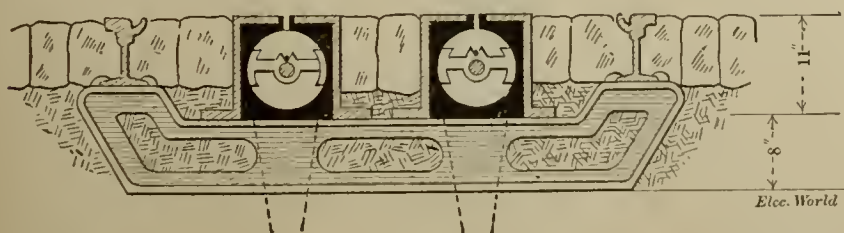


FIG. 3.

hence the working conductor may be smaller than ordinary trolley wires and should it break the road is still operative at all points except at the break. If it be desired that the sub-

trolley conductor be insulated, the use of an alternating motor is required for propelling the car, together with a converter of especial construction.

Figs. 1 and 3 are insulated conduits; this conduit may be made of any suitable insulating material, such as concrete, cement, asphaltum, fireclay, or vitreous substances, such as earthenware waterpipe. They may be filled with mud and water without leaking a perceptible current if properly constructed. Arrangements for flushing the conduit may be made by equipping a car for this purpose. Unlike cable

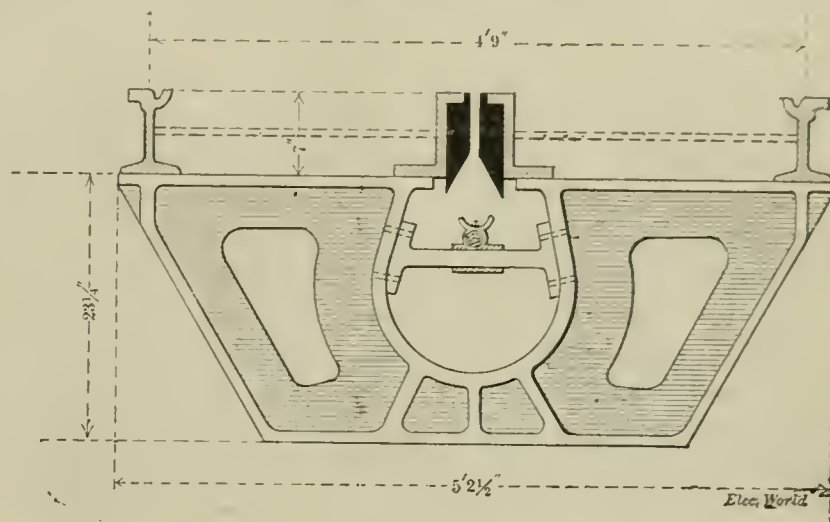


FIG. 4.

roads, one car may run faster than another and in either direction, and there are no rigid sub-surface connections preventing the moving of cars on any but cable roads.

The excavation for road, as here shown, is 19 inches, as compared with 30 1-4 inches for cable road construction.

In view of the desire of the cable companies in some instances to substitute electric traction for their present systems, the inexpensive adaptation of this system to such roads, utilizing the cable and conduit already down is shown in Figs. 4 and 5. The change can be made at minimum cost and without necessarily disturbing the street pavements.

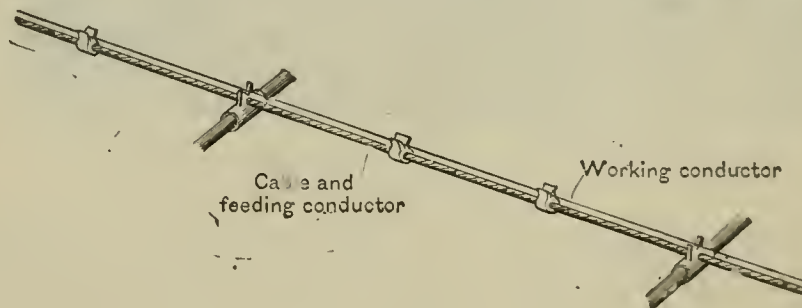


FIG. 5.

The cable (Fig. 5) is mounted upon and supported by (ground glass) insulators (coated, for instance, with paraffine), and is used as a feeding conductor energizing the working, or trolley, wire.

A "Bitter-Sweet" Compliment.

It is refreshing to see that sometimes the London electrical journals find something good and original in America, even though they cannot resist adding a bitter remark. A recent issue of a London contemporary, in speaking of the office buildings of the American type, states "Would we had a few of them in London. The American office building is the one (!) item in America wherein Americans might safely claim absolute pre-eminence, and it is the one item they never do brag about."

A Westward Movement of the Centre of Gravity of the Electrical Industry.

In a recent issue of a German electrical journal every one of the five leading illustrated articles are of American origin, and in the very next issue three out of five are American.

The New Telephone Exchange at Atlanta, Ga.

The Southern Bell Telephone and Telegraph Company has in operation in Atlanta, Ga., the most modern and complete telephone exchange and wiring system in the entire South, and one of the most complete in the country. Realizing the growing commercial importance of Atlanta, the company decided over a year and a half ago to erect a telephone exchange building and underground cable system for that city. The work was begun in January, 1893, and everything was completed and in operation by January of the present year.

The new telephone building, as shown in the cut, is a handsome three-story structure of stone and terra cotta, covering an area 30 feet by 107 feet. It has a large and commodious basement, containing a storage battery room, furnace room, and general storage and district supply rooms. At the front, extending far out under the street, is the office manhole, connecting with a side passage forming the cable runway. The office manhole, from which the cable runs, is a cement lined, vaulted roof chamber, 8 feet wide by 44 in length and 9 feet high, and is ventilated very efficiently by two pipes, one running from the surface of the ground to near the bottom of the chamber to supply fresh air, the



FIG. 1. ATLANTA TELEPHONE EXCHANGE.

other connecting the top of the chamber with the top of the building, and carrying off all foul air and gases. The difference in air pressure between the chamber and the top of the building causes a continuous flow of air. The cable runway is 4 1-2 by 57 by 11.

The first or ground floor contains a handsome set of offices in the front. In the rear are the inspectors' rooms, distributing rooms for wires and district supply stock room.

On the second floor, front, are the offices of the district superintendent, Mr. John D. Easterlin, and back of them the office of the electrician, Mr. James A. Wotton, adjoining the shop rooms. The shop is the largest in the Southern territory, and is equipped with all the machinery and tools for manufacturing and electro-plating the special apparatus necessary for telephone work. It is operated by two 3-h. p. motors, obtaining current from the city lighting company. In the laboratory part of the shop are to be found the necessary electric and chemical apparatus for experimental work and testing.

The third floor is given up entirely to the operators and operating room. The front rooms of this floor are fitted up most comfortably as parlor, dressing room and toilet and bath rooms for the girl operators, and adjoining them is a kitchen, with gas stove and utensils for use at meal time. The operating room in the rear is large and well ventilated and lighted.

The switchboard is a bridged terminal metallic circuit mul-

tiple switchboard on the Law system, 100 feet in length, of a capacity of 4,000 metallic circuits, and wired at present for 2,000 circuits. This board was built in Atlanta, and its arrangement is of special interest, differing as it does from that of almost all other telephone exchanges. It is equipped with listening and ringing keys to facilitate connection, and



FIG. 2.—DISRUPTIVE DEVICE.

uses the current furnished by a storage battery for switchboard transmitters. The alternating current for the call-bell working is furnished by an Eickemeyer dynamo, which also supplies a direct current for charging storage batteries for emergency use. Should the dynamo be shut down, the storage batteries are automatically thrown into circuit and operate the call-bell circuit through a pole changer.

A special feature is the device adopted for the "busy test," indicating when a subscriber's line is busy. Owing to the electric railways throughout the city, the ordinary device would give the "busy test" clicking sound in the earphone when the line was not in use. To obviate this difficulty a relay circuit was employed, which the earth railway currents are not strong enough to operate, but which is readily operated by the battery current.

The cables enter through the office manhole and cable runway, and at the end of the runway the cable wires are all connected to Okonite wires, which run to a distributing frame. From the distributing frame each circuit is connected to the lightning arresters, which consist of strips of carbon separated by a sheet of mica.

An interesting and unique feature of the call circuit is the protective device against heavy currents. This is the invention of Electrician Wotton, who holds a patent on it. It is a difficult thing to have a small-capacity fuse act with certainty, and Mr. Wotton, appreciating this, devised a disruptive device, which will act with absolute certainty whenever the current exceeds three-tenths of an ampere. This device is shown in Fig. 2, and consists simply of a small graphite cylinder capped at both ends with brass caps, to which the circuit wires are connected. A small amount of fulminate of mercury is placed in the ends of the graphite cylinder under the caps. On the passing of an excessive current a small explosion occurs, blowing out the graphite and disrupting the circuit.



FIG. 3. DISTRIBUTING POLE.

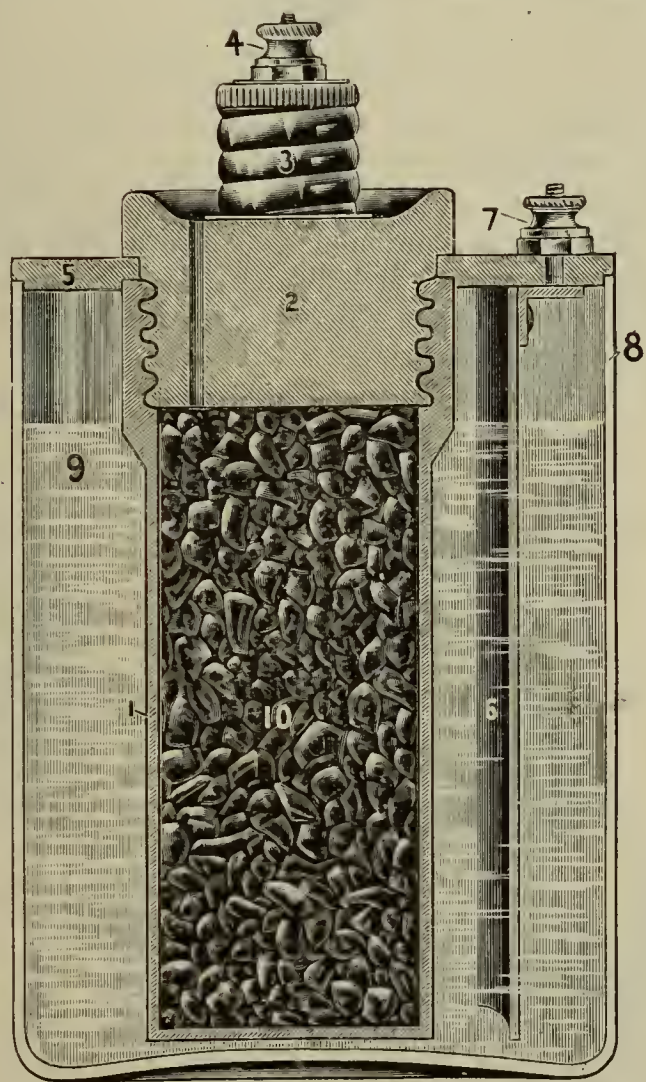
The distributing boxes on the poles throughout the city have similar protective devices for each wire.

For the underground cables 15,000 feet of trench was dug, in which was laid in cement 150,000 feet of three-inch iron cement lined conduits of the National Conduit Com-

pany's make. The conduit starts with forty ducts, sufficient for forty cables, seventeen of which are installed. The cables are paper and lead insulated, of the Standard Underground Cable Company's make, each cable containing 200 wires. The actual length of cable in use is over 150,000 feet. The underground conduits extend a radial distance of about 4,000 feet from the centre of the city, and beyond this distance the wires are carried overhead on poles. The wires are distributed from pole tops in radial fashion, as shown in the cut, 200 arms from each pole. Pine poles are used, 90 feet high, and are set in tar cement.

The Hayden Carbon Porous Cup Cell.

We illustrate herewith a carbon porous cup cell manufactured by the Hayden-Booker Manufacturing Company, 2,140 De Kalb street, St. Louis, which differs in important points from similar cells. Figure 1 is the carbon porous cup, made by a special process which renders it very porous. The walls are but one-quarter inch thick, and the cell attains its full strength immediately it is set up. The cup is screw-threaded at its upper end to receive a carbon screw cap, 2, which is of close-grained carbon, and being a sepa-



CARBON POROUS CUP CELL.

rate piece, is treated so that it cannot absorb moisture, and thus renders corrosion impossible; 3 is a metal screw cap and 5 the jar cover, which is clamped between the carbon screw cover and the carbon cup. This cover is provided with an opening for the zinc, 6, which is clamped to the cover, as shown, though a loose zinc can be used, in which case it or the carbon must have rubber bands to prevent contact between the two. The solution should stand to the shoulder of the carbon cup. The depolarizer is of manganese, which is renewed when exhausted. In the usual carbon porous or clay cup cell where a depolarizer is used, the whole element is worthless when the depolarizer is exhausted, and as the depolarizer does the work, it therefore in time becomes dead. The cup and its cover being indestructible, and not injured by service or time, the only renewal necessary is the filling, which is as simply done with this cell as in renewing the solution,

A New System of Electric Power Station Construction.

Mr. B. J. Arnold, of Chicago, has designed a system of electric power station construction which, it is claimed, combines the flexibility of the low speed other large engine belted plant with the low first cost of a direct connected or direct belted plant.

The advantages of the new system are summed up as follows: Less cost per kilowatt of plant installed; less cost in operating expenses; less real estate occupied; great flexibility; less depreciation; greater ease in handling than in power plants as heretofore installed.

Referring to Figs. 1 and 2, the system will be described as applied to a plant having a capacity of 2,000 h. p. Engines 1 and 2 are cross compound condensing engines of 1,000 h. p. each, and generators 1 and 2 are of 750 kilowatt each. The armatures of the generators are mounted on hollow cast steel shafts or quills, Cc, running in independent bearings, Pp, so arranged that they are free to revolve independent of either engine and of each other. Through these quills and supported at its centre by a bearing D, extends a steel or wrought iron shaft carrying upon its ends circular cast steel or iron discs, Fi, securely keyed to the shaft.

The illustration shows the engines connected to generators with magnetic clutches which operate as follows: Attached to the end of the engine shafts, Aa, are circular cast iron or cast steel discs, Hh, carrying in recesses copper coils, Oo, which are connected to brushes, Qq, by means of rings, Rr, in such a manner as to permit a current of electricity to be passed through the coils while the discs are in motion. Around the vertical face of discs Hh, near the peripheries, are carried cast steel or cast iron rings, Ii, which are held in position on discs Hh, by means of three gudgeons or bolts equally spaced around the periphery of discs Hh. Rings Ii are normally held against discs Hh by small spiral springs surrounding the gudgeons or pins. Attached to quills Cc are cast iron or cast steel discs, Jj, carrying two coils of copper wire, Mm, Nn, which are connected to brushes Kk so as to allow a current to be passed through the coils when the discs are in motion.

If a current of electricity is passed through the coil M a magnetic field will be created around it which will have a tendency to attract the disc I, overcoming the action of the springs, which normally hold it against the disc H and clamping it securely to the disc I, so that power can be transmitted from one disc to the other disc by friction so long as the current traverses the coil, M. If the engine No. 1 now be set in motion, it will drive generator No. 1 directly connected, and in like manner engine No. 2 can be connected to generator No. 2, thus forming two direct connected power units. The shaft, E, lies in the bearing, D, and is not used except in case it becomes necessary to drive either generator from the opposite engine or both generators from the same engine.

If engine No. 1 and generator No. 2 were disabled, generator No. 1 could be driven from engine No. 2; current would be passed through coil O, thereby attracting disc I, which would set shaft E in motion. Current would also be passed through coil N attracting disc L, which would set the armature of generator No. 1 in motion. Current would then be cut off from the coil, M, allowing the generator No. 2 to come to rest. In a similar manner, if engine No. 2 were disabled, generator No. 2 could be driven direct from engine No. 1, and either generator or both generators are thus available from either engine. It will be seen in Fig 1 that the main shaft of both engines is cut off in the middle and the two parts joined together by positive jaw clutches operated by steam cylinders. Thus, when the load is light the engine and generator No. 1 can be shut down. Cylinder

D of engine No. 2 is cut off by means of a jaw clutch, and no portion of the plant operates except the high-pressure cylinder of engine No. 2 directly connected to generator No. 2. This cylinder can be run condensing and the plant thus economically operated even under these circumstances.

In case of repairs, for example, to the high-pressure cylin-

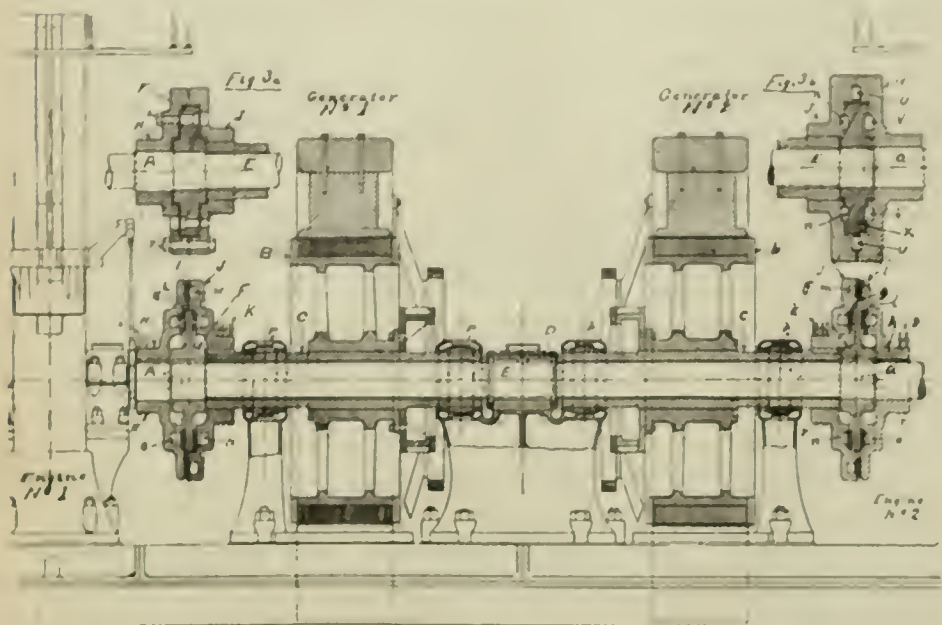


FIG. 2. NEW SYSTEM OF POWER STATION CONSTRUCTION.

der of No. 2, at the same time that full power is demanded of engine No. 1, high-pressure steam may be admitted to the low-pressure cylinder of engine No. 1, which will thus give full power for driving the generators while the high-pressure side of No. 2 is shut down for adjustment.

The system also includes a method of electrically starting the generators so as to prevent wear on the rings of the magnetic clutches, the generators being run as motors until

An Electric Carriage.

The Benz electric carriage was first shown at the late Munich Exposition, and the Emperor William is said to have recently ridden from Maxau to Lauterburg. The trip, a distance of 15 miles, is claimed to have been made in 35 minutes. On his return home the Emperor ordered a very luxurious carriage to be built at once for his private use.

Among the first to recognize the importance of this field in this country was Mr. G. K. Cummings, of Chicago, who has recently finished and put on the streets of that city an electric carriage embodying the latest and best designs for successful commercial operation.

An examination of the accompanying illustration will show that the gearing is positive and direct in action, while the use of the link belt allows a certain flexibility which practice has demonstrated is necessary. The speed is under perfect control by means of the foot pedal actuating a switch under the forward part of the carriage, and the direction of the carriage is so easily controlled by the handwheel that a child can direct it, and the various parts so accessible and simple that after a few moments instruction and explanation a novice can operate the vehicle.

The motor is a 2-h. p. series wound 24-volt machine. The end of the armature shaft carries a rawhide pinion engaging with an iron gear on a countershaft directly connected with the rear axle through a link belt. The rear wheels are both driven, but when the vehicle turns a corner or deviates from a straight course, by an ingenious device through a system of hardened steel roller clutches, either driven wheel may move independently of the shaft or the other wheel, so that the one on the outside of the curve will automatically adjust its speed to the distance it has to traverse. This difference of speed of the two driven wheels is

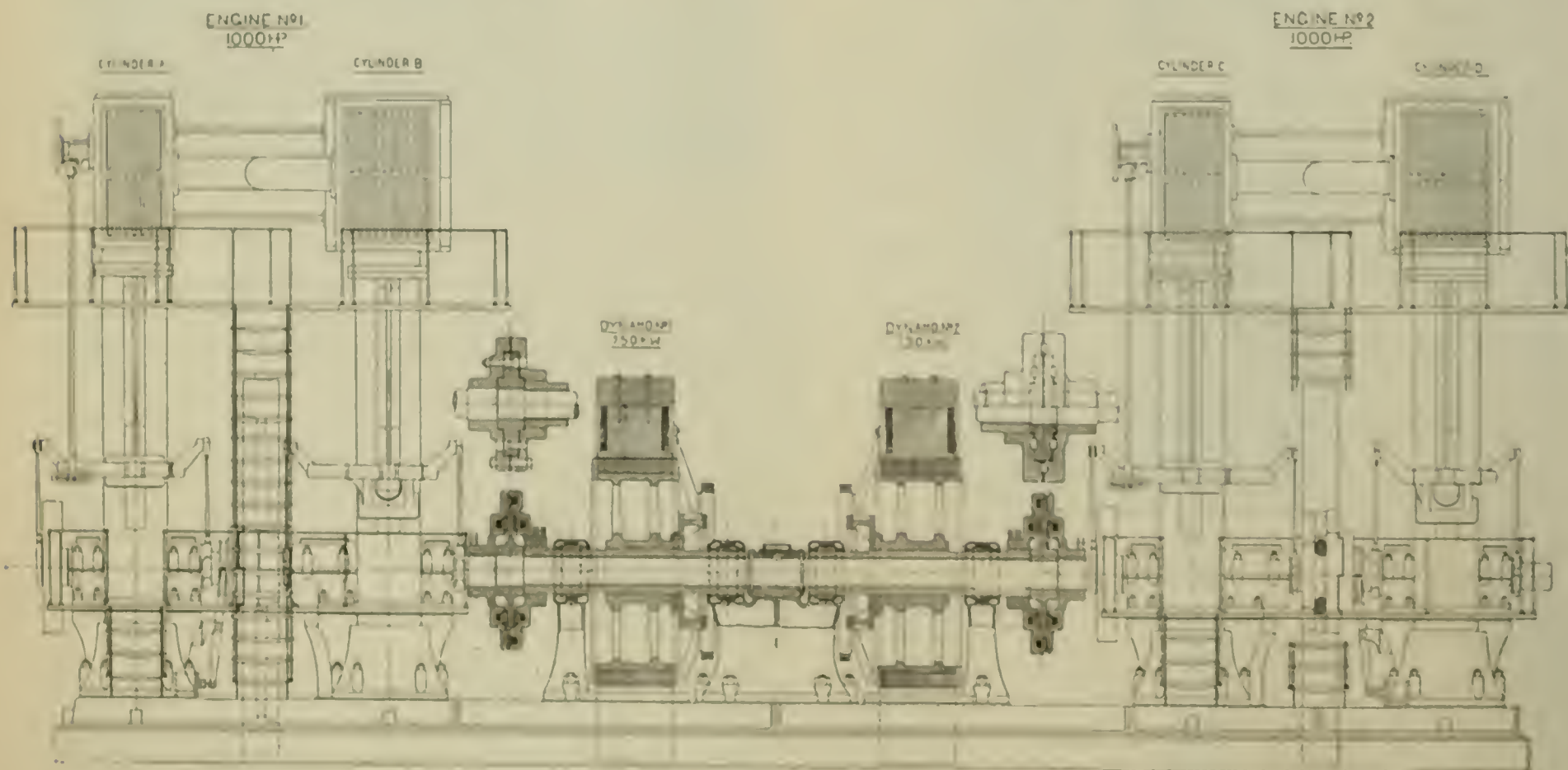


FIG. 1.—SYSTEM OF POWER STATION CONSTRUCTION.

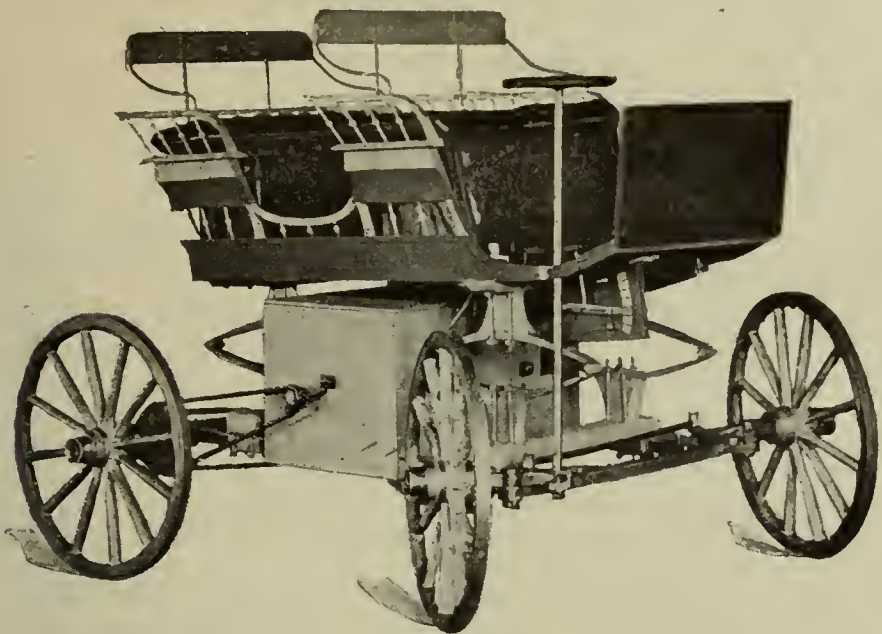
their armatures attain the necessary speed. In case that it ever becomes necessary to increase the capacity of a power plant like that described, it can be done by adding generators and engines to the right and left of the two engines shown. It will thus be seen that any generator in such a plant can be started or stopped at will without stopping either engine and without using belts, pulleys or friction clutches, and in addition there are advantages heretofore noted as to reliability, cost, ease of handling and operation.

considerable, as on the sharpest turn the periphery of the inner wheel covers only one-half the distance traveled by the outer one. The front axle is made of aluminum bronze, is rigid and carries two short supplemental movable axles, to which are attached the front wheels. The movable axles are connected to each other by a pivoted iron bar, so that their action is reciprocal. The inner end of the right-hand one is toothed, engaging with a pinion on the end of the shaft carrying the handwheel.

The framework of the running gear is of angle iron, supporting four springs placed longitudinally with the body of the carriage, which has a seating capacity of four people.

The current needed is derived from 200 ampere-hour storage battery cells placed under the seats of the carriage. The brake is a leather lined steel band clutch.

Recent tests of this carriage show that over level city roads



ELECTRIC CARRIAGE.

at a normal speed of ten or twelve miles an hour, a maximum average of from 1 1/4 to 2 electrical horse power is all that is required, the difference in power consumed depending on the state of the roads and the style of paving traversed. The questions of running through the mud, over street car tracks, raised obstructions, such as manhole

of charge for current of the Chicago Edison company, the expense would be only \$10 per month; this would be cut down to \$5 or \$6 per month if an average daily trip of 20 to 25 miles be made. This would compare very favorably with a great majority of city vehicles.

A company is being formed to place a line of these carriages on the market, including six-seated phaetons for use in the different park systems in large cities, and smaller vehicles of three-wheel variety to seat two persons, which may be rented out by the hour.

Automatic Muck Bar Shear.

The method heretofore employed for shearing a muck bar of steel has been to carry the bar to the old-fashioned alligator shear, place the end against a fixed gauge, which determined the length of the pieces, and pass the bar along by hand for the successive cuts. This method not only requires the labor of several men to handle the bar, but calls for considerable skill on the part of the shear man, and unless great care is used, the results are liable to be unsatisfactory. The illustration represents a machine designed by the E. W. Bliss Company for doing this work automatically, thus requiring but one man to do the work, who need not be a skilled shearman. The machine consists of a powerful gate shear, driven directly by an engine. A clutch is attached to the engine shaft, which can be operated either by hand or automatically. To the right of the machine is a carrier composed of a train of rolls driven continuously. The muck bar, coming hot from the rolls, is placed upon these carriers, which propel it toward the cutters between side gauges, which keep it in position at right angles to the shear blades. Just before entering between the cutters a pair of feed rolls take hold of the bar so as to feed it positively.

A clamping device is placed in the path of the bar and so arranged with a lever that the progress of the bar may be arrested by the operator. This lever also controls the feed rolls, so that when the clamps are in contact with the bar, the rolls are removed from it and vice versa. This arrangement gives the operator full control over the bar, and he is enabled to bring it into proper position to square off the ragged end by throwing the clutch into operation by means of the hand lever shown in the cut at the front of the cutter housing.

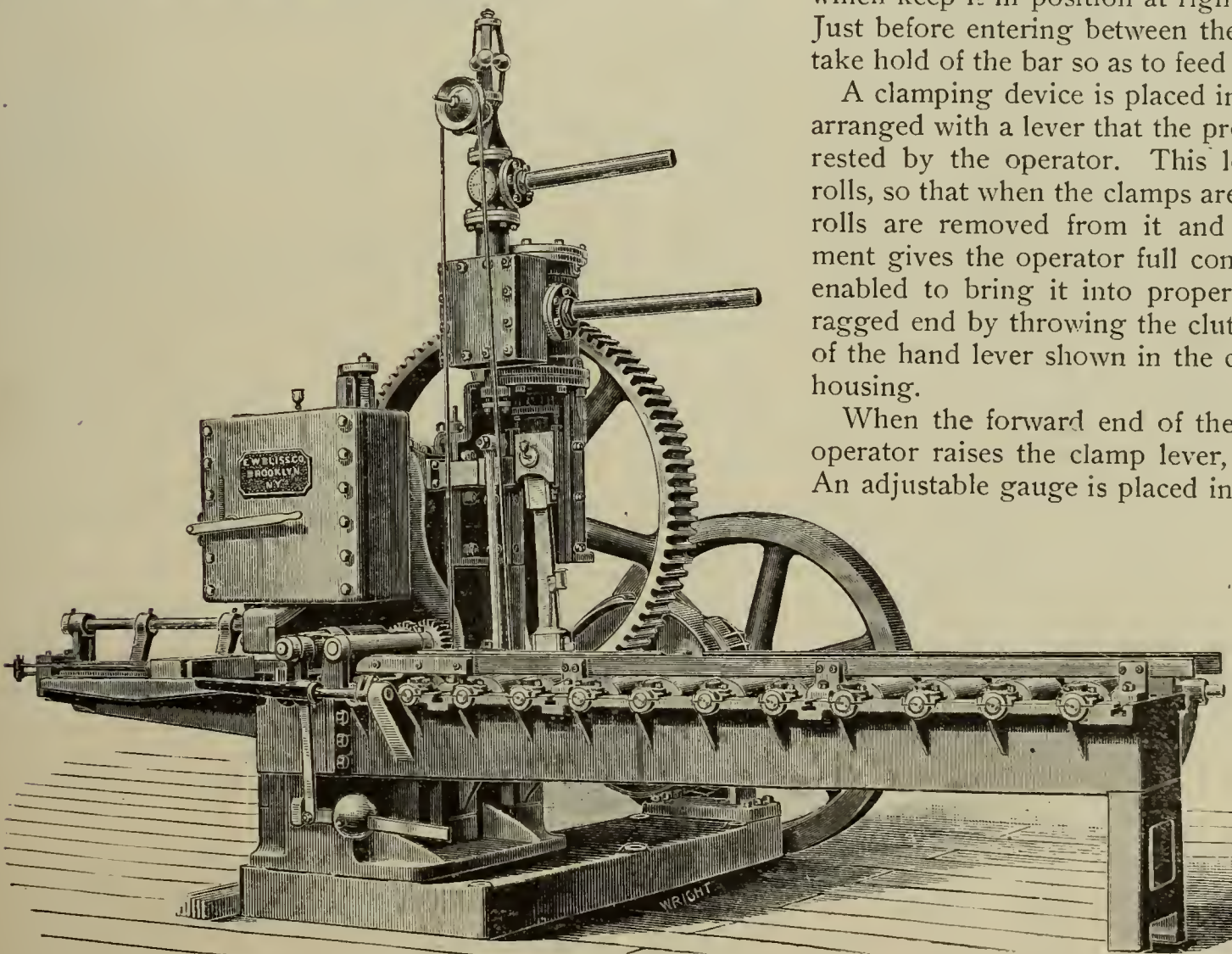
When the forward end of the bar has been squared, the operator raises the clamp lever, and the bar feeds forward. An adjustable gauge is placed in its path, and upon striking

this its progress is arrested and the clutch is automatically thrown into operation, causing the upper shear blade to descend and cut off the first length. As soon as this occurs the piece drops out, the shear blade ascends to its upper position and stops, while the bar again feeds forward, and the operation is repeated until the bar is all cut to lengths.

By this system the bars

are cut accurately, and as rapidly as they come from the rolls.

In order to adapt the machine to the practical requirements of mill work, experiments were conducted for some time by the makers at the mills of the Canonsburgh Iron and Steel Company, and this machine is the outcome of these experiments.



AUTOMATIC MUCK BAR SHEAR.

covers and the like, starting up from ruts and gutter, have been taken up carefully in turn, and through actual operation it has been demonstrated that the vehicle easily overrides such obstacles.

As to cost of operation, taking as a basis a daily run of 50 miles at 10 miles an hour and the average consumption of power at two electrical horse power, at the published rate

Financial Intelligence.

The Electrical Stock Market.

New York, May 12, 1894.

THE ELECTRICAL STOCK MARKET this week has been practically confined to two stocks—General Electric and Westinghouse. Some little interest has been shown here in Western Union, and Boston has devoted some attention to American Bell Telephone, but the dealers in this class of securities have been mostly concerned in the operations of the two first-named stocks.

GENERAL ELECTRIC, as was intimated in the last review of the electrical stock market, continued to be bearded all week long. The friends of the property have disappeared. Wall Street is no longer regaled, as it was a few weeks ago, with "official" recitations of the enormous revival of business and the brilliant future of the General Electric Company. There is a rather well grounded opinion held in many Wall Street quarters that insiders know a good deal more about the present pressure on General Electric than is consistent with their relations to the company, officially and otherwise. It is well known that one or two Boston interests, hitherto closely identified with the company by reason of large holdings of stock, have been quietly liquidating their lines. One or two New Yorkers are also not free from suspicion of similar doings, and, while the weakness of the stock was started by the operators on the short side of the market, they have been materially aided by the endeavor of several so-called "inside" interests to get out even around present prices. The success of the bear campaign has been due to a combination of causes, but the operators on the down tack have made good use of their opportunities, and are now firmly entrenched in a position whence it will not be easy work to dislodge them. They are in full control of the manipulation of the stock, and every attempt to rally General Electric is met with persistent offerings of the stock that effectually block any upward movement or even undue show of strength.

WESTINGHOUSE ELECTRIC naturally profits by all that has been said against General Electric. All the comment that comes to light is most favorable. At the annual meeting, held in Pittsburgh this week, where the old board of directors was re-elected by a vote of 113,000 shares, President Westinghouse laid special emphasis in his address on the fact that, since the date of the present annual report, when the outstanding bills payable were \$560,982, the latter had been further reduced by collections so that the amount now outstanding was only \$280,575. It will thus be noted that the business methods that have been applied to the management of the property are accomplishing most excellent results.

AMERICAN BELL TELEPHONE quotations have not varied much of late. Legislative interference with the company's plans is disappearing, and the company's service is everywhere being improved upon. Some of the sub-companies are about to introduce the Buffalo system of rates as a further bid for popular favor. In the Buffalo system the charges for a telephone are according to the number of telephone calls. Some experimental telephones are to be put into New York residences based on this system, by which beyond, say, 1,000 calls per annum, tolls are to be charged. When a plan of toll service for telephone subscribers has been worked out, it will lead to concentrated action by all the exchanges operating through the American Bell Telephone Company.

WESTERN UNION TELEGRAPH has been somewhat under a cloud. The departure of George Gould for Europe has been a signal for an aggressive bear campaign against all the Gould stocks, and Western Union has not been spared. It is alleged that big inroads have been made upon the company's earnings by the substitution in many quarters of long distance telephones for private telegraph wires. Thus there are now only three or four private telegraph lines between brokers' offices in New York and Chicago, where there were formerly a score. Between New York and Philadelphia, and New York and Boston the telegraph has been discarded altogether in favor of the telephone. Then, too, the pool rooms in this city continue tightly closed, and this big loss to the Western Union continues permanent. None the less the stock does not yield easily because of the large spread of holdings in investors' hands, and their unwillingness to be scared into liquidation.

ELECTRICAL STOCKS.

	Per.	Hid	Asked
Brush Ill., New York	50	10	30
Detroit Electrical Works	10	2	3
Cleveland General Electric Co.	—	85	90
East River Electric Light	100	—	65
Electric Co. & Supply Co., prof.	15	15	16
" " " "	15	15	17
Edison Electric Ill., New York	100	100	101 1/2
" " " " " " " "	—	107 1/2	107
Edison Electric Ill., Brooklyn	100	102	103
" " " " " " " "	100	116	117
" " " " " " " "	100	130	135
" " " " " " " "	100	125	127
Edison Electric Light of Europe	—	80	8
" Bonds	—	10	11
" Ore Mining	—	3	4
Fort Wayne Electric	100	35 1/2	36
General Electric Company	—	88	89
" " " " " " " "	100	86	87
Interior Conduit and Ins. Co.	—	—	65
Mount Morris Electric	50	37	38
Westinghouse Consolidated	50	51 1/2	52
" " " " " " " "	—	80	—
Western Union Telegraph	—	190	190 1/2
American Bell Telephone	—	—	—

*Ex. Dividend.

New Incorporations.

THE MOUNT PLEASANT STREET RAILWAY COMPANY, Des Moines, Iowa, has been incorporated by Geo. E. Smith and others.

THE CRESCENT ELECTRIC COMPANY, Chicago, Ill., capital stock \$10,000, has been incorporated by Walter H. Adams and others.

THE GILLILAND TELEPHONE COMPANY, Chicago, Ill., capital stock \$1,000,000, has been incorporated by Andrew F. Crane and others.

THE PACIFIC STETHOPHONE COMPANY, San Francisco, Cal., has been incorporated, and is to deal in stethophonic and telephonic appliances, etc.

THE COLUMBUS TELEPHONE MANUFACTURING COMPANY, New York, capital stock \$100,000, has been incorporated by Edw. S. Wallace and others.

THE BLOCK HEAT AND LIGHT COMPANY, Camden, N. J., capital stock \$100,000, has been formed by Samuel H. Robbins and others. It may be addressed.

THE QUINDARE PARK ELECTRIC RAILWAY COMPANY, Kansas City, Kan., capital stock \$200,000, has been incorporated by J. P. Moore, C. C. Dail and others.

THE MONONGAHELA MAGNETIC TELEPHONE COMPANY, Monongahela City, Pa., capital stock \$3,000, has been incorporated by C. S. Crall, Oliver Scott and others.

THE PITTSBURGH AUTOMATIC LIGHTING COMPANY, Pittsburgh, Pa., capital stock \$25,000, has been incorporated. C. H. Colbell and Lawrence Wolfel are interested.

THE CO-OPERATIVE ELECTRIC RAILWAY COMPANY, Chicago, Ill., capital stock \$1,000,000 has been formed. Morris S. Evinger, Charles E. Burnap and Isaac T. Dyer are the incorporators.

THE INTERSTATE CONSTRUCTION COMPANY, Des Moines, Iowa, capital stock \$500,000, has been incorporated by E. I. Rosenfeld and others to construct and operate railway and telegraph lines.

THE CHESTER TRACTION COMPANY, Chester, Pa., capital stock \$500,000, has been incorporated by E. Harvey, Geo. Pottelger and others, to construct and operate motors, cables and other machinery, and also to supply power to passenger railways.

THE AUTOMATIC ELECTRIC COUPLER AND TRAIN SIGNAL COMPANY, Portland, Ore., capital stock \$100,000, has been incorporated by W. E. Wamsey, Geo. W. Simons and others for the purpose of purchasing and dealing in electric car couplers, etc.

THE MAYFIELD AND LELAND STANFORD, JR., STREET RAILWAY COMPANY, Mayfield, Cal., capital stock \$10,000, has been incorporated by Alex. Pierce, Bernal Mayar, Gordon Wigle and B. L. Ryder, and the work of construction will at once be begun.

THE AMERICAN ELECTRIC COMPANY, Toledo, Ohio, capital stock \$10,000, has been formed to acquire, make and sell electrical apparatus and to control and sell patents on same. O. S. Brumback, F. H. Hurd, C. F. Wall, A. A. Thatcher and S. C. Schenck are interested.

THE HARDWARE CITY TELEPHONE AND ELECTRICAL COMPANY, New Britain, Conn., capital stock \$500, has been incorporated to manufacture telephones and to do general electrical work. A. F. Bromley, E. A. Loomis and C. B. Andrews, all of New Britain, are interested.

THE FLETCHER AND FLETCHER ELECTRIC COMPANY, Cleveland, Ohio, capital stock \$10,000, has been formed to manufacture and deal in electrical instruments and supplies of every description. H. S. Gray, J. M. Monroe, J. R. McQuigg, G. B. Riley and John Colahan are interested.

THE INDIANA TELEPHONE AND CONSTRUCTION COMPANY, Indianapolis, Ind., maximum capital stock \$300,000, has been formed to construct and operate telephone lines, machinery, etc., also railways, etc. Charles Selden, E. W. Day and C. O. Scull, Baltimore, Md., are the promoters.

THE GILLILAND TELEPHONE COMPANY, Chicago, Ill., capital stock \$1,000,000, has been formed to manufacture, sell, construct and operate telephone lines, acquire property, franchises and patent rights incident thereto. The interested parties are A. E. Crane, James Miles and H. Z. Durand.

THE WHITE-CROSBY COMPANY, maximum capital stock \$250,000, has been incorporated to manufacture and sell dynamos, motors, batteries, etc.; to construct electric railways, build power plants, etc. The promoters are James G. White, E. J. D. Cross, E. J. Silkman, H. H. Harrison and H. Wallbridge, Baltimore, Md.

CORTLAND, N. Y.—The Cortland and Homer Traction Company, capital stock \$300,000, has been incorporated to build a 12 mile road. Herman Bergholtz, De F. Van Fleet and E. H. Bestwick, of Ithaca; Horace L. Hand and Isaac L. Post, of Scranton, Pa.; H. L. Bronson and L. A. Fish, of Cortland, N. Y., are interested.

THE RUMSEN IMPROVEMENT COMPANY, Red Bank, N. J., capital stock \$100,000, has been formed to produce electricity for light and power, provide water, etc. E. Kemp, E. D. Adams, C. N. Bliss, M. C. D. Borden, H. L. Terrell, New York; W. F. Havemeyer, H. E. Owen, J. C. Hoagland, R. Hoagland, Brooklyn, N. Y., and F. W. Hope, of Red Bank, N. J., are interested.

THE CONSOLIDATED ELECTRIC IMPROVEMENT COMPANY, Camden, N. J., capital stock \$100,000, has been formed to manufacture and sell all kinds of electrical appliances, dynamos, motors, fans, switches and patented specialties of every kind. The promoters are P. E. Costello, Tacony, Philadelphia, Pa.; James Franklin, 500 Chestnut street, E. W. Patten, 3926 Walnut street, and F. A. Lee, 18 South Seventh street, Philadelphia, and T. P. Curley, 552 Federal street, Camden, N. J.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, New York, May 21, 1894.

MR. H. B. COHO, 203 Broadway, New York, who has been suffering the past two weeks with a severe attack of typhoid fever, is convalescing, and hopes to be at his office in a few days.

TRAFFIC on the trolley lines of the Atlantic Avenue Railroad Company, of Brooklyn, was suspended on Sunday, May 20, owing to a grievance of the employes in regard to a change in uniforms. The men claim that they had to buy new suits last spring and again in the fall, and that the company asks an extortionate price for the new uniforms.

THE GENERAL TERM OF THE SUPREME COURT handed down a decision yesterday affirming Justice Barrett's decision in dismissing the suit brought by Miles M. O'Brien and James G. Cannon, as receivers of the Madison Square Bank, against R. T. McDonald and the Fort Wayne Electric Light Company, to recover \$150,000 due on three promissory notes.

THE ABENDROTH & ROOT MANUFACTURING COMPANY, 28 Cliff street, New York, has issued a handsome 96-page pamphlet entitled "A Few Plain Facts Concerning Water Tube Boilers." While the matter has immediate reference to the Root boiler, yet it will be found of considerable general technical interest. We know of no textbook or other publication on boilers that contains anywhere near so much information relating to the various details of tubular boilers, their construction and the theory of their operation.

Canadian Notes.

OTTAWA, Ont., May 19, 1894.

GALT, ONT.—A general meeting of the shareholders of the Galt and Preston Street Railway Company was held last week in the council chamber of the Town Hall. Thomas Todd, president, read the report of the directors for the past year, showing that \$42,125 of stock had been taken up by 107 shareholders, on which a first call of 10 per cent. had been made. The contract for the electrical equipment had been let to the Westinghouse company for \$15,925, for the engine and boilers to the Goldie & McCulloch company for \$6,000, the building and laying of the track to J. Hartnett, of Toronto, and the contract for the cars to the Atlantic Avenue Railroad Company, Brooklyn. The total cost of the road, completed and fully equipped, is not expected to exceed \$75,000.

OTTAWA, ONT.—The Canadian Pacific Railway Telegraph Company has started the construction of a line from Kingston to Ottawa, via the Rideau Canal route. There are now 15 men working for the company in the vicinity of Kingston Mills. The contract will be finished at the end of six weeks.

TORONTO, ONT.—City Engineer Keating has returned from his visit to American cities to look into the operation of electric lighting plants under civic control. The visit has impressed upon Mr. Keating the feasibility of the city taking this service in charge to the extent at least of supplying light for the streets and public buildings. At Chicago, the last point visited, he found that even with the enormous and excessive first cost of the system, the operation of the plant is a success. The city engineer is preparing a report which will certainly favor the city undertaking its own electric lighting.

English Notes.

(From our own Correspondent.)

LONDON, England, May 9, 1894.

ELECTRICITY VS. GAS.—Both electrical and gas engineers have in this country hitherto made a point of averring that the advent of the electric light would make next to no difference in the consumption of gas. An examination, however, of statistics would appear to controvert this view. There were at the end of 1893 some 700,000 10-candle 35 watt lamps connected to the mains of the statutory electric supply companies in London, and the most reliable authorities show that on an average these lamps were alight some 400 hours during the year, so that they gave the unwieldy total of 2,800 million candle hours. Reliable tests of gas burners show that one cannot expect to obtain more than two candles from one cubic foot of London gas per hour used in an average burner. From this it can be shown that had these 700,000 glow lamps been replaced by the same number of equivalent gas burners, the gas consumption of London would have been greater by some 1,400 million cu-

bic feet than was actually the case. But this is not all. When we consider the large number of big isolated plants at work in the metropolis, we are in no danger of exaggeration if we add another 100,000 lights to the above total, making the equivalent gas consumption 1,600 millions. Now, the rate of increase between 1886 and 1891 in the sale of gas in London averaged 947 million cubic feet, the increase for 1891 being no less than 1,313 millions. In 1892, however, the very year in which electric lighting first got fairly to work, the increase in the London consumption fell to less than 35½ million cubic feet, and last year there was an actual decrease in the consumption of not less than 1,000 million cubic feet, involving a loss in revenue of £140,000. When we consider that London continues to grow, this falling off, not merely in the consumption of gas per capita, but in the aggregate, is most significant.

ELECTRIC RAILWAYS IN LONDON.—The contract for the construction of the electric tubular railway running from Waterloo Station to the city has been secured by the well known firm of Mowlem & Co., the price being £229,000, the work to be completed within 2½ years from the present time. In its eagerness to secure unusually good terms for workmen's trains, the London County Council has again succeeded in killing a suburban railway scheme. A bill giving powers to a company to run an electric or steam railway from the heart of the city to Epping Forest came before a committee of the House of Commons. The committee, at the instance of the London County Council, inserted a clause obliging the company to run workmen's trains at a penny for nine miles. The promoters of the bill now assert that unless the clause is withdrawn, the bill will be withdrawn, as it is impossible to raise capital in face of such a clause.

DEPTFORD.—The report of the London Electric Supply Corporation for the past year shows that the working of the Deptford station has resulted in a profit of £3,914, instead of the usual loss. This is stated to be mainly due to the installation in the houses of most of the consumers of an improved type of transformer.

News of the Week.

Telegraph and Telephone.

PARKERSBURG, W. VA.—A new telephone company is being organized in Parkersburg.

SALISBURY, MD.—W. B. Mitter is in the market for a complete telephone system of 60 telephones.

FLORENCE, S. C.—The Southern Telephone Company is constructing a telephone system. Franch Welch is to be the local manager.

HARTFORD, CONN.—A joint stock company has been formed to operate a new telephone system, capital stock \$50,000. R. L. Andrews and Richard Schuey are the promoters.

CARROLLTON, GA.—J. L. Lovvorn, Bowden, Ga., has purchased the telephone line running from Carrollton to Graham, Ala., and is organizing a company to continue its operation.

VERNON, ALA.—The Vernon "Courier" has built a telephone line to the nearest point on the railroad from Vernon, a distance of 12 miles, and will soon purchase the necessary equipment.

KINGWOOD, W. VA.—The Kingwood and Cranberry Telephone Company will want 40 miles of No. 9 or No. 10 galvanized steel telephone wire, brackets, glass, insulators, etc. Julius K. Monroe is the president.

TAMPA, FLA.—F. A. Salomonson, J. S. McFall and W. E. Padgett, all of Tampa, Fla., have applied for the incorporation of the Tampa and Manatee River Telephone and Telegraph Company. Capital stock \$2,500.

WASHINGTON, D. C.—The Agricultural Department is inviting, until June 6, proposals for the purchase of 130 miles of telegraph line extending from Titusville to Jupiter, Fla., comprising poles, wires, insulators, battery cells, tools, etc.

LINCOLN, NEB.—The Nebraska Telephone Company has accepted the terms of the City Council, and will begin the work of burying the wires in the business districts within 30 days. A solid fireproof building will be erected and equipped with a new switchboard.

LOCKPORT, N. Y.—City Superintendent of Fire Alarm Edward Griffin is trying to interest the Business Men's Association in the proposition of the Harrison Telephone and International Electrical Company, of New York, to put a telephone system in Lockport. Two hundred subscribers are needed.

Electric Light and Power.

CUSTER, S. D.—Residents talk of putting in an electric light plant.

TOLEDO, OHIO.—The Telephone Exchange has been completely destroyed by fire.

WILKESBARRE, PA.—The electrical works of J. G. Seitzinger have been burned.

CHESTERVILLE, S. D.—A company is being organized to put in an electric light plant.

SOUTHERN PINES, N. C.—S. M. Morfit is in the market for a lighting outfit for a hotel.

ROCHESTER, MINN.—The street lighting committee will purchase additional arc lights.

OSHKOSH, WIS.—The Board of Public Works is negotiating for electric lighting for the city.

GRAND RAPIDS, MINN.—The village authorities of Grand Rapids are taking steps towards electric street lighting.

ELKHART, IND.—The Home Electric Company has been given the contract to put in 75 arc lights for street lighting.

STILLWATER, MINN.—The plant of the Electric Light Company is buried under a mountain of sand. Loss \$25,000.

CARDINGTON, OHIO.—A bill is before the Ohio Legislature authorizing the city to issue \$25,000 in bonds to build an electric road.

BELVIDERE, N. J.—Permission has been given to the Warren Wood Working Company to introduce electric lights into the town.

MOUNT GILEAD, OHIO.—E. F. Gwynn and L. L. Denison, of Delaware, Ohio, have been granted a franchise for an electric light plant.

EVART, MICH.—Bids for the proposed electric light plant will be received till June 2, at 7:30 P. M., by C. E. Bell, chairman of the committee.

ROME, N. Y.—Architect Jacob Agne may be addressed concerning electric motor and lighting apparatus for the new county almshouse.

VALESBURG, N. J.—The Newark Electric Light Company has made a proposition to furnish electric light to the borough, but action was deferred.

TOPEKA, KAN.—Architect J. W. Perkins, 720 Kansas avenue, may be communicated with relative to electric lighting apparatus for the Santa Fe Hospital.

CHESANING, MICH.—Residents are considering water works and an electric light plant. G. L. Chapman, E. T. Long and Bert Morhouse are the committee.

LONDON, CANADA.—Address A. Ormsby Graydon, city engineer, concerning contract for lighting that city for a term of one, three, five or eight years.

CHICAGO, ILL.—The Western Electric Company, of 242 South Jefferson street, will build an addition to its factory from plans of Treat & Polz, of 58 Wabash avenue.

BUCKSPORT, ME.—The Bucksport Electric Light and Power Company was formed May 14 with a capital stock of \$10,000. It will be in need of supplies immediately.

BELLEVILLE, ILL.—City Clerk W. F. Puederer, in his report to the council, recommends that the city build its own electric light works. The plant can be put in for \$41,000.

BERLIN, PA.—The Berlin Town Council has made a contract for lighting the streets of the city by oil lamps, which would seem to do away with the proposed electric street lighting.

SAN ANGELO, TEX.—The San Angelo Electric Light Company will increase its plant by adding an 80-h. p. compound engine with boiler, pump, heater and extractor and all connections.

MACON, GA.—The Macon Gas Light and Water Company has been placed in the hands of a temporary receiver. A hearing is to be had May 15 relative to making the receivership permanent.

LAKE CITY, FLA.—The Lake City Ice, Light and Water Company will erect an electric light plant with 30 arc, 1,200-candle power, and 300 16-candle power lights. Wm. R. Bush is manager.

LANCASTER, WIS.—Meyer & Shawalter are asking for an exclusive franchise for 15 years to operate an electric light plant, and they will be in the market for the necessary equipment when the matter of a franchise is settled.

SOUTH MILWAUKEE, WIS.—The Electric Light Board and W. M. William, owner of the plant, are at odds as regards price. The village president states that they cannot afford to take a step backward, even if the board had to take charge of the plant.

ROCHESTER, N. Y.—The petition of the Central Light and Power Company for right to construct an underground conduit on Main street is being opposed by the Rochester Gas and Electric Company, and the executive board is trying to compromise matters.

HEMPSTEAD, L. I., N. Y.—The Hall Electric Light Company, which succeeded the first electric light company, finds that business in Hempstead is unprofitable, and it has given notice that after June 10 all lamps and fixtures will be removed from the stores.

CAIRO, EGYPT.—Address Frederick C. Penfield, United States Agent and Consul General, regarding bids invited by the Khedive for the proposed concession for constructing and operating a system of electric tramways in Cairo and its environs. The bids are to be opened August 1.

NIAGARA FALLS, N. Y.—Secretary Wm. R. Rankine, of the Cataract Construction Company, has authorized John J. McIntyre, who is interested in property in Grand Island, to secure right of way across the island and to erect poles and string wires for the purpose of transmitting power.

HARLEM, ILL.—The Village Council has appointed W. F. Frechs, of Oak Park, to make plans for the village electric light plant, and the board will call for bids at an early date. They will

require a 100-h. p. boiler and a 100-h. p. engine for the power house. The lighting will be done by 300 incandescent lights.

BROOKLYN, N. Y.—The gas and lamp committee reported in the matter of the application of the Kings County Electric Light Company, Noah Cocheu, president, for a franchise, that they were in favor of granting same on certain conditions, but on motion of Alderman Gullfoyle the matter has been laid over for a week.

MARTIN'S FERRY, OHIO.—It is stated that the injunction gotten out against the proposed civic electric light plant was procured by opponents on the ground that the vote was taken 17 days before the time advertised by law, whereas 30 days are required. There seems to be no doubt that the scheme will be pushed to completion.

JACKSON, TENN.—S. C. Lancaster, city engineer, may be addressed regarding bids to be opened June 1 for furnishing the city for five years with the privilege of 50 300-candle power arc lamps for street illumination. The city government will grant a franchise for the exclusive operation of an incandescent plant for domestic use for five years.

LEADVILLE, COL.—An electric lighting company has been formed by the prominent business men of Leadville for the purpose of furnishing the city with light and power. The company is incorporated under the name of "The Citizens' Electric Light Company," with officers as follows: J. M. Maxwell, president; H. H. Tomkins, vice president; D. La Salle, secretary and treasurer, and Geo. P. Brown, general manager, and will be in competition with the Leadville Electric Light and Power Company, who have enjoyed the exclusive privilege of lighting the city for about 10 years. The Citizens' Electric Light Company has amply proven its staying qualities in an injunction suit brought against it by the old company, by whom a temporary injunction was obtained on the ground that it was impossible for the new company to operate a plant in the same town without great and irreparable damage to the plaintiff's wire, machines and apparatus. The case was tried before Judge Dickson and the injunction denied. Messrs. Shepard and Searing, consulting mechanical and electrical engineers, have been placed in charge of the design and installation of the complete plant, and are expected to make it one of the model plants of the State. The station will have an ultimate capacity of 3,000 incandescents and 150 arcs.

The Electric Railway.

MONTREAL, CANADA.—The Montreal Street Railway Company is to erect a \$14,000 building for motor cars.

JAMAICA, L. I., N. Y.—On May 21 will be heard the petition for another electric railway from Jamaica to Rockaway.

WESTERLY, R. I.—The Town Council has granted a franchise, as asked for, to the Pawtucket Valley Street Railway Company.

WASHINGTON GROVE, MD.—Thomas E. Brooke and others are interested in the construction of an electric railway to Sandy Springs.

JACKSONVILLE, FLA.—L. R. Benjamin will soon begin work on a dummy line from Jacksonville to Gillea, to be changed later to electric power.

WESTERLY, R. I.—The proposed electric railway from Westerly to Watch Hill is now assured, and E. P. Shaw states that that road will soon be in operation.

NASHVILLE, TENN.—The Overland Electric Railway was sold by order of the court on May 11, subject to \$100,000 mortgage bonds. R. W. Hunter bought the road, paying \$10,433.

STILLWATER, MINN.—The freeholders who bought the street railway will organize a company with a capital stock of \$75,000. The line will be extended and additional stock purchased.

TROY, N. Y.—The Troy and New England Railway Company, which proposes to build an electric railway through the town of Sand Lake, will be given a hearing at Averill Park on May 31.

NIAGARA FALLS, N. Y.—J. W. Hoffmann and Chas. A. Simms, of Philadelphia, Pa., have been in Niagara Falls looking over the ground for the proposed double track electric railway from here to Buffalo.

RANDALLSTOWN, MD.—The Randallstown, Granite and Harrisonville Rapid Transit Company has applied to the Baltimore County Commissioners for permission to extend its electric line along certain roads.

JASPER, N. Y.—The proposed electric railway between Jasper and Genesee seems to be an assured fact in the near future. The names of the promoters have not yet been published, but details will soon appear.

CORTLAND, N. Y.—The Cortland and Homer Electric Railway Company, which was granted permission to change its motive power from horse to electricity, states that it will have the road completed about August 1.

DALLAS, TEX.—The Dallas and Fort Worth Rapid Transit Terminal Railway Company and the West Dallas Railway are reported to have been purchased by Henry C. Scott, president of the St. Louis Trust Company. Improvements are to be made and the motive power may be changed to steam.

BELLEVILLE, ILL.—The Belleville Electric Railway Company has closed a deal with the East St. Louis Electric Railway Com-

pany for terminal privileges in East St. Louis, and it will construct an electric line between these two towns at once.

WEST UNION, OHIO.—The County Commissioners have been petitioned by Frank E. Holiday, of Boston, Mass., for a franchise for an electric railway from Manchester, by way of Bentonville, to West Union. Right of way has been given by residents.

BALTIMORE, MD.—Architect Henry Brauns has completed plans for the new power house of the City and Suburban Railway Company, and contracts will soon be awarded. The building will cost \$150,000, and the electric equipment will bring the cost to \$500,000.

ST. LOUIS, MO.—The Bellefontaine Electric Road will build a \$5,000 addition to its plant at 20th and Bissell streets. The increase in power is intended for the Herbert street division, which is to be extended to Sportsmen's Park. The office of the company is at 4238 North Twentieth street.

SCRANTON, PA.—Mayor W. L. Connell has written to General Manager Archer, of the Traction company, stating that as the company had not complied with the terms of franchises granted to it for certain streets, and the time for same having expired, the franchises are null and void.

PHILADELPHIA, PA.—A franchise has been granted at Harrisburg to the Diamond Street Railway Company to operate by any other power than steam a street railway on Diamond and other streets in Philadelphia, Pa. The incorporators of the company are Henry C. Moore, David C. Golden, Thomas B. Foote and Joseph C. Lugar.

CAMDEN, N. J.—Articles of incorporation for the Midland Improvement Company have been filed in the office of the county clerk. The capital stock of the company is \$100,000, and they propose to build, equip, purchase and operate electric street railways. The incorporators are C. Henry Allen, of Moorestown; Ephraim K. Allen, of Philadelphia, Pa., and Henry L. Washburn, of New York.

PHILADELPHIA, PA.—Charters have been issued at Harrisburg for the following companies to operate in Philadelphia, all having the same incorporators: The Citizens' North End Street Railway Company, the Citizens' Clearfield and Cambria Street Railway Company, the Brown and Parrish Street Railway Company, and the Citizens' East End Railway Company, all to be operated by any power except locomotives. Jeremiah J. Sullivan, Robert C. Brewster, and George S. Gandy are interested.

JAMAICA, L. I., N. Y.—The Long Island Electric Railway Company, which is stated to be the local name of the Pennsylvania Traction Company, is applying for a franchise for an electric road from Brooklyn to Patchogue, and the highway commissioners have agreed to grant the franchise, subject to certain stipulations to be detailed hereafter. Jere Wernberg, of Brooklyn, is counsel for the company, and the officers are A. R. Hart, of Brooklyn, president; C. H. Mullin, of Mount Holly Springs, Pa.; Clarence Wolf, and J. C. Von Arx, of Philadelphia, Pa.

Trade and Industrial Notes.

THE CARPENTER ENAMEL RHEOSTAT COMPANY, Hoboken, N. J., has made another notable reduction in the price of rheostats for motors from 1-12 to 2 h. p.

THE GENERAL ELECTRIC LAUNCH COMPANY has just sold an electric launch to Cornelius Vanderbilt, for use at Newport. It will be equipped with the Consolidated Electric Storage Company's batteries.

THE AUTOMATIC ELECTRIC SPECIALTY COMPANY, 136 Liberty street, New York, which has the agency for the sale of the Hoggson electric date and time stamp, is daily appointing sub-agents throughout the country.

MR. M. H. JOHNSON, formerly of Milwaukee, has opened an office as consulting electrician in the Martin Building, Utica, N. Y. Mr. Johnson has had varied experience in this line of work, and will no doubt meet with well merited success.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is placing upon the market a complete magneto telephone system for private lines and office and factory exchanges. The principal feature of the system is in its Acme magneto telephone.

MR. CHARLES F. FOSTER, late mechanical engineer of the World's Columbian Exposition, has opened an office at 1411-1412 Manhattan Building, Chicago, Ill. Mr. Foster intends to carry on a general engineering business, for which his past experience has well equipped him.

THE MILLER ELECTRICAL WORKS, of North Fourth street, Philadelphia, though very recently established, are very busy repairing armatures and commutators with the Miller tempered copper, which apparently is an innovation in tempered copper. It is claimed that there is practically no wear to this material.

THE INTERIOR CONDUIT AND INSULATION COMPANY, 44 Beard street, New York, has issued a handsome 56-page catalogue embodying descriptions of all Lundell machines up to date, including fan outfits. The binding, paper and presswork are of the highest quality, and it is only necessary to say that the admirable cuts are by Bartlett.

THE ELECTRIC SELECTOR AND SIGNAL COMPANY, 45 Broadway, New York, has completed a new type of electric light

and power controller, which is much simpler and cheaper than that formerly manufactured by it. Notable improvements have been introduced in the mechanism under new patents, so that the controller is now practically perfect.

THE AUTOMATIC SWITCH COMPANY, 703 Equitable Building, Baltimore, Md., has received some flattering testimonials in regard to its automatic motor starters. The Michigan Electric Company, of Detroit, states that in one case its use reduced the cost of running an electric elevator from \$35 to \$7.50 per month, and the Boston Electric Company speaks of its good qualities in strong terms.

I. P. FRINK, 551 Pearl street, New York, is making a reflector for arc lamps suitable for lighting very large spaces, similar to a parabolic reflector, but larger, and lined with silverplated corrugated glass cut in small pieces to break up the light and diffuse it thoroughly. Mr. Frink has recently installed a large number of these reflectors in Buffalo Bill's Wild West Show, South Brooklyn.

EDWIN HARRINGTON, SON & CO., Incorporated, 1527 Pennsylvania avenue, Philadelphia, have issued a pamphlet descriptive of apparatus for the economical handling of heavy central and power station machinery, consisting of differential hoists, overhead tramways, travelling cranes, travellers, turn-tables, etc. Station managers and others will find it to their interest to look up these standard equipments.

THE D'ESTE & SLELEY COMPANY, of Boston, reports a largely increased sale of the Curtis engineering specialties, being 20 per cent. more in 1893 than in any previous year; also that its sales are steadily increasing this year over last. Among recent sales it reports a third order from the American Sugar Refining Company, of New Orleans, for 24 Curtis balanced steam traps, with condensing capacity for 30,000 feet of pipe each; also a large combined reducing and relief valve for the Rock Cliff Water Company, of New York.

HILL BROS. & CO. and A. C. Sneed & Co., of Waco, Tex., the firms consisting of B. H. Hill, N. S. Hill and A. C. Sneed, on May 1 dissolved by mutual consent. B. H. Hill and N. S. Hill assume all liabilities of the firm of Hill Bros. & Co., and all amounts due said firm are payable to them. They will continue in business at the former stand of Hill Bros. & Co., No. 325 Austin avenue, under the firm name of Hill Bros. A. C. Sneed assumes all liabilities of the firm of A. C. Sneed & Co., and all amounts due said firm are payable to him. He will continue in business at the former stand of A. C. Sneed & Co., No. 402 Austin avenue, under the firm name of A. C. Sneed & Co.

THE GENERAL ELECTRIC COMPANY reports the following orders for railway apparatus taken during the past week from the New York office alone: Brooklyn, Queens County and Suburban Company, 450 motors; Bridgeport (Conn.) Traction Company, 60 motors and generators; Danbury (Conn.) Street Railway Company, 20 motors; New Haven (Conn.) Street Railway Company, 20 motors and generators; Hart (Conn.) Street Railway Company, 8 motors; Allegheny Traction Company, Pittsburgh, Pa., 30 motors and generators; Jacob Rich, San Jose, Cal., 2 equipments and generators; W. B. Ferguson, Boston, generator; Franklin, Pa., 6 motors; Electric Traction Company and People's Traction Company, Philadelphia, Pa., large marble switchboards.

J. GRANT HIGH & CO., of Philadelphia, have recently gone into the manufacture of switchboards of all sizes. This company has just shipped two fine boards, fitted up with quick break switches, to the Ringing Rock Electric Railroad Company, at Pottstown, Pa., and is now very busy making a very elaborate switchboard containing 185 feet of Italian marble, and which will have 34 circuits. The particular feature of this board is that the back will have a closet with bevel French plate glass doors, thus showing all the back connections. The fuse connections are so arranged that on the failure of the first fuse, the second one is automatically thrown in. Mr. Eyanson, treasurer of the firm, is bringing out a new quick break switch, which he expects to put on the market very shortly.

MR. C. J. FIELD and the Field Engineering Company, with which company the former has been identified since its organization as president and chief engineer, are making a number of changes in their business. They have been identified as engineers and contractors with some of the largest electric railway and central station construction work, and have also been associated with several of the large syndicates as their engineers. Mr. Field and Messrs. Bourne and Cook, who have been connected with him in the management of the company, have determined, owing to the large demand for such services, to devote their time entirely to consulting and supervising engineering work, and to discontinue their interests in construction work. They are, therefore, arranging to gradually wind up the business of the Field Engineering Company, and to continue the engineering and consulting business under the name of C. J. Field, consulting engineer. They will continue to do business in the same offices and location in the Central Building, New York, where they have been located for the past four years. They are at present acting in this capacity for several large roads and banking interests. The wide experience of Mr. Field, who has largely outlined by his work in the past the present practice in the design and construction of central and power stations, will give him an enviable advantage in the field to which he will hereafter confine himself.

THE HOPPES MANUFACTURING COMPANY, Springfield, Ohio, reports the following sales: Edison Illuminating Company, Monmouth, Ill., 625-h. p. live steam purifier; Columbus (Ohio) Electric Light and Power Company, 2,000-h. p. exhaust steam heater; Delaware (Ohio) Electric Light and Power Company, 500-h. p. live

steam purifier; Bay City (Mich.) Union Railway Company, 400-h. p. live steam purifier, and 400-h. p. exhaust steam heater; Oconomowoc (Wis.) Electric Light Company, 200-h. p. exhaust steam heater; Freeport (Ill.) Gas Light and Coke Company, 200-h. p. exhaust steam heater; Citizens' Street Railway Company, Muncie, Ind., 250-h. p. exhaust steam heater; Heat, Light and Power Company, Muncie, Ind., 200-h. p. exhaust steam heater; Muscatine (Iowa) Electric Railway Company, 400-h. p. exhaust steam heater; Columbus (Ohio) Street Railway Company, 1,000-h. p. live steam purifier; Omaha (Neb.) Gas Manufacturing Company, 200-h. p. live steam purifier; Elmira (N. Y.) Illuminating Company, 1,000-h. p. live steam purifier; Citizens' Gas and Electric Company, Jacksonville, Fla., 80-h. p. live steam purifier; East River Gas Company, Long Island City, N. Y., 625-h. p. live steam purifier; Edison Electric Light Company, Dayton, Ohio, 750 h. p. live steam purifier; Calumet Electric Railway Company, Burnside Crossing, Ill., 1,000-h. p. live steam purifier; Shreveport (La.) Gas, Electric Light and Power Company, 200-h. p. exhaust steam heater; Waco (Tex.) Electric Railway and Light Company, 800-h. p. exhaust steam heater; People's Traction Company, Philadelphia, Pa., two 3,000-h. p. exhaust

steam heaters; Public Lighting Commission, Detroit, Mich., seven 3,000-h. p. live steam purifiers.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 195 South Warren street, Syracuse, N. Y.

THE CONSOLIDATED ELECTRIC STORAGE COMPANY is now making a special type of battery for the General Electric Launch Company—strong, durable and of good capacity. Address, Edison Building, New York, or Drexel Building, Philadelphia.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. **THE HAYDEN-BOOKER MANUFACTURING COMPANY.** 2140 DeKalb St., St. Louis, Mo.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED MAY 8, 1894.

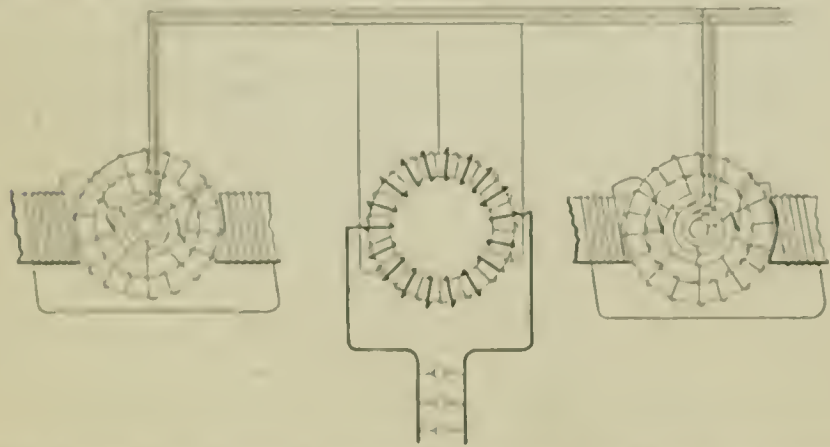
(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

519,325. **CONTACTING DEVICE FOR ELECTRIC RAILWAYS;** D. F. Graham, Springfield, Ohio, and W. P. Allen, Chicago, Ill. Application filed Oct. 25, 1893. The combination with conductors of hinged bars carrying grooved wheels, a hollow standard supporting the bars, and insulated conductors extending from the hinged bars through the standard.

519,329. **GALVANIC BATTERY;** C. W. A. Hertel, Berlin, Germany. Application filed July 14, 1893. The combination of a containing vessel, carbon electrode, porous carbon cylinder, zinc electrode within the same, and a glass rod passing through the stem of the electrode and resting upon the top of the cylinder.

519,331. **CARBON HOLDER FOR ARC LAMPS;** E. Lavens, Brooklyn, N. Y. Application filed Sept. 30, 1893. The combination of a base piece, two arms pivotally connected to each other, and a cam or wedge movable between the arms so as to move one of them relatively to the other.

519,335. **REACTIVE COIL;** H. Lemp, Lynn, Mass. Application filed Nov. 21, 1889. This comprises a sectional conductor and a conductor on locally closed circuit, and adjustable in inductive relation to the first, switch contacts and connections to the terminals of the sectional conductors for changing the sections from series to series-multiple or to multiple, and vice versa.



NO. 519,376—ALTERNATING CURRENT TRANSFORMER.

519,336. **ELECTRIC WELDING MACHINE;** H. Lemp and C. G. Anderson, Lynn, Mass. Application filed May 26, 1891. This comprises a movable work holder, an adjustable stop connected therewith, a contact in the path thereof, and a cut-off magnet, the circuit of which is connected to the contact.

519,338. **ELECTRIC SWITCH;** J. F. McElroy, Albany, N. Y. Application filed Aug. 2, 1893. This comprises a cylinder having coiled passageways, a series of metallic plugs placed within the ways, the plugs being substantially flush with the surface of the cylinder and insulated from the periphery thereof.

• 519,376. **ALTERNATING CURRENT TRANSFORMER;** C. S. Bradley, Avon, N. Y. Application filed March 15, 1892. This comprises a polyphase alternating current circuit of a transformer having a closed coil winding connected with the several wires of the polyphase circuit, the transformer being provided with a closed coil secondary winding, tapped at two opposite points for connection with the distribution circuit. (See illustration.)

519,377. **GENERATING AND UTILIZING ELECTRIC CURRENTS OF HIGH POTENTIAL;** C. S. Bradley, Avon, N. Y. Application filed Nov. 10, 1892. A generator mounted upon supports insulated in oil and provided with an insulated platform upon which an attendant must mount to gain access to the machine.

519,380. **CONDUIT ELECTRIC RAILWAY;** J. F. Cook, Mansfield, Pa. Application filed Feb. 5, 1891. This consists of sections of earthenware or other non-conducting hollow boxes placed end to end and provided with an opening at the side and a top or shield

somewhat wider than the bottom projecting out over the opening, the conducting wire being supported at intervals by cross wires insulated from and attached to the inside faces of the sides.

519,382. **SAFETY WATER COLUMN;** H. Engel, Cleveland, Ohio. Application filed Feb. 9, 1894. This comprises a vertically moving rod, and a push rod through the column, and a shoe on the inner end of the rod, and a part with two separated contact points to bear against the shoe and actuated by the float rod.

519,446. **TROLLEY WIRE HANGER;** A. B. Crouse and A. Rutledge, Passaic, N. J. Application filed July 21, 1893. A trolley hanger provided with an insulating cup containing a liquid insulating medium, in combination with an adjustable cup or cover.

519,482. **ELECTRIC ACCUMULATOR OR SECONDARY BATTERY;** A. J. Smith, London, England. Application filed July 20, 1893. This consists in repeatedly coating a metal sheet or plate with a metallic oxide and driving or kneading the oxide into the metal by means of pointed rods or needles.

519,497. **ELECTRIC FIRE ALARM TRANSMITTER;** A. Dunish, Ravenna, Ohio. Application filed Jan. 16, 1894. This comprises movable and stationary binding posts, a cord easily separable by heat, a rod connecting the cord with the movable binding post and retaining it from contact with the other binding post.

519,519. **TROLLEY WIRE CROSSING;** E. H. Allen, Cramer's Hill, N. J. Application filed Feb. 2, 1894. The combination of a central insulating block, projecting arms and plates whereby the arms are secured to the insulating block.

519,602. **STORAGE BATTERY PLATE;** C. P. Elleson, London, England. Application filed Oct. 26, 1893. A plate built up of parallel layers of corrugated and perforated metal, the corrugations of one layer being at an angle to those of the adjacent layer.

519,621. **TROLLEY WIRE HANGER;** C. F. Strasburg, Lincoln, Neb. Application filed Aug. 31, 1893. A trolley wire clamp having a rectangular groove for the trolley wire, substantially coextensive with the body portion of the clamp and continuous.

519,634. **ELECTRICAL TEMPERATURE ANNUNCIATOR;** E. Kloss, Stettin, Germany. Application filed Dec. 22, 1893. This comprises a casing closed by a diaphragm, a projection fixed to the diaphragm and adapted to close an electric circuit, and an adjustable screw arranged parallel to the diaphragm, the screw forming a cone at its end adapted to limit the movements of the projection.

519,662. **ELECTROMAGNETIC TOOLS;** C. F. Carpenter, Louisville, Ky. Application filed June 20, 1891. This comprises end magnets separated from each other, and a central magnet carrying an alternating current having a loose armature coil reciprocating between the inner extremities of the cores of the end magnets, and a bit operating hammer rod carried by the armature core.

519,674. **ELECTRICAL PROPULSION OF RAILWAY CARS;** J. J. Hellmann, Belfort, France. Application filed Dec. 18, 1890. An electrically propelled train consisting of a plurality of vehicles, the ends of which are provided with wings adapted to open outwardly on vertical axes, and when shut to cover the space between the vehicles and preserve the skin continuity of the train.

519,686. **METHOD OF OPERATING ELECTRIC MOTORS;** J. S. Bancroft, Philadelphia, Pa. Application filed Dec. 15, 1892. This comprises two or more motors with current for the fields, a reversing switch for the armature circuit of each motor, a rheostat controlling the potential of the armature current and means for interlocking the actuating parts of the reversing switches with the actuating part of the rheostat.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., 353 Broadway, New York.

The Electrical World.

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RAPID TRANSIT FOR NEW YORK.

When Governor Flower last week, reluctantly acting under the pressure of public opinion, signed the Rapid Transit bill for New York City, he relieved his feelings by pointing out that after all the measure was so encumbered that it was doubtful if the public would derive any benefit from it. The opposition of politicians everywhere to underground projects of rapid transit is very significant. In such schemes they see no visions of franchises to be bargained for, no chance of employment of "pulls" in condemnation and damage proceedings, no campaign and personal contributions to be extorted for immunity from interferences in the operation of the property. The fact that underground roads are the only solution of the rapid transit problem plays no figure with our rulers—how to accumulate the greatest amount of "boodle" for themselves or their followers is the only problem that interests them, and to this the building of elevated railways offers a more satisfactory solution. The friends of rapid transit do not despair of finally overcoming the numerous obstacles placed in their way, and as they are committed to the underground system, which implies the adoption of electric traction, they have the warmest sympathy of all connected with the electrical industries.

THE CANDLE POWER OF ARC LAMPS.

Prof. Mendenhall, at the recent Washington National Electric Light Convention, when discussing the subject of the rating of arc lamps, humorously referred to the statement of a foreign electrician that in America the candle power of arc lamps was arrived at by taking a photometric measurement from each of the cardinal points of the compass, adding the results together and calling the sum the candle power of the arc. That the original author of the witticism or any of the gentlemen of the Association really believed there was any foundation in fact for this statement we very much doubt, but we are now able to announce that there is at least one "electrical expert" who not only believes in that novel method of determining the candle power of an arc, but has actually expressed himself officially to that effect. The Board of Public Works of a city not so very distant from New York recently applied for expert advice relative to a clause in a street lighting contract with a local electric light company, and the following is the manner in which it was enlightened: "The arc lights are hung at the street intersections, and each one throws its light in four directions; 2,000 c. p. of lights on each of the four streets cannot, therefore be expected. An arc light which throws 500 c. p. of light along each of four streets is a 2,000-c. p. lamp, as called for in the contract."

THE PRACTICAL MAGNETIC UNITS.

In a recent number of "L'Industrie Electrique" Prof. Hospitalier welcomes the provisional names recently adopted by the American Institute of Electrical Engineers for the C. G. S. magnetic units, and states that he will introduce them into the coming edition of the "Formulaire de l'Electricien"—a work which is accepted and used as a standard by electricians in every country in the world, and will therefore give a wide and authoritative circulation to the new practical system. He refers to the great need of names that existed for the designation of the principal magnetic units, and most strongly counsels, as a matter of great practical importance, the adoption by electricians of the gauss, gilbert, weber and oersted, "in spite of opposition from the savants of pure theory, who have no need to give a concrete

form to their ideas and formulas." Scientific men in America, fortunately, are not separated into castes antagonistic to each other, and as our "savants of pure theory," if, indeed, that narrow term is at all applicable here, do not consider "practice" as unworthy their consideration, we need not in this country fear the opposition referred to by Prof. Hospitalier. The great benefit to be derived from the new terms must have impressed itself upon the audience at the recent Institute meeting at Philadelphia when in the discussions they had contrasted the expressions "15,000 lines per square centimetre" or "15,000 C. G. S. lines per square-centimetre" with "15 kilogausses."

THE JUBILEE OF TELEGRAPHY.

Fifty years ago, on May 24, 1844, the first public message was received in the United States by the Morse recording telegraph, having been sent over a line erected between Baltimore and Washington. With those wonderfully appropriate words, "What hath God wrought," was inaugurated nothing less than a new era of civilization, and a blessing conferred upon man to which the inventions of writing and printing were only comparable. From the two temporary offices used on that memorable day have sprung the little less than half million now distributed over the face of the earth, and the progeny of that first message now numbers almost 300,000,000 annually. The beginning of the growth which has culminated in these figures can rightly be ascribed to the event mentioned, for it gave the commercial impetus which resulted in the rapid spread of telegraphy over the world, though the only invention concerned was the recording instrument then used. Previous to 1837, the date of publication by Morse of his invention, numerous experimental forms of electric telegraphs had been devised, and in that same year the needle telegraph, or alternate right and left deflection instrument, was made practically perfect, and put in actual operation in 1838 on the line of the London and Blackwall Railway in England by Cooke. It is worthy of note that while this latter system of telegraphy, but with one instead of two needles, is yet much used in England, particularly in the auxiliary offices of large cities, the Morse recorder has become largely a thing of the past. The service the latter rendered, however, by accomplishing what was then considered to be the *sine qua non* of practical telegraphy—the actual recording of messages—was an immense one, and, united to the no less great services of the inventor through his indefatigable efforts in pushing the invention commercially, justly entitle Morse to be considered the "Father of Practical Telegraphy," though, at the same time, the work of Henry, Davy, Cooke, Vail and others should receive a due share of credit.

THE INSTITUTE AND UNDERWRITERS' ELECTRICAL INSPECTION RULES.

Owing to its national character and the professional standing and influence now possessed by the American Institute of Electrical Engineers, too much care cannot be taken in lending the weight of its authority to measures asking its indorsement. The necessity of exercising the greatest caution in this respect was illustrated at the recent annual meeting at Philadelphia, where the Institute was asked to adopt a set of "Standard Rules for Electrical Construction and Operation" prepared by a committee of the National Electric Light Association. Though the intrinsic value of the rules is undoubtedly very great, and the services of the National Electric Light Association in taking up the subject of insurance rules have had a most valuable effect in the past, the result of an indorsement by the Institute would make it a party to a feud with the Underwriters' Association of Electrical Inspectors, a number of whom are members of the Institute. While we cannot indorse the action of that body in adopting almost bodily, as they did, the former rules of the National Electric Light Association without giving

the proper credit, nor the narrow policy pursued in excluding from its deliberations some who should have been invited, yet its work should first be impeached before the Institute takes an action whose effect would be to injure it. Formerly electrical inspection was in a chaotic state, almost every insurance inspector having his own set of rules. In one place one set of rules was enforced and a different set in another place, and all subject to constant change without notice. In those days it was war when the contractor and inspector met over a piece of work, not the least cause being the facility with which one code of rules could be set up against another. The Electrical World referred editorially to this matter almost two years ago as follows: "The present state of electrical insurance inspection is extremely unsatisfactory, and this is largely due to the non-uniformity of rules and methods. When one inspector under one set of rules can pass work that another inspector under his rules would have to condemn, the result can only be to bring electrical insurance inspection into disrepute generally, and render the duties of the inspectors difficult and disagreeable to perform. Perhaps the greatest boon from the adoption of a uniform set of rules would be to reputable electric light contractors, who are now harassed by the different sets of rules in force and who, under the healthy system the new regime should inaugurate, would have some protection from the horde of incapables now doing shameful electrical work." To obviate this great source of trouble, which bore almost equally on the inspector and contractor, a code of rules based upon the excellent one of the National Electric Light Association was, after long and careful deliberation by a body composed of underwriters' electrical experts, adopted more than a year ago, and is now used with scarcely an exception by all the various underwriters' associations of the United States. If the effect of the adoption of a set of insurance rules by the Institute would be to cause the underwriters to substitute it for their own, then the consideration of such an action would of course be unobjectionable. But the latter would probably do nothing of the kind, as they would claim, and with reason, that it would be absurd for them to thus confide to others the protection of the immense money interests they have at stake in the matter. With two sets of rules, one having the high professional indorsement of the Institute, there would be a return to the old state, and as the underwriters, unlike the Institute, would have the power to enforce their rules, the only result would be a highly unsatisfactory state of affairs to both electrical contractor and insurance inspector. Should any of the present underwriters' electrical rules be unjust to electrical interests, then it would of course lie within the province of the Institute to attempt to bring about the necessary change, and it is probable that any recommendations on its part would receive proper consideration. By co-operation in an advisory capacity, it could render valuable service to both the electrical and insurance interests, but it would not be proper policy for it to adopt a rival set of rules which necessarily, as remarked before, could not be enforced and would only lead to the renewal of a bitter warfare between two interests which had become largely harmonized. The report of the Institute committee was against the summary adoption of the rules submitted, but as it was not discharged the matter may come up again.

Production of Copper.

The "Engineering and Mining Journal," in a table compiled by its editor, Richard P. Rothwell, on the mineral production in the United States in 1892 and 1893, gives the quantity of copper mined in the latter year as 322,585,500 pounds, valued at \$34,677,940 at the place of production. This shows a falling off of 2,914,500 pounds, and \$2,038,460 from the figures of the previous year.

SWITZERLAND AS THE PRESENT ELECTRICAL CENTRE OF EUROPE

BY FREDERICK BATHURST.

The above title may be taken either literally or in metaphor, as it may appeal to the individual reader, but the writer asks permission to use it as the heading under which, through the medium of *The Electrical World*, he can put before American electricians some particulars of one or two of the more recently installed electrical plants of Switzerland. It is thought that these representative installations, while presenting in themselves novel features of considerable interest, also indicate in no small degree the direction in which the most approved electrical practice tends to advance.

Switzerland, it is true, is small, even as a centre minute in size, with its 3,000,000 people cooped up within an area one-third that of New York State, for example, and it has already become to be generally recognized as a field wherein there is considerable electrical activity, but it is perhaps only

fore the time arrives for arranging the summer holiday tour, we have not before us this year the distraction of a Columbian Exposition, but instead a Continental display—Antwerp—and perhaps many may be induced to extend their annual peregrination so as to include this, in which case I would suggest the slight further extension into the Swiss mountains, as one that would well repay the electrical explorer, both hygienically and scientifically.

Entirely surrounded by large countries, France, Germany, Austria and Italy, all nations which are impoverishing themselves by their dread and jealousy of each other, each maintaining large armies of non-productive workmen, little Switzerland, with enlightened policy, prefers to remain impartially neutral to all, and allow its people to live as producers instead of soldiers. Mother Nature, although so generous of wealth in other potentialities, would seem to



THE TOWN OF ZURICH, SWITZERLAND.

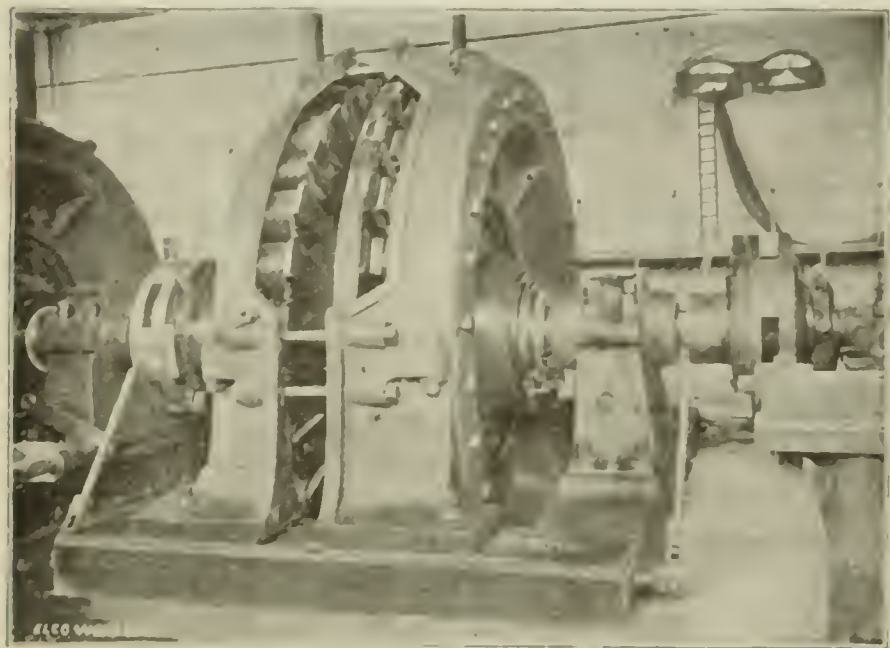
the few electricians who may have visited this lovely little country, either for health or pleasure, who have noticed how thoroughly progressive the Swiss are in their electrical work, how high they stand in comparison with Americans or Europeans, and what praise should be accorded to them for the design, execution and stability of their installations.

As a further reason, for introducing this theme just be-

have forgotten to provide the all-important natural resource, coal, which would tend to confirm the political policy, but possibly only to give cause for the remark that the Swiss people combine to their advantage, as their national characteristic, the artistic culture of the Italian, the energy of the Frenchman and the perseverance of the German, and to stand as a further proof that the harder natural conditions

always combine to bring forth a type of man suited to rise superior to the physical deficiencies. In any case, the absence of coal renders necessary the utilization of the substituted resources, and develops the numerous water powers.

Electricity has taken its place as the medium, par excellence, by which power may be transformed and transmitted, so that it is not unnatural to find it here receiving



200-KW. ALTERNATOR COUPLED TO TURBINE.

rapid and extended application. The conditions are also such that not only is capital more willing to find investment in the neutral field, but a larger market is open to the productions therefrom, for none of its neighbors will buy from another a commodity which it may by natural or created advantage be better fitted to supply, for fear that by so doing it may benefit the rival and thereby indirectly injure itself. Any extension of demand that Switzerland receives for its productions from these causes again reacts to promote further developments in its initial powers and again increases the demand for electrical apparatus.

In order to show the high standard that such apparatus has attained, and the engineering skill and judgment with which it is installed, I propose to instance as typical installations—First, for light, the electric lighting of the town of Zurich; second, for power, the transmission to and installation in the Oerlikon Electric Works; third, for electric railways, the Zurich-Hirslanden Street Electric line.

1.—THE ELECTRIC LIGHTING OF THE TOWN OF ZURICH.

This installation is of considerable interest, from the fact that although in a town that cannot lay claim to be in the first rank as regards number of inhabitants (Zurich has a population of 110,000 people), it is at present the largest electric system of supply yet installed in which a high pressure alternating current is distributed through a complete network of underground mains arranged in districts, wherein are placed separate transformer stations, and from which, as centres, a low pressure supply is obtained. It is again more interesting because it is the utilization of a water power.

Coming into the centre of the town by the railway, it is but a few minutes' walk to the offices of the "Elektricitäts-werk der Stadt Zurich," on the Bahnhof Bridge. It is here that the engineers can be found, and all information relating to the work will be most willingly given. I wish to record my indebtedness to the engineer-in-chief, Herr W. Wyssling, and his able assistant, Herr Hans Buechler, for the courtesy and willingness with which they placed all the particulars and privileges before me, and to say that it is a pleasure in store for any electricians who intend to visit Zurich to meet these gentlemen.

Like all the most enterprising and enlightened municipalities, the town council of Zurich has been wrestling with the question of electric lighting for many years past, although

(and perhaps in this respect unlike other municipalities) they, from the very first, decided that any work which was done should be in the hands of the municipality itself.

Experiments were made with various systems and technical assistance was asked from the best known experts in Switzerland. Ultimately, from among the various plans submitted, the choice was made in April, 1890, in favor of an alternating system having one central station and many transforming centres, but it must in fairness be said that this choice was largely determined by the argument that, if afterward necessary, these same transforming centres could be conveniently utilized as centres, with alternating motors, from which district accumulators for a direct supply system could be charged. The first accepted plans also comprised a direct current series system of arc lighting, the lamps on which were to be placed on the principal streets and lake front. Passing through the usual delays and vicissitudes, the system, as it now stands, started to supply current in August, 1892.

The same building which contains the electrical department's offices contains also those for the municipal gas supply, and it is a very significant feeling that takes possession of the visitor as he stands in these offices and sees side by side all the accessories needed for the installation of either gas or electricity and learns that the departments keep in touch with all manufacturers of these goods, buys from them at the best discounts and is able to supply the town consumer with any material he may require even more advantageously than he can procure them for himself elsewhere. In reality these showrooms are in the nature of a general sample room where the buyer can see all types of fittings, compare their price and select from the stock those having most merit. Will not this fact in itself help along municipal supply?

Leaving the offices and proceeding to the central station we find that the town authorities are again in an exceptionally advantageous position, for the electrical machinery is placed under the same roof as the turbines and pumps providing the city water supply. This pumping station is situated 1 1/4 miles away from the lake on the River Limmat, which forms the northern outlet for the waters collected in the Lake of Zurich, one of the many Swiss lakes caused by the



THE SWITCHBOARD.

melting snows of the northern Alps. The view shows the town lying at the end of the lake, with the Alps behind to the south. In this view on the left, between the railway bridges, can be seen the canal, about half a mile long, which has been constructed so as to divert the river through the pumping station. An adjustable dam is thrown across the river, so that as much water can be thrown into the canal as desired.

At the station end of the canal a fall is obtained, which varies from 6 feet to 11 1-2 feet, according to the season of the year.

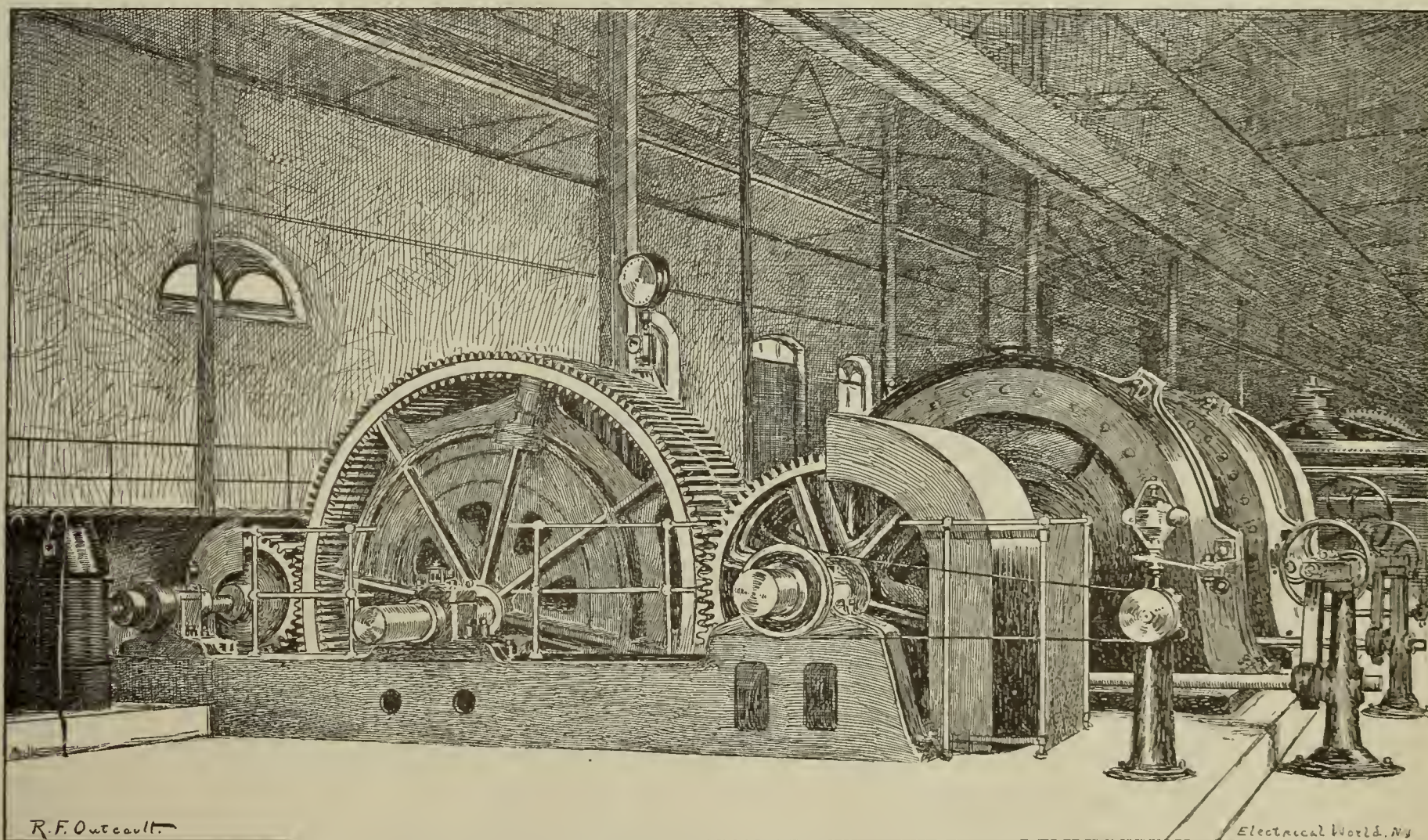
Conditions are the reverse of those obtaining in America, inasmuch as in summer, owing to the rapid melting of the Alpine snows, there is always an excess of water, whilst in winter it has sometimes happened that the water supply was so diminished that it was necessary to fall back upon the steam reserve in the station for a part of the electrical power.

The pumping station is a fine, substantial brick and iron building, some 400 feet long and 80 feet wide, beautifully designed for the purpose it fulfills. A transverse overhead crane runs the length of the building, so that the heavy parts of the turbines and pumps can be handled without difficulty. Eight 150-h. p. turbines of the three-tier Jonval type drive on to a main countershaft and operate as many duplex double acting pumps. Each pump can be driven by its opposite turbine or from the countershaft, as most convenient. The water of the canal is utilized by means of these low pressure turbines and pumps to draw water from an intake away in the lake and force it up into a series of three closed reservoirs on the Zurichberg. From these reservoirs, which have a combined capacity of 2,500,000 gallons, the town is supplied. The capacity of the pumps is considerably in excess of the requirement for this work,

at the northern end of the building, and consists of large alternators (2,000 volts) driven by high-pressure turbines. The turbines were made by Escher Wyss & Co., of Winterthur, and are designed to work under a pressure of 225 pounds per square inch. When under full load, 300 h. p., they have a commercial efficiency of 75 per cent., and are arranged vertically to drive directly on to the horizontal shaft of the generator. As it is undesirable to draw upon the high-pressure reservoir during the day for the small load, the station countershafting is arranged so that the generators can be driven from two of the low-pressure turbines (worked from the canal), each of which is then disconnected from its pump and the regular water supply. A 300-h. p. steam engine, condensing, working at 112 pounds steam pressure, made by Sultz Brothers, is also provided, more as a reserve for the winter months, so that in case the high-pressure reservoir is too severely taxed this can also be coupled on to the shafting to assist either day or night load.

The station, then, it can be seen, may be run with steam engine, high-pressure or low-pressure turbines, either individually or all assisting one another.

Below is an interior view of the station as seen from the switchboard. It shows the ends of the main countershafting (in the centre), the alternator and high-pressure tur-



INTERIOR OF THE ZURICH STATION.

so that when electric lighting was contemplated, it is only to be supposed that attention was given to this fact. Strangely opportune also was the knowledge that of the reservoirs on the mountain, the highest and largest was not in use, for at the time of a fever epidemic in the town, 10 years previous, the source of the disease had been traced to this large open basin, and it was then abandoned. It is this reservoir, now forming a hydraulic accumulator, that makes the electric lighting of Zurich possible. After the pumps have filled the closed drinking water reservoirs they are turned on to the large open one, which has a capacity for 2,640,000 gallons and is 525 feet above the station. From this artificial source the power required for driving the dynamos at night is derived.

The electrical generating plant proper is arranged together

bine shafting and the subsidiary shafting for exciters, and also the method of gearing.

At present four 200-kw. generators are installed, three of these are usually sufficient for the night load, so that one can be left in reserve for emergencies. In addition to these a small generator of 100-kw. capacity has been placed in the station temporarily for the day load. This generator is belted to the main countershaft.

The 200-kw. generator gives 2,000 volts and 100 amperes when running at 200 revolutions per minute, and having 30 poles produces 6,000 reversals per minute or 50 cycles per second. They are of the Kapp type, with stationary exterior field ring, the rotating armature carrying the high potential coils. The current is collected on copper rings on either side of the armature, so that any danger to the at-

tendants is minimized. Under full load a commercial efficiency of 88 per cent. is obtained. The excitation required is 2 1-2 per cent. Two exciters, Manchester type, ring armature, continuous current machines, are used, which, when running at 400 revolutions per minute, develop 100 volts and 200 amperes. One of these is held as a reserve. They are driven either from the main countershafting or two small high-pressure 30-h. p. turbines. The commercial efficiency of the exciters is 86 per cent. at full load.

The 100-kw. alternator is self-contained, its exciter being on the armature shaft. It has 18 poles and runs at 335 revolutions per minute, so as to produce 50 complete cycles per minute. All the generators were manufactured by the Oerlikon Works.

During the hours that the output is largest it is necessary to connect the generators in parallel and this station again presents the interesting feature of machines of different sizes and design running together. The "throwing in" would also seem to present exceptional difficulties from the fact that one generator is "belted" while the others are geared rigidly. The cut shows the 200-kw. generator with half the frame drawn out of position (in order to permit an examination of the armature coils), and the crown type clutch, by which the armature and turbine shafts are connected together.

The same type of clutch is used to throw the generators together in parallel. It consists of two open "star" plates, one rigidly keyed to the turbine and the other to the armature shaft, and a sliding "jaw" plate, the teeth of which pass in between the arms of the star plates. It is evident that as the generators must be thrown together in like phase, all the star plates must be keyed to the shafts in the same relation to the armature coils. No trouble whatever is experienced in "switching in" together, the operation taking but a few moments, watchfulness and precision being the requirements of the operator.

Placed conveniently near the generators is a handsome switchboard (see illustration); from this the generating plant is completely under control. The board contains double-pole switches and fuses, ammeters and voltmeters for each generator. Low potential voltmeters are employed, the converters for them being placed on the top of the board. Measuring instruments for the exciting machines, a voltmeter showing the potential in the city and automatic relays for effecting the requisite regulation, are also included.

The field resistance boxes of all the machines are arranged at the bottom of the board. To the right can also be seen the automatic field regulator, power for moving the contact lever being obtained from a diminutive high-pressure turbine, which consumes about 10 litres (2.2 gallons) of water per minute.

(To be continued.)

The Chicago Local Meeting of the A. I. E. E.

The local meeting of the American Institute of Electrical Engineers at Chicago on Thursday of last week was even a greater success than either of the preceding ones, and, in connection with the previous meetings, not only vindicates the wisdom of those who struggled, at first against odds, to bring about the establishment of local meetings, but also furnishes ample excuse for the almost complete reversal of opinion of those who formerly opposed that measure. Prof. Stine's smaller lecture room at Armour Institute, where the former meetings have been held, had to be abandoned, as the seating capacity is only 50, and even the larger lecture room used, seating 100, was not large enough to hold the audience present. Extra chairs were added, but still a number of those in attendance were compelled to stand; by actual count there were about 140 present, about 40 of whom were

Armour Institute students. Some 50 invitations were sent to neighboring central station men and others interested in station apparatus, and 50 to prominent members of the now defunct Chicago Electric Club. The Armour Institute people took pains to provide everything needed. It was not known until late that a 1,000-volt current would be needed, and just previous to the meeting a dynamo was set up and extra wiring done in order to supply it.

The lecture, with the accompanying experiments, passed off very satisfactorily. The discussion which followed lasted for an hour, and was participated in by Messrs. Abbott, Gutmann, Stine, Pierce, Haskins, Meyers and others. Among the members present besides those just mentioned were Messrs. Rodman, Hibbard and others, and prominent among the non-members were Dr. Walter Lobach, of the German Imperial World's Fair Commission; Carl Kammeyer; Mr. Tebbett, of the Chicago office of the Westinghouse Electric Manufacturing Company; W. L. Mason, of the Mason Electric Company; W. L. Githens, manager of the Hyde Park Electric Light and Power Company, and others. Mr. B. J. Arnold was chosen chairman for the evening. At the close of the meeting a vote of thanks was tendered to Mr. Wurts for the trouble he had taken to present his lecture to the Chicago members of the Institute, and a hearty vote of thanks also given to Prof. Stine and his assistants for their kindness in placing at the disposal of the lecturer the admirable facilities which enabled him to exhibit his experimental and commercial apparatus in such a complete manner.

Moonlight Tables for July, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of July under his modified form of moonlight schedule.

TABLE NO. 1. Standard Moonlight System.				TABLE NO. 2. Frund's New Moonlight System.			
Date.	Light.	Date	Exting.	Date.	Light.	Date	Exting.
1	8 00 P. M.	2	3 30 A. M.	1	8 00 P. M.	2	3 30 A. M.
2	8 00 "	3	3 30 "	3	8 00 "	3	3 30 "
3	8 00 "	4	3 30 "	4	8 00 "	4	3 30 "
4	8 00 "	5	3 30 "	5	8 00 "	5	3 30 "
5	8 00 "	6	3 40 "	6	8 00 "	6	3 30 "
6	8 00 "	7	3 40 "	7	8 00 "	7	3 30 "
7	8 00 "	8	3 40 "	8	8 00 "	8	3 30 "
8	8 00 "	9	3 40 "	9	8 00 "	9	3 30 "
9	8 00 "	10	3 40 "	10	8 00 "	10	3 30 "
10	8 00 "	11	3 40 "	11	8 00 "	11	3 30 "
11	8 00 "	12	3 40 "	12	8 00 "	12	3 30 "
12	8 00 "	13	3 40 "	13	8 00 "	13	3 30 "
13	8 00 "	14	3 40 A. M.	14	8 00 "	14	12 M.
14	8 00 "	15	3 40 "	15	8 00 "	15	12 "
15	8 00 "	16	3 40 "	16	8 00 "	16	12 "
16	8 00 "	17	No Light.	17	8 00 "	17	12 "
17	8 00 "	18	No Light.	18	8 00 "	18	12 "
18	8 00 "	19	8 00 P. M.	19	8 00 "	19	12 "
19	8 00 "	20	10 10 "	20	8 00 "	20	12 "
20	8 00 "	21	10 30 "	21	8 00 "	21	12 "
21	8 00 "	22	10 50 "	22	8 00 "	22	12 "
22	8 00 "	23	11 10 "	23	8 00 "	23	12 "
23	8 00 "	24	11 30 "	24	8 00 "	24	12 "
24	8 00 "	25	11 50 "	25	8 00 "	25	12 "
25	8 00 "	26	12 30 A. M.	26	8 00 "	26	12 30 A. M.
26	8 00 "	27	1 10 "	27	8 00 "	27	1 10 "
27	8 00 "	28	2 10 "	28	8 00 "	28	2 10 "
28	8 00 "	29	3 10 "	29	8 00 "	29	3 10 "
29	8 00 "	30	4 00 "	30	8 00 "	30	4 00 "
30	8 00 "	31	4 00 "	31	8 00 "	31	4 00 "
31	8 00 "						
Total hours, 142 40				Total hours, 179 50.			

Note—These schedules are made up on sun time. Where standard time is used, and it varies considerably from sun time, the proper deduction or addition must be made to all the times here given.

An Impartial Witness.

In recent legal proceedings in London regarding the noise and vibration caused by a neighboring factory, a phonograph was used to record these noises and reproduce them in court, at the suggestion of Prof. S. P. Thompson.

The Harmonics of Alternating Currents.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

As much unnecessary mystery appears to surround the subject of harmonics in alternating currents, it may be of interest to point out the fact that the subject is in reality of great simplicity.

In music, a tone or musical note is seldom, if ever, produced perfectly pure, being almost invariably associated with a number of feebler, higher tones, whose frequencies are multiples of the fundamental or principal note. These addi-

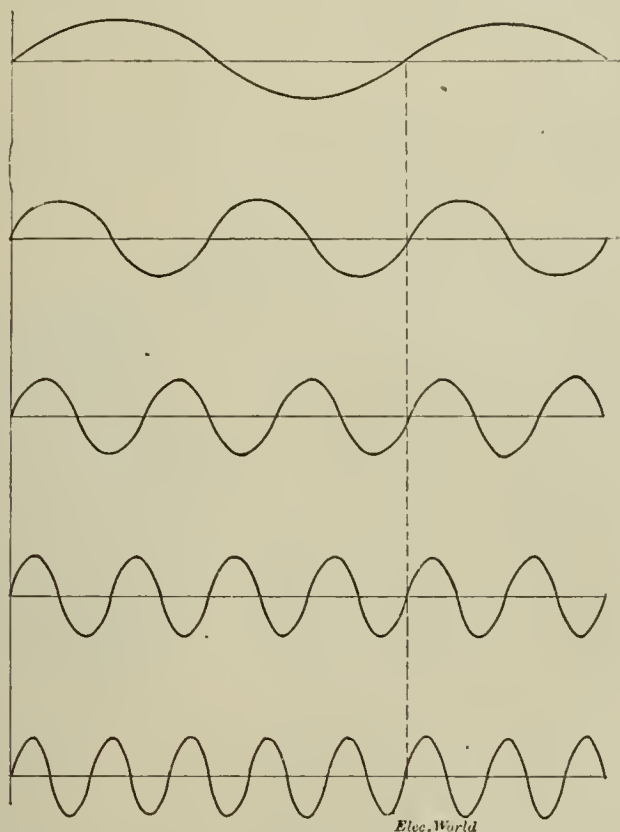


FIG. 1.—FUNDAMENTAL SINUSOID AND HARMONICS UP TO THE FIFTH, ALL WITH EQUAL AMPLITUDE.

tional tones are called overtones or harmonics, and their frequencies are 2, 3, 4, 5, 6, 7, etc., times the frequency of the fundamental. Ordinarily, the harmonics are only to be detected by the trained ear, the fundamental tone alone being heard; but, blending with the fundamental, they serve to give it that characteristic generally known as the quality of the sound.

To distinguish these harmonics, the double frequency or octave is called the second harmonic, the triple frequency, the third harmonic, and so on. A series of harmonics is

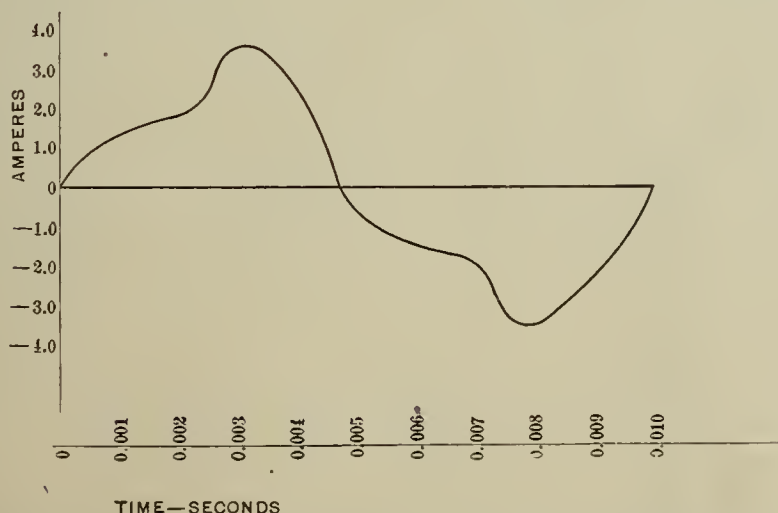


FIG. 3.—TYPE OF ALTERNATING CURRENT WAVE DISTORTED BY THE INFLUENCE OF HYSTERESIS IN MAGNETIC CIRCUIT OF TRANSFORMERS.

represented in Fig. 1 with their amplitudes, or maximum wave heights all equal.

When a sinusoidal E. M. F. is impressed on a circuit which contains only non-ferric inductances, a true sinusoidal current is produced. Under these circumstances neither the E. M. F. nor the current will contain harmonics, but will be represented respectively by sinusoidal curves, such as shown in Fig. 2. But if the circuit contains coils embracing iron, i. e., ferric inductances; or if in any case the E. M. F. produced by the alternator is not sinusoidal, the current in the

circuit will not be sinusoidal, and may be represented by some periodic curve, such as that in Fig. 3.

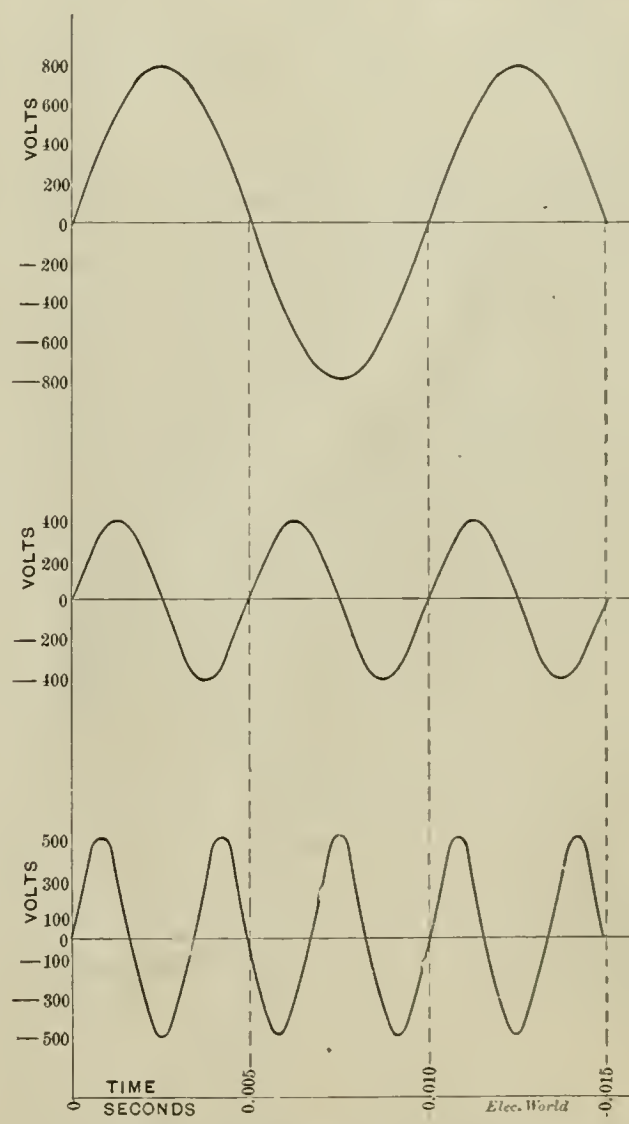
If we take an alternator that produces a pure sinusoidal wave of E. M. F., having, say, a frequency of 100 $\sim$ and an amplitude of 800 volts, this E. M. F. may be represented as in Fig. 2.

Again, if another similar sinusoidal alternator be selected with a frequency of 200 $\sim$ and a maximum E. M. F. of 400 volts, its curve will be represented by Fig. 4.

Now rigidly coupling these two alternators together, and connecting them in series, so that their waves cross the zero line coincidentally, their E. M. Fs. are added, and the resultant E. M. F. in the circuit, obtained by summation, is shown in Fig. 5.

Similarly, taking a third sinusoidal alternator of 300 $\sim$ and 500 volts maximum E. M. F., represented in Fig. 6, and coupling this in series with the first two alternators, so that all the E. M. Fs. start together from zero, the resulting E. M. F. is shown in Fig. 7.

Therefore, Fig. 5 represents a particular combination of a



FIGS. 2, 4 AND 6.—FUNDAMENTAL SINUSOIDAL E. M. F. AND TWO HARMONIC WAVES.

sinusoidal E. M. F. of amplitude 800 volts, with its second harmonic of amplitude 300 volts, combined in a definite phase relationship, namely, starting together from zero.

Fig. 7 similarly represents another particular combination of a sinusoidal E. M. F. of amplitude 800 volts—the fundamental—and its second and third harmonics of amplitude 400 and 500 volts, respectively, in a certain phase relationship.

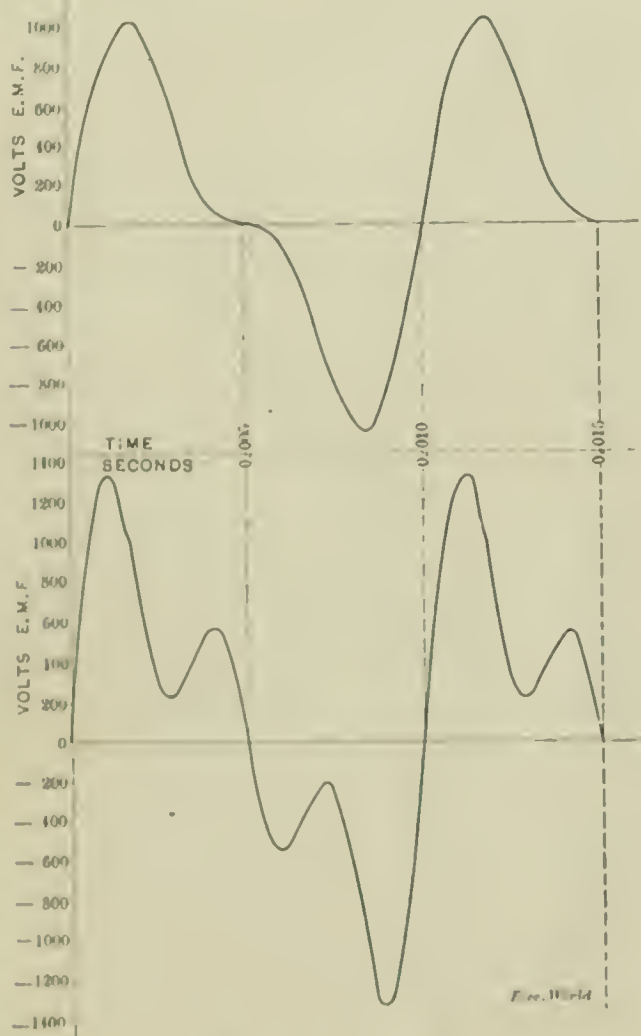
This superposition of harmonics, varying in number, amplitude and phase, might be carried to any extent, and the resulting curves might obviously give rise to great complexity.

Conversely, it can be shown that no matter how complex a curve of alternating E. M. F. appears, there must always be some combination of sinusoidal alternators, acting in series, which will produce it, and whose frequencies are in the ratios 1, 2, 3, 4, 5, 6, 7, etc., although an indefinitely large number of such alternators might happen to be needed and

their amplitudes and positions of coupling might all be different. This would correspond to resolving the complex curve into a fundamental and its series of harmonics; or, in other words, of an irregular wave into a simple wave and a series of ripple chains.

As already remarked, the current strength is not sinusoidal in an alternating current circuit supplying transformers (ferric inductances). It can be regarded, however, as a combination of a simple sinusoidal wave and some series of harmonics. Strictly speaking, in this case, the harmonics are not really present in the same sense as when a musical string is vibrating, or when a series of harmonic alternators are working together, and the conception is merely one of convenience. We merely regard them as being present in the distorted wave because the superposition of such a series of harmonics upon a plain sinusoidal fundamental wave would produce such a resultant wave.

It is evident from an inspection of Figs. 5 and 7 that in the case of a sinusoidal alternator, running in series with its



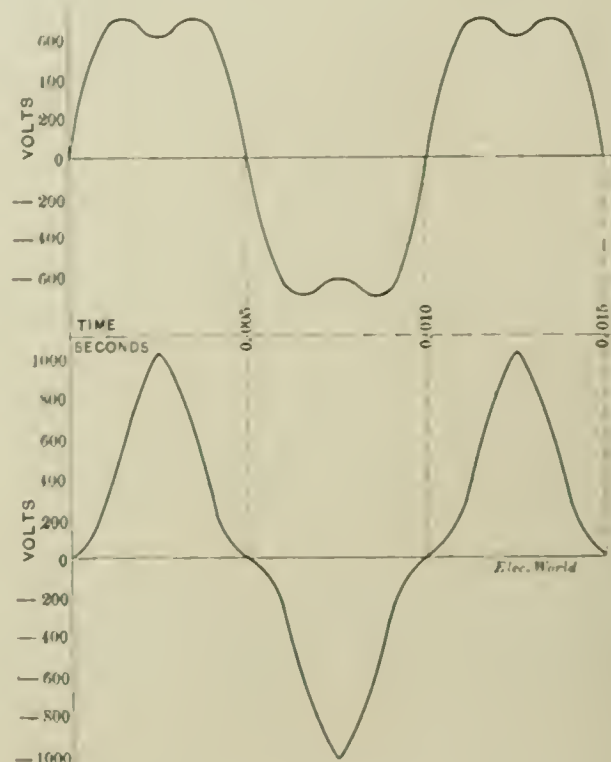
FIGS. 5 AND 7.

second harmonic, the resultant wave of E. M. F. is dis-symmetrical, that is to say, the positive wave or portion above the zero line is different from the negative wave or portion below the zero line. The former starts from the zero line abruptly; the latter slowly. The wave is also dis-symmetrical in the case of Fig. 7, where the second harmonic is also present; and it may be readily found by trial, that any superposition of the second, fourth, sixth, etc., harmonics of any amplitude or phase, i. e., even harmonics, upon a fundamental alone, or upon a fundamental mingled with its third, fifth, seventh, etc., or odd harmonics, produces a dis-symmetrical wave. But no alternator in practice does produce a dis-symmetrical wave, and, in the most complex curve of current produced from the distortion of iron, the wave must be symmetrical about the zero line, no cause being assignable for any difference in shape between positive and negative waves. This is tantamount to the statement that no even harmonics, such as the second, fourth, sixth, or fiftieth, can be expected in waves of current or E. M. F. developed in any practical alternating current circuit.

Fig. 8 shows the effect of superposing upon the funda-

mental wave of E. M. F. in Fig. 2 with 800 volts amplitude, its third harmonic wave, as shown in Fig. 10, with an amplitude of 200 volts, the waves starting together from the zero line in the same direction. The resultant curve is symmetrical, but very much flattened.

Similarly, Fig. 9 shows the effect of combining the same two waves with a semi-wave length of phase displacement, namely, the waves starting from the zero line coincidently in

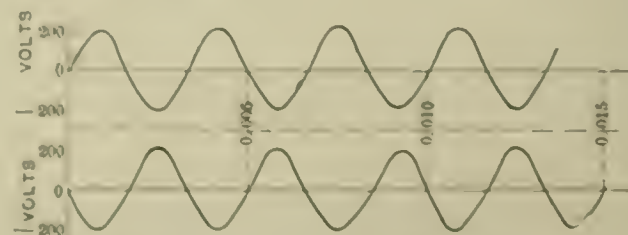


FIGS. 8 AND 9.

opposite directions, or the harmonic being displaced half a wave length, as in Fig. 11. The resultant curve is also symmetrical, but very much peaked.

Since, however, flat waves or peaked waves are the commonest deviations in form of an E. M. F. wave from the sinusoidal, Figs. 8 and 9 show that a prominent third harmonic is very common in such cases, i. e., a third harmonic of considerable amplitude is to be expected. Practically, harmonics above the fifth are not usually prominent in alternating current waves, although cases may occur in which very much higher harmonics might have a distinct influence.

Harmonics in the waves of alternating currents or E. M. Fs., or, in other words, distortions from the simple sinusoidal wave form, are objectionable in practice, when prominent. They increase the loss of energy in transformers by hysteresis and eddy currents. In motors, they tend, in addition, to generally diminish the torque and efficiency. In long insulated conductors for alternating current circuits, such as are used in the transmission of power,



FIGS. 10 AND 11.

there may exist conditions of inductance and capacity such that non-sinusoidal waves of current may be capable of producing electrical resonance by some of the theoretical or equivalent component harmonics in the distorted waves. Such waves of resonance may, either alone, or in favorable combination with the fundamental, give rise to abnormal and dangerously high voltages. Thus, in Fig. 8, the combination, in opposition, of an 800-volt wave fundamental

with its third harmonic of 200 volts, produces in the resultant a maximum of about 650 volts; but in Fig. 9, the combination of the same fundamental and harmonic, with a semi-wave length of phase variation, produces a maximum resultant pressure of 1,000 volts.

For these reasons it is advisable so to design alternators that the wave of E. M. F. they deliver is nearly a pure sinusoid. Small departures from the sinusoid, i. e., the presence of small harmonics, does not usually produce deleterious consequences.

The term "higher harmonics" is really a misnomer. The word harmonic is sufficient, except; perhaps, for distinguishing upper from lower harmonics.

Discriminating Lightning Arresters, and Recent Progress in Means for Protection Against Lightning.*

BY ALEXANDER JAY WURTS.



THE author divided his paper into three parts, the first of which described an experiment with lightning arresters on a 3,000-volt alternating current circuit at Telluride, Col. Lightning storms in those mountainous regions are of such frequency and violence that ordinary devices completely fail to give protection, and the author devoted a great deal of attention to investigating the subject and spent a number of months in Colorado testing the apparatus devised.

The well-known 1,000-volt non-arcing lightning arrester, which consists of seven non-arcing metal cylinders arranged side by side with 1-64-inch spark gaps intervening, the two outside cylinders being connected to the respective sides of the circuit and the middle one to the ground, was employed in connection with choking coils. Experiments were made to determine the number of cylinders and spark gaps necessary to interrupt a short circuit on a 3,000-volt alternator with the potential raised to 3,300 volts. Nineteen cylinders were found sufficient, and three 1,000-volt non-arcing metal arresters were used, being arranged as in Fig. 1. The form of choking coil adopted after experiment was a flat coil about 18 inches in diameter and consisting of 17 turns of wire, the size of which varied with the carrying capacity of the circuit on which it was placed. After further experimenting it was decided that the trial apparatus should consist of eight choke coils and twelve 1,000-volt non-arcing metal arresters. The relative positions of these are shown in Fig. 1, which represents one end of each of three circuits.

The theory upon which this apparatus was based is that disruptive discharges form nodal points in the system. Choke coils form points of reflection where there will be a maximum tendency to discharge. A discharge spark gap should therefore be connected directly in front of a choke coil. Choke coils also offer a very high resistance to the passage of disruptive discharges. It was found desirable to connect several coils in series so that in case only a portion of a discharge should pass across the first arrester a second, third, etc., opportunity for discharge would be found. To substantiate this theory the apparatus shown in Fig. 2 was arranged, consisting of a battery of Leyden jars, *B*, choke coils, *a*, *b*, and *d*, connected into the line *L*, in series, and discharge circuits, 2, 3, 4 and 5; 1 is a 12-32-inch spark gap separating line from inside coating of the jars. This is a similar arrangement to that shown in Fig. 2. Experiments

showed the difficulty the discharges had in passing the coils and the tendency they had to divide into two or more paths, part passing across the first or second gap and the rest to succeeding gaps.

The plant selected for the trial of this apparatus was that of the San Miguel Consolidated Gold Mining Company, of Telluride, Col., which is equipped with a 3,000-volt alternat-

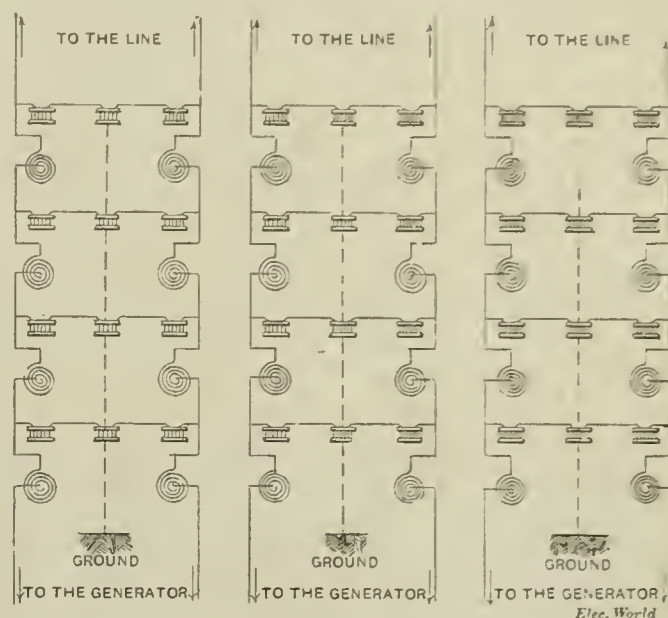


FIG. 1.

ing current synchronous system, operating stamping mills and furnishing current to the Telluride Electric Light Company. These points are situated among the mountains at distances varying from three to ten miles from the power house. Three separate circuits leaving the power house extend over a wild and rocky country and in some places rise above timber line. The location of each bank of arresters was selected with particular reference to securing permanently damp earth for the ground plate, the lines being led to this spot. The apparatus was then installed in a specially constructed and weather-proof lightning arrester house, the arrester and choke coils being mounted on thoroughly dried wooden frames and every precaution taken to insulate these from the ground and from each other. The connections inside the arrester house are shown in Fig. 1. Great precautions were taken with the ground connections, they being made as follows: First, a hole six feet square was sunk directly under each bank of arresters until permanently damp earth was reached; second, the bottom of this hole was covered with two feet of crushed charcoal (about pea size)—crushed coke would have answered equally well; third, over this was laid 25 square feet of No. 16 copper plate; fourth, the ground wire was

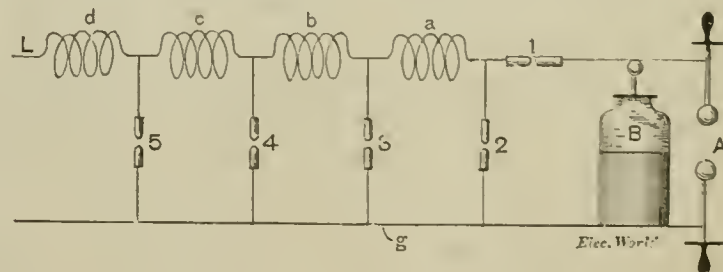


FIG. 2.

then firmly soldered all the way across the ground plate; fifth, the plate was now covered with two feet of charcoal; and, sixth, the hole then filled in with earth, using running water to settle.

Observations were taken by competent men at each bank of arresters during the entire lightning season, and the results obtained indicate that the discharges occurred most frequently over the second arresters; many passed over the third arresters; very few, however, over the first or fourth.

In Part II, a system of protection against lightning on circuits of any potential is described. The proposition is to connect in series with the circuit, and at frequent intervals, a sys-

* Abstract of a paper read at the Eleventh Annual Meeting of the American Institute of Electrical Engineers.

tem of properly constructed choke coils, the expectation being that the energy stored in the circuit in the form of static electricity will, at moments when there is a tendency to a disruptive discharge, dissipate itself in heat through the electrical surgings which will be set up between and among the several choke coils. The theory upon which this is based is more or less familiar. In many cases the lines become statically charged by the atmosphere. When a lightning discharge occurs, the potential of the atmosphere sinks to zero, and the static charge of the wire now seeks an equilibrium and in doing so sets up electrical waves which travel to the extremities of the system, are there reflected to other parts to be reflected again, etc. It is at these points of reflection that the damage is done. Circuits are probably also charged by static induction from clouds and by dynamic induction from cloud discharges. While a line is seldom, if ever, struck by direct lightning discharges, it occasionally becomes charged by some of the ramifications which accompany a lightning stroke.

If the theory of "electrical surgings" be correct, these dangerous points of reflection can, by means of choke coils, be confined to long lines and made to wear themselves out, as it were, between the coils. The number of coils which it would be necessary to use for a given length of circuit has not yet been determined, but the writer would suggest placing four to each mile of single wire. For convenient accommodation on the poles these can be arranged alternately on the two legs of the circuit, thus avoiding two coils on any one pole.

Discriminating lightning arresters are considered in Part III., the condenser lightning arrester being first taken up. The discriminating arrester must allow static electricity to pass, but must prove an effectual barrier to the dynamo current. Condensers with one side connected to line, the other to earth through a spark gap, would evidently serve this purpose. To discharge them a wet string was first used, but as a permanent leak a pencil mark over ground glass proved very satisfactory. For line or outdoor use the condenser was placed in a suitable cast-iron box, one terminal of the condenser being grounded to it while the other was led out through a specially designed and water-tight bushing. If then this iron box were buried in damp earth, as a ground plate, so to speak, the outer terminal connected to the lower electrode of a small spark gap placed on a pole, and the upper electrode of the gap connected to the line, the combination would constitute a discriminating line lightning arrester. This arrester proved itself most efficient in points of sensitiveness, durability and reliability.

A non-arcing railway arrester was, however, designed, which was smaller and more desirable than the condenser arrester. It was based on the fact that a disruptive discharge will leap over a non-conducting surface much more readily than through an equal air space. The first one constructed consisted of a pencil mark about two inches long over an unpolished piece of marble, a second piece of marble serving as a cover, with aluminium foil slipped between as terminals to the pencil mark, the whole being bound together with twine. To prevent the tendency to throw the two pieces of marble apart, a small groove was cut in the lower marble and the pencil mark made in this. As the pencil mark was gradually dissipated a piece of wood was laid in the lower marble and a groove burned in this. In the final form of the arrester the blocks were made of lignum vitae, the grooves being burned directly in the lower block. This arrester operated with uniform success.

Three Phase Installations Abroad.

One European company has already installed 24 large three-phase dynamos, aggregating a total of 3,710 h. p., mostly for power transmission.

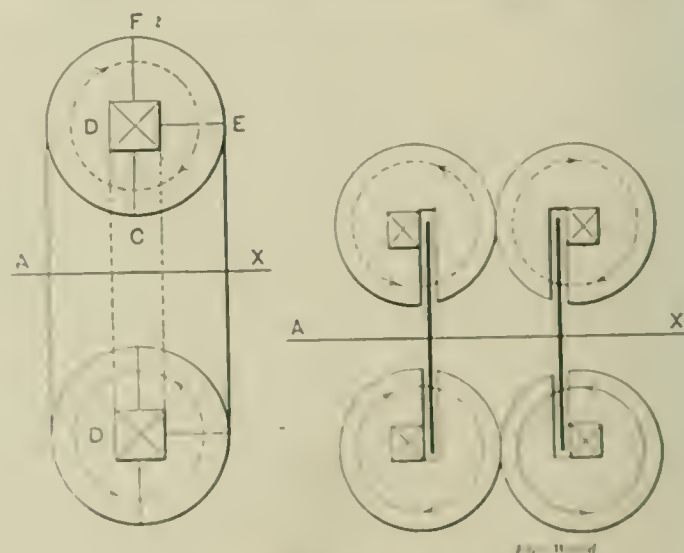
Unipolar Dynamos for Electric Light and Power.*

BY F. B. CROCKER AND C. H. PARMLY.



DYNAMOS and motors of the unipolar type are much more practical and generally applicable than is ordinarily supposed to be the case, and the object of this paper is to bring out this fact. The term unipolar dynamo is here used in its ordinary sense to designate a machine in which electric currents are generated by the continuous cutting of lines of force. The term "non-polar" suggested by Forbes is preferable to unipolar, but it is rather meaningless and is liable to be understood to mean any kind of ironclad machine. Unipolar dynamos are also called disc or tube machines, since the armature is usually made in one or the other of these forms. Neither of these terms, however, covers the other, and they are liable to be confused with other types of machine, similar in form but different in principle. The authors suggest continuous pole dynamo as a good name for this type of generator.

It is also a common error in regard to unipolar machines to suppose that the armature cannot be made of iron. As a matter of fact, iron or steel is usually better than copper, because it is a much better conductor of magnetism and the reluctance of the magnetic circuit can be reduced far below what is possible with a copper armature, the only air gaps being the small mechanical clearances required for free rota-



FIGS. 1 AND 2.

tion. A steel or wrought iron armature is much stronger than one of copper, not only on account of its greater strength for the same thickness but also because it can be made much thicker without causing any appreciable increase in the reluctance of the magnetic circuit, whereas a copper armature would have to be made very thin. The greater specific resistance of iron is not objectionable, since an armature composed of it would have a current capacity far greater than is required and the thickness can be increased to make up for the higher specific resistance.

The best type of magnetic circuit for unipolar dynamos is the circular ring, as shown in Fig. 1, where the axis of the magnetizing coil is coincident with the axis of the ring, the direction of the lines of force being indicated by the arrow. There are, however, but two directions in which the magnetic circuit can be cut so as to form a field suitable for practical use. One is along the radius CD , in which case the inductor will rotate in a plane perpendicular to the axis, and the other is along the radius ED , in which case the inductor will move in the convex surface of a cylinder whose axis is the axis of rotation. In the first case the armature of the resulting dynamo will be a disc, and in the second case a cylinder.

* Abstract of a paper read at the Eleventh Annual Meeting of the American Institute of Electrical Engineers.

In both, the way to collect the current would be to provide one set of collectors at the centre of the circular cross-section and the other set at the axis, thus utilizing the shaft as a portion of the electrical circuit. The relative advantages and disadvantages of the two forms depend upon circumstances in each particular instance.

In many cases the single magnetic circuit shown in Fig. 1 is not the best for practical use, because it would be necessary to make the diameter of the ring larger than it would be if two rings were placed side by side, as shown in Figs. 2 and 3, because in this type of dynamo the total magnetic induction and speed of rotation must be wholly depended on to produce the E. M. F., as it does not appear to be practicable to greatly multiply the voltage by multiplying the number of turns.

From formulas deduced in the paper it is shown that with an induction of 14 kilogausses in the field and armature, both of cast steel, the diameter of the latter to generate 10 volts at 1,200 revolutions per minute would be 24.28 inches, and for a direct connected dynamo to generate 130 volts at 200 revolutions the diameter would be 214.4 inches.

Two machines like the last one mentioned, if coupled at the ends of the shaft of a 100,000 h. p. engine would supply more current than is at present consumed in any two cities in the world. Nor is the excessive current a disadvantage, for while we would point out the tremendous capacity of one of these dynamos, there is no necessity for running them at their maximum output. Even if we

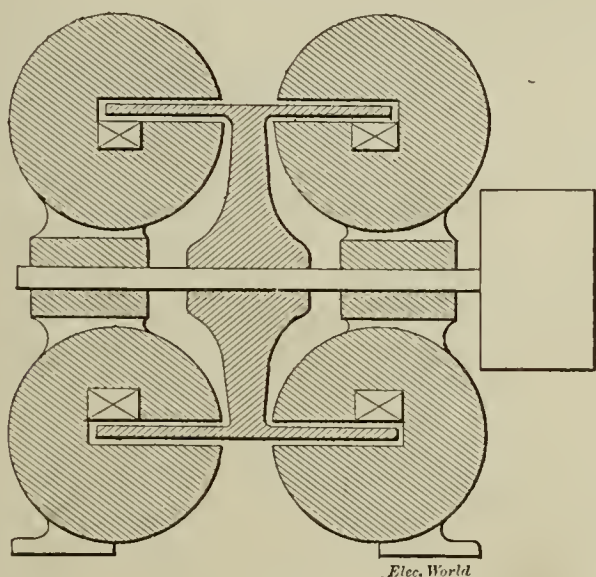


FIG. 3.

diminish the current to one-hundredth its ultimate value and only use a 1,000 h. p. engine to drive the dynamo, the loss due to the resistance of the armature will still be only

Methods of Taking Off the Current.—The best means of making electrical connection with the revolving armature is a very important but somewhat difficult matter. A great many devices have been tried or suggested. The principal of these are brushes of copper gauze or carbon, and mercury contacts applied to the edges of the disc or tube. Belts or straps made of flexible sheet copper or copper wire cable have also been used. One application of this latter device consists in connecting together two armatures by such a belt whereby the E. M. Fs. of the two machines are added together, and, if necessary, the mechanical power for driving one or both machines can be transmitted by this same belt. There would not seem to be any great difficulty in applying brushes to a unipolar dynamo; in fact, for a given current it would seem to be a much easier problem than with a direct current machine having a commutator, since the former has a continuous and smooth bearing surface for the brushes instead of the somewhat uneven surface of copper and mica which exists on a commutator. It is a fact that the speed may be very high, but with the perfectly smooth surface and by the use of brushes with light pressure and composed

wholly or partly of graphite or some friction metal which might even be lubricated, it would appear to be possible to take off a current sufficient for almost any electric light or power use. If the very high speed makes the friction too great to permit of the use of brushes, the edge of the tube or disc may be arranged to run in a mercury trough, thereby making a good electrical contact with very little friction. In this case, however, provision should be made to prevent the mercury from being thrown off by centrifugal force, as by the use of a guard ring extending all round the edge of the tube or disc. Another device would consist of ball bearings applied to the shaft or to the periphery of the disc or cylinder. These might perform their ordinary mechanical function and also serve to take off the current.

An arrangement for driving which seems to possess great advantages would consist of a steam turbine running at 10,000 or 20,000 revolutions per minute, which is the ordinary speed of such machines, directly coupled to a unipolar dynamo.

Advantages of Unipolar Dynamos and Motors.—The greatest advantage of the unipolar machine is its extreme simplicity. Its armature consists of nothing but a solid cylinder or disc of steel, or other suitable metal firmly mounted upon a shaft. We have only to compare this construction with that of the ordinary armature, consisting of hundreds of pieces of sheet iron, bolted or otherwise held together to form the armature core, and wound with a great many turns of wire or bars of copper, which have to be thoroughly insulated from each other and which are not very securely held in place. In addition to this, we have the commutator, consisting of 50 or more sections of copper, separated by strips of mica and held together by nuts, etc. The electrical connections between the armature and commutator also add to the complication. In short, it would be difficult to find any two pieces of machinery in which the contrast between simplicity and complication is greater. The construction of the field magnet and the rest of the machine is also very simple. The elimination of the commutator, although already mentioned in connection with simplicity, is, nevertheless, an essential feature of this type of machine, and is a great advantage. The almost infinitesimal armature resistance of these machines is decidedly advantageous, not only in increasing efficiency and decreasing heating, but also because it causes the machine to regulate more closely either as a dynamo or as a motor. According to all accepted theories there would be no hysteresis in these machines, because both the armature and field are always magnetized in exactly the same direction and to exactly the same intensity. For similar reasons there would be no Foucault currents, since the E. M. F. generated in any element of the armature would be exactly equal to that generated in any other element, and there could be no tendency to produce eddy currents. This perfect uniformity of the magnetic field is secured by the construction, which is exactly symmetrical, the air gap being precisely the same at all points.

The question of armature reaction is somewhat doubtful, since some authorities state that it is quite considerable, but in the opinion of the authors it is very small, and certainly no greater than in other types of machine. The armature consists of only a single turn, consequently the maximum magnetizing effect of the armature in ampere turns is numerically equal to its current capacity, and since the ampere turns on the field would be made considerably greater than this, the armature reaction cannot be great. It is interesting to consider how armature reaction can occur in such a machine. The probability is that it has the effect of curving and slightly lengthening the lines of force so that they do not pass perpendicularly from one pole surface to the other in the air gap and have a spiral path in the iron, since the field current tends to produce lines in planes passing through

the axis, and the armature current acts at right angles, producing an inclined resultant. There can, of course, be no change of distribution of magnetism as a result of armature reaction, which is the really objectionable effect that it produces in the present types of machines, and in the unipolar machines there are no back ampere turns and no magnetic leakage.

In conclusion, we may say that unipolar machines are practically indestructible, since they are so simple and so strong that they are not likely to be damaged mechanically, and it is almost impossible to conceive of one being burnt out or otherwise injured electrically, since the engine would be stalled by the enormous current before the armature could be fused by it. A machine possessing all these important advantages certainly deserves a prominent place in electrical engineering, whereas it now has practically no existence whatever.

Practical Notes on Dynamo Calculation.—III.

BY ALFRED E. WIENER.

In the last section of this article, published in *The Electrical World* of last week, Chapter 3, on "Conductor Velocity," was accidentally omitted. It is given below. Also the headings of Tables IV. and V. were interchanged; that is, the table under the heading "Table IV.—Practical Field Densities in English Measure," should have been placed under the heading for Table V., and vice versa. Formula (5) should read as follows:

$$S = \frac{d'_a \times \pi}{12} \times \frac{N}{60} \quad (5)$$

In formula (6) the second equality sign was misplaced; it should be:

$$d'_a = \frac{12 \times 60}{\pi} \times \frac{S}{N} = 230 \times \frac{S}{N} \quad (6)$$

3.—Conductor Velocity.

Since it is cheapest to increase the E. M. F. of a dynamo by raising its speed, it will be best economy to run a dynamo at as high a conductor velocity as practically possible. The cutting speed of an armature is limited mechanically as well as electrically; friction in the bearings, strain in the revolving parts due to centrifugal force, and heating of the armature, caused by hysteresis and eddy currents in the iron, play an important part in determining the proper conductor velocity. Furthermore, if the number of revolutions of the armature is fixed, either by its mechanical limit, or by the speed of the engine in case of a steam dynamo, or otherwise, then the above mechanical and electrical limitations alone are not sufficient for choosing the cutting speed, for too high a velocity, for instance, permissible from all other considerations, would excessively increase the diameter of the armature, and consequently would bring the size of the whole machine entirely out of proportion to its output.

TABLE III.—MEAN CONDUCTOR VELOCITIES.

Capacity in kilowatts.	Conductor velocity, in feet per second.		
	Belt driven dynamos.		Direct-driven dynamo
	Drum armatures.	Ring armatures.	
.1	25	50	..
.25	30	55	..
.5	32	60	..
1	35	65	..
2.5	40	70	25
5	45	75	26
10	50	80	28
25	50	80	30
50	50	85	32
100	50	85	35
200	50	88	40
300	50	90	42
400	..	92	44
600	..	95	45
800	..	95	45
1,000	..	95	45
1,500	..	100	45
2,000	..	100	45

In modern high speed (belt driven) dynamos the value

of S , for drum armatures, varies from 25 to 50 feet per second, and for ring armatures, which offer a better ventilation and are much lighter than drum armatures of the same diameter, ranges between 50 and 100 feet per second. In slow speed (direct driven) machines, velocities from 25 to 50 feet per second are employed.

In the average values of S for various classes and sizes of dynamos are compiled.

8.—Dimensioning of Toothed and Perforated Armatures.

Armatures with toothed and with perforated core discs, which have been much used in recent years, offer the following advantages over smooth armatures: (1) Excellent means for driving the conductors; (2) mechanical protection of the winding, especially in cores with tangentially projecting teeth, and in perforated bodies; (3) lessening of the resistance of the magnetic circuit, and, therefore, saving in exciting power; and (4) prevention of eddy currents in the conductors. Their disadvantages are: (1) Increased cost of manufacture; (2) greater difficulty of insulating the winding from the core; (3) eddy currents set up by the teeth in the polar faces; (4) additional heat generated in the iron projections by hysteresis; and (5) leakage of lines of force through the armature core.

The latter disadvantage, however, is cancelled by the advantage of reducing, by lessening the magnetic resistance, the necessary exciting power in about the same degree as the leakage would otherwise increase it. The amount of this core leakage depends upon the relative sizes of the slots and the teeth, and, if the armature is otherwise properly dimensioned, will vary within the following limits:

TABLE XI.—CORE LEAKAGE IN TOOTHED AND PERFORATED ARMATURES.

Ratio of width of slots to their pitch on outer circum- ference. $\frac{n's}{d'_a \times \pi}$	Factor of armature leakage.		
	Toothed armatures.		Perforated armatures
	Straight teeth.	Projecting teeth.	
0.4	1.40 to 1.35	1.55 to 1.50	.....
.45	1.35 to 1.30	1.50 to 1.45	.....
.5	1.30 to 1.25	1.45 to 1.40	1.50 to 1.45
.55	1.25 to 1.20	1.40 to 1.35	1.45 to 1.40
.6	1.20 to 1.15	1.35 to 1.30	1.40 to 1.35
.65	.....	.....	1.35 to 1.30
.7	.....	.....	1.30 to 1.25

On account of this core leakage, toothed and perforated armatures are to be designed for lower field densities than smooth ones; for values of practical field densities for straight tooth armatures of various sizes see columns 4, 5, 10, and 11 of the previous Tables IV. and V., respectively, and for corresponding values for projecting tooth -, and for perforated cores, columns 5, 7, 12 and 13 of the same tables.

a.—Toothed Armatures.

The mean winding diameter, d'_a , of a toothed armature being determined by means of formula (6), its core diameter, or diameter at bottom of slots, d_a , Fig. 1, is obtained by deducting from d'_a the height of the winding space, or, in this case, the depth of the slots, h_a , averages for which are



FIG. 1.

given in the fourth column of Table XV., Chapter 9. The outside diameter of the armature, d''_a , over the teeth, is obtained by adding h_a , from Table XV., to d'_a , from formula (6).

The number of the slots, n' , depends upon the size of the

armature. Practice has shown that better results are obtained from deep and narrow slots than from shallow and wide ones, and, in consequence, a large number of slots is preferable to a small one. The following are good practical limits:

TABLE XII.—NUMBER OF SLOTS IN TOOTHED ARMATURES.

Diameter of armature, in inches, d'_a .	Number of slots, n' .	Diameter of armature, in inches, d'_a .	Number of slots, n' .
5	30 to 50	50	150 to 200
10	40 to 70	100	200 to 300
20	60 to 100	150	250 to 350
30	100 to 150	200	300 to 400

As to the width of the slots, its relation to that of the teeth is governed by the following considerations: On account of the disadvantage of the teeth creating eddy currents in the pole pieces, their width ought to be small compared with that of the slots; in order to reduce the hysteresis loss in the teeth, and the heat caused by the same, to a minimum, the mass of the teeth should be small, and their area perpendicular to the flow of the lines, hence their width, large; for the sake of effectively reducing the magnetic resistance of the circuit the teeth ought to be as wide as possible; and in order to prevent an excessive core leakage, finally, a small width of the teeth should be chosen. Summing up all these conditions, a good practical rule seems to be to make the width of the slots

$$s = \frac{d'_a \times \pi}{2 \times n'}, \quad (7)$$

that is to say, to make the width of the slots equal to half their pitch on the outer circumference; for the special case of a straight tooth core, then, the width of the slots is equal to the top width of the teeth.

Applying this rule to armatures of various sizes, the writer has calculated the following table, giving dimensions of toothed armatures:

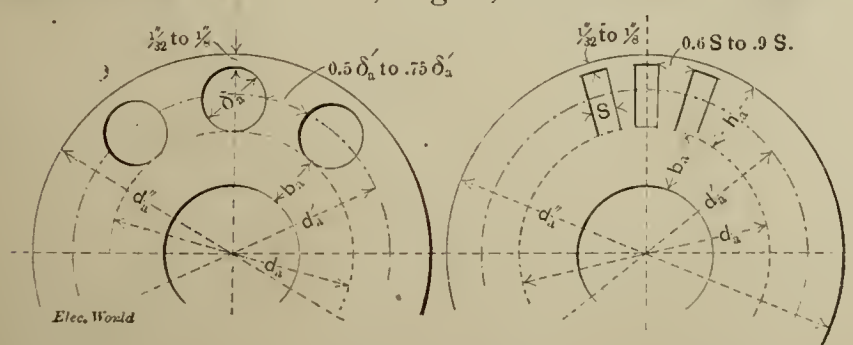
TABLE XIII.—DIMENSIONS OF TOOTHED ARMATURES.

Dimensions of slots.				Number of slots n'	Core diameter, in inches, d_a	Width at bottom of tooth, in inches, s
Diameter of armature, in inches, d'_a .	Depth, in inches, h_a .	Width, in inches, s .	Ratio of depth to width, $h_a : s$.			
5	$\frac{5}{8}$	$\frac{1}{4}$	2.50	31	$3\frac{3}{4}$	.125
6	$\frac{3}{4}$	$\frac{17}{64}$	2.83	36	$4\frac{1}{2}$	.128
8	$\frac{7}{8}$	$\frac{9}{32}$	3.11	45	$6\frac{1}{4}$	.156
10	1	$\frac{19}{64}$	3.37	53	8	.178
12	$1\frac{1}{8}$	$\frac{5}{16}$	3.60	60	$9\frac{3}{4}$	.198
15	$1\frac{1}{4}$	$\frac{21}{64}$	3.81	72	$12\frac{1}{2}$	.218
18	$1\frac{3}{8}$	$\frac{11}{32}$	4	82	$15\frac{1}{4}$	.241
21	$1\frac{1}{2}$	$\frac{3}{8}$	4	88	18	.268
25	$1\frac{5}{8}$	$\frac{13}{32}$	4	97	$21\frac{3}{4}$	.299
30	$1\frac{3}{4}$	$\frac{7}{16}$	4	108	$27\frac{1}{2}$	.362
40	$1\frac{7}{8}$	$\frac{15}{32}$	4	134	$36\frac{1}{4}$	.383
50	2	$\frac{1}{2}$	4	157	46	.422
60	$2\frac{1}{8}$	$\frac{17}{32}$	4	178	$55\frac{3}{4}$	.454
70	$2\frac{1}{4}$	$\frac{9}{16}$	4	196	$65\frac{1}{2}$	.487
80	$2\frac{3}{8}$	$\frac{19}{32}$	4	212	$75\frac{1}{4}$	.521
90	$2\frac{1}{2}$	$\frac{5}{8}$	4	226	85	.557
100	$2\frac{3}{4}$	$\frac{11}{16}$	4	230	$94\frac{1}{2}$	.602
125	3	$\frac{3}{4}$	4	262	119	.678
150	$3\frac{1}{2}$	$\frac{7}{8}$	4	270	143	.791
200	4	1	4	314	192	.920

b.—Perforated Armatures.

The same considerations that prevailed in determining the number and the width of the slots in toothed armatures are also decisive for the dimensioning of perforated cores. The number of perforations, for this reason, can be taken in the same limits as the number of slots for toothed cores. See Table XII.

In case of round holes, Fig. 2, the thickness of the iron



FIGS. 2 AND 3.

between two adjacent perforations should be taken between 0.5 and 0.75 times the diameter of the hole.

For rectangular holes, Fig. 3, the thickness of the iron

between them is to be taken somewhat greater than for round holes, namely, from 0.6 to 0.9 times the width of the channel.

The distance of the holes from the outer periphery is to be made as small as possible, and may vary between 1-32 and 1-8 inch, according to the size of the armature.

9.—Length of Armature Core.

The number of wires that can be placed in one layer around the armature circumference, and the depth of the winding space determine the total number of conductors on the armature, and the latter, together with the length of active wire, gives the length of the armature core.

a.—Number of Wires per Layer.

For smooth armatures the number of wires per layer is obtained in dividing the available core circumference by the thickness of the insulated armature wire. If the whole circumference is to be filled by the winding, then

$$o = \frac{1,000 \times d_a \times \pi}{\delta'_a}, \quad (8)$$

where o = number of armature wires per layer;

d_a = diameter of armature core in inches;

δ'_a = width of insulated armature conductor, in mils.

See Chapter 10.

In case the winding is to consist in separated coils, the sum of the separating spaces is to be deducted from the armature circumference.

The value of o is to be rounded off to the nearest lower even and easily divisible number, and, in the case of a drum armature, allowance for division strips, or driving horns, is to be made according to Table XIV. This table gives the average circumferential space occupied by the division strips in drum armatures of different sizes and various voltages, in per cent. of the core circumference. After fixing the number of armature divisions, which will be shown in Chapter 11, this table may also be used to determine the thickness of the driving horns, which are usually made of hard wood or fibre, and sometimes even of iron.

TABLE XIV.—ALLOWANCE FOR DIVISION STRIPS IN DRUM ARMATURES.

Diameter of armature core, in inches.	Percentage of core circumference occupied by division strips.		
	Up to 300 volts.	400 to 750 volts.	800 to 2,000 volts.
Up to 3	12%	15%	....
6	10	12	15%
12	8	10	12
20	7	9	10
30	6	8	9

Denoting one-hundredth of these percentages by k , the core circumference being unity, the formula for the number of wires per layer in a drum armature becomes:

$$o = \frac{1,000 \times d_a \times \pi \times (1 - k)}{\delta'_a}. \quad (9)$$

In toothed armatures the number of wires in one layer is found from the number, n' , and the available width, s' , of the slots by the equation:

$$o = 1,000 \times n' \times \frac{s'}{\delta'_a} \quad (10)$$

In this formula the value of s' is to be derived from the actual width, s , of the armature slots (Chapter 8), by deducting the thickness of insulation used for lining their sides. data for the latter being given in Chapter 10.

b.—Height of Winding Space. Number of Layers.

In dividing the available height, h'_a , of the winding space by the height, δ''_a , of the insulated armature conductor, the number of layers of wire on the armature is found:

$$u = 1,000 \times \frac{h'_a}{\delta''_a} \quad (11)$$

u = number of layers of armature wire;

h'_a = available height of winding space, in inches;

δ''_a = height of insulated armature conductor, in mils.

The height of the insulated armature conductor, δ''_a , in the case of round or square wire, is identical with its width, δ'_a .

The available height, h'_a , of the winding space is obtained from its total height, h_a , averages for which are given in Table XV, by deducting from $1/32$ to $3/16$ inch (see Chapter 10), according to size and voltage of machine, for the insulation of the armature core, insulation between the layers, thickness of binding wires, etc.

The nearest whole number is to be substituted for the value of u .

TABLE XV.—HEIGHT OF WINDING SPACE IN ARMATURES.

Diameter of armature in inches.	Height of winding space, in inches.		
	Smooth armature core.	King armature.	Toothed armature core.
Up to 2	.25	....	...
" 3	.3	....	...
" 4	.35	.20	...
" 6	.4	.225	$\frac{3}{4}$
" 8	.45	.25	$\frac{7}{8}$
" 10	.5	.275	1
" 12	.55	.3	$1\frac{1}{4}$
" 15	.6	.325	$1\frac{1}{4}$
" 18	.65	.35	$1\frac{3}{4}$
" 21	.7	.375	$1\frac{1}{2}$
" 25	.75	.4	$1\frac{5}{8}$
" 30	.8	.45	$1\frac{3}{4}$
" 40	...	.5	$1\frac{7}{8}$
" 50	...	.55	2
" 60	...	.6	$2\frac{1}{4}$
" 70	...	.65	$2\frac{1}{4}$
" 80	...	.7	$2\frac{3}{8}$
" 90	...	.75	$2\frac{1}{2}$
" 100	...	.8	$2\frac{3}{4}$
" 125	...	.85	3
" 150	...	.9	$3\frac{1}{2}$
" 200	...	1.0	4

c.—Total Number of Armature Conductors. Length of Armature Core.

The product of the number of layers and the number of conductors per layer gives the total number of conductors on the armature; and this, divided into the total length of active armature conductor, furnishes the active length of one conductor, that is, the length of the armature body:

$$l_a = \frac{12 \times L_a}{o \times u} = \frac{12 \times p \times L_a}{o \times u}, \quad (12)$$

where

l_a = length of armature core parallel to pole faces, in inches;

L_a = length of active armature conductor, in feet, from formula (3);

o = number of wires per layer, from formula (7), (8) or (9), respectively;

u = number of layers of armature wire, from formula (10);

p = number of wires stranded in parallel to make up one armature conductor of area δ_a^2 , formula (4);

$\frac{o \times u}{p}$ = total number of conductors on armature.

For preliminary calculations an approximate value of the number of conductors, K , all around the polefacing circumference of the armature may be obtained by dividing the conductor area found from formula (4) into the net area of the winding space. Taking .6 of the total area of the winding space as an average for its net area in smooth armatures with winding filling the entire circumference, we obtain:

$$\frac{o \times u}{p} = K = \frac{1,000,000 \times .6 \times d_a \times \pi \times h_a}{\delta_a^2} = 1,885,000 \times \frac{d_a \times h_a}{\delta_a^2} \quad (13)$$

This result is to be correspondingly reduced for windings filling only part of circumference, or to be multiplied by $(1 - k)$, see formula (9), in case of a drum armature, respectively.

In toothed armatures the average net height of the winding space is about three-fourths of the total depth of the slot, hence the approximate number of armature conductors:

$$\frac{o \times u}{p} = K = \frac{1,000,000 \times n' \times s' \times \frac{3}{4} h_a}{\delta_a^2} = 750,000 \times \frac{n' \times s' \times h_a}{\delta_a^2} \quad (14)$$

In (13) and (14) the values of d_a , h_a and s' are given in inches, and δ_a^2 in circular mils.

(To be continued.)

The Practical Importance of Resonance in the Transmission of Electrical Power.—IV.

BY F. W. DUNBAR.

Up to this point we have considered the problems of tuning the circuit by means of varying both the capacity and inductance, but if for any reason it is impossible or inadvisable to change but one of the constants, the circuit may still be more or less perfectly tuned by varying the other constant, just as it is possible to tune more or less perfectly any string to a certain pitch by altering either its tension or weight alone. We have shown that if $L\omega > 5\pi R$ then the circuit may be perfectly tuned by altering either C or L alone, but if $L\omega$ is less than $5\pi R$, then the circuit can be only imperfectly tuned, just as it is impossible to make a very light string respond perfectly to a low pitched tone. Its tension must be so little that the wave impulses quickly die out—are absorbed by the string and their energy dissipated in the form of heat instead of being stored up as potential energy and given out to the immediately succeeding impulse. Just so when our line wires are built with their electrical inertia (L) small with respect to their resistance—the almost invariable practice at present—it is impossible to make them respond to low pitched tones and a large part of the energy which is pumped into them, instead of being transmitted, is simply absorbed and dissipated as heat.

We shall, however, discuss the cases of partial resonance secured by varying either one alone of the constants C and L , the other being maintained constant. The equations for these two cases we have already deduced.

Thus for C constant L varying we have

$$\frac{L\omega}{(K^2 + L^2\omega^2)^{1/2}} = \frac{a l}{2} \left\{ \frac{\sinh\left(\frac{a l}{\tan \mu}\right)}{\tan \mu} - \sin a l \right\} \quad (12)$$

and for L varying C constant we have

$$\frac{a l}{2} = \frac{\cosh\left(\frac{a l}{\tan \mu}\right) - \cos a}{\frac{\sinh\left(\frac{a l}{\tan \mu}\right)}{\tan \mu} + \sin a l} \quad (13)$$

The solutions of these two equations are evidently similar in form, and are continuous valued functions, varying through infinity an infinite number of times, and include both the values which will render I a maximum and which will render I a minimum.

Fig. 5 gives the solution of equation (13), where L varies and C remains constant; that is, if C has any definite fixed value, whatever it may be, the ordinate of this value of $C\omega$ as an abscissa is the values of $L\omega$ which will yield the maximum possible current with this particular value of $C\omega$.

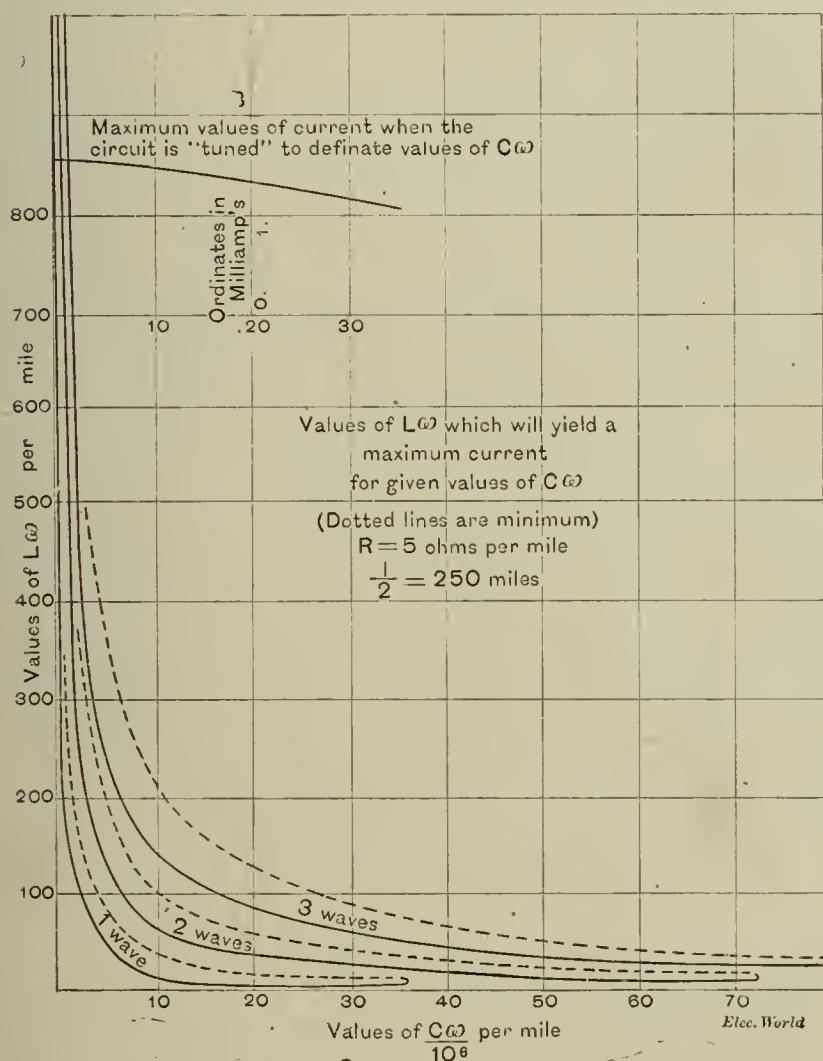
Fig. 6 is the solution of (12), and gives the values which $C\omega$ must have in order to yield the maximum possible current at the distant end for any definite values of $L\omega$.

The dotted lines indicate the portions of the curve which yield minimum values, and it will be noticed that for every wave length (of which only three are plotted), the maximum value changes to a minimum value at some definite values of $L\omega$ and $C\omega$, then continues back to infinity, where it again changes to a maximum value as the wave lengths increase from n to $n + 1$.

It will also be noticed that the values of $C\omega$ for a given value of $L\omega$ are less in Fig. 6 than in Fig. 5, but that above the values of 80 ($5\pi R$) for one wave, 160 ($10\pi R$) for two waves and 240 ($15\pi R$) for three waves, the curves of maximum $C\omega$ and maximum $L\omega$ coincide, and this method of solving equation (14) might have been adopted but for its laboriousness. For the coincidence of these two curves gives those values which mutually satisfy equations (12) and (13), that is, which satisfy equation (14). This, then, again gives the result that $L\omega$ must exceed $5\pi Rn$.

At B in Fig. 6 is shown the maximum values which the current can attain by tuning the circuit as perfectly as possible (by adjusting the capacity) for values of $L\omega$, including those values where $L\omega$ does not exceed $5\pi Rn$. The ordinates are in milliamperes and the total maximum voltage is 2; i. e., 1 volt on each side. The maximum values for one, two and three waves are shown.

It will be noticed that it requires a smaller value of $L\omega$ to make the circuit perfectly resonant when there is but one wave length in the circuit than when there are two or more.

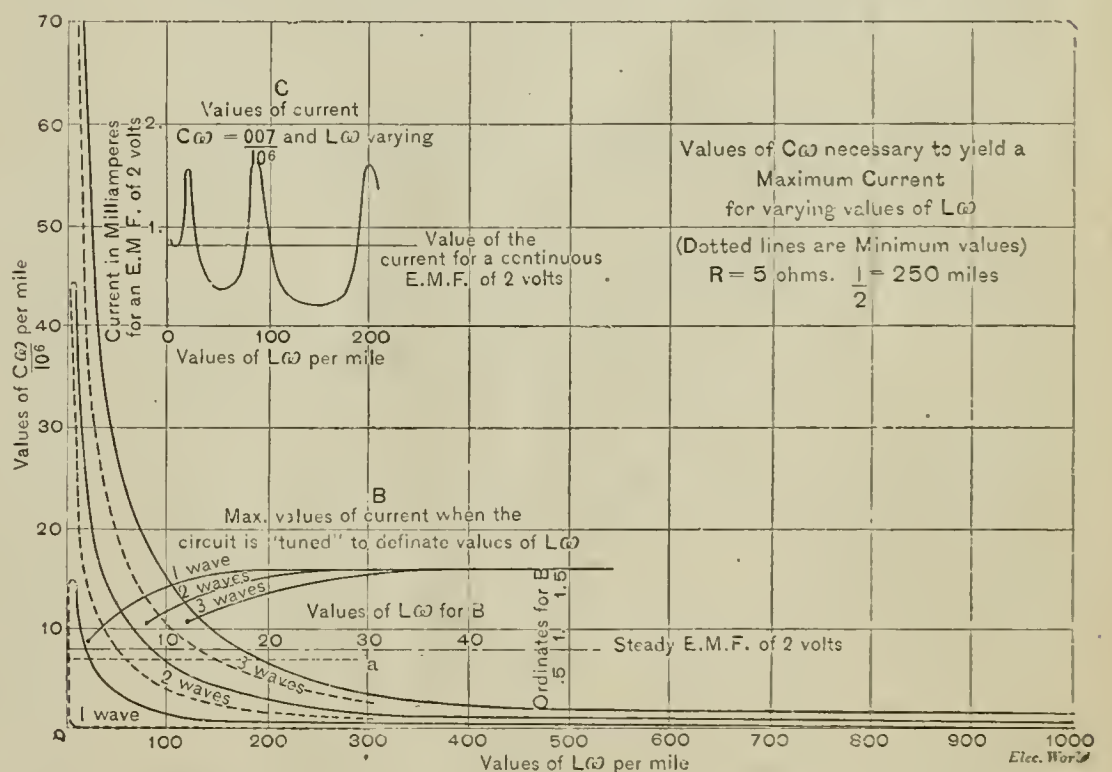


side with the phase of the current for the maximum value of the current at this point. The plot indicates clearly, however, the necessity for increasing the inertia (inductance) of the circuit up to or above a certain value before the complete advantages of resonance can be secured.

Diagram C in Fig. 6 represents the values of the current which will result at the distant end of this circuit, 250 miles in wire length, and of 5 ohms resistance per mile, if the capacity be maintained constant at one-half the value it would naturally have with a separation of the wires of about 12 inches; that is, a mutual capacity of about .00375 microfarads per mile, and if the value of $L\omega$ be increased from 0 up to 200 or more, ω being maintained constant at 1,000, corresponding to a frequency of about 160 ~ per second.

Thus C may be described as a section of the main plot in Fig. 6, taken through the dotted line a, which corresponds to a value of $C = .007$ microfarad. It will be noticed that at the first maximum, which occurs at $L\omega = 22$ ($1.4\pi R$), the current does not reach as high a value as is reached when there are two or more wave lengths in the circuit, but yet it is far in excess of the value which could be obtained with a steady E. M. F. But it must be remembered that the phase of the current does not coincide exactly with the phase of the E. M. F. at this first maximum, and consequently the energy transmitted at this first maximum is less than will be transmitted at the succeeding maxima when the circuit is more nearly perfectly resonant.

It will be noticed that the value of C in these formulae has been assumed to be the capacity between either wire and



FIGS. 5 AND 6.

This, of course, is directly expressed in the equation $L\omega = 5\pi Rn$.

It will also be noticed that the values of the maximum current seem to indicate a perfect resonance before $L\omega = 5\pi Rn$. Thus with one wave the maximum value of the current seems to be reached at about $L\omega = 30 = 2\pi R$, but the plot is somewhat misleading, as it does not include the phase of the current. Thus, it would appear possible to transmit a greater amount of power with an alternating current upon this circuit when $L\omega$ has a value of but 2.2 or less than $1/2 R$ than with a direct current, for the plot indicates that a greater current at the distant end will result if the circuit is tuned as perfectly as possible with this value of $L\omega$ than would result with a continuous or steady voltage of equal magnitude. But while the current would be greater were there no receiving instruments at the distant end of the line, yet the power would be much less, as the phase of the E. M. F. would not coin-

a ground half way between the direct and return conductors; that is, just twice the *mutual* capacity of the two wires and approximately the value of the capacity of either wire alone to ground as measured in ordinary cases in either line or cable conductors.

At the time of constructing Fig. 3 this distinction was not perceived, and consequently instead of Fig 3 representing the case of a line with the capacity which it would naturally have, as was intended, it represents a case where the capacity is but one-half as great. However, the actual numerical value of the capacity is immaterial to the question, and Fig. 3 truly represents the case of partial and complete resonance on a circuit having a mutual capacity of .0037 microfarad per mile. To Mr. Kennelly is due the credit of pointing out the fact that the factor C represents twice the mutual capacity.*

(To be continued.)

* See The Electrical World, Feb. 17, 1894.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

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ELECTRICAL JOURNALS
BY CARL HEDING

ELECTRO-PHYSICS.

New Experiments with Vacuum Tubes.—The results of some new experiments of Sir David Salomons are briefly summarized in the Lond. "Elec. Rev.," May 4; among other things he finds that the bands are not formed in large open tubes as they are in small ones; the effect of short rods, as also contractions in screens, placed in the tubes, are given; the sticking effect of the bands to the glass is shown very clearly with spheres; by altering the current it may be shown that the bright and dark bands are illusory, and that the bright bands really overlap, the overlappings appearing double as bright, and that therefore the positions of the apparently bright bands are really the true positions of the dark bands.

Electromagnetic Synchronization.—A long paper by Mr. Cornu, chiefly of a mathematical character, is given in full in the "Bul. Soc. Int." for April; he discusses synchronization in general, mechanical as well as electrical, as also various applications of the theory.

Curve of Magnets and Transformers.—A Physical Society paper by Major Hipplesley on "A Graphical Method of Constructing the Curves of Current in Electromagnets and Transformers" is abstracted briefly in the English journals of May 11.

Mechanism of Electrical Conduction.—A Physical Society paper of Mr. Burton is abstracted briefly in the English journals of May 11.

New Views Regarding the Nature of the Electric Current.—The "Elec. Anz.," April 29, contains an article by Mr. Schwartze on this subject.

MAGNETISM.

Magnetic Qualities of Iron.—The paper of Prof. Ewing and Miss Klaassen is concluded in the Lond. "Elec.," May 11. A striking example of the influence of molecular shaking is described; two independent magnetizing coils were used, in one of which the current was rapidly reversed, and it was found that the magnetizing effect of a steady current then became almost wholly independent of the previous magnetic history, or, in other words, the effects of hysteresis nearly disappeared; this method of agitating the metal obliterated hysteresis more completely than mechanical vibration. The next experiments showed the effects of time lag, which was most apparent in the softest iron, especially when solid or poorly laminated; even for low frequencies, such as three seconds and 0.43 seconds per cycle, the hysteresis curve grew shorter and wider, had rounded corners and a nearly elliptical shape; curves for these are given; the time lag thus lowered the maximum of magnetization enormously; it also increased the work spent in magnetic reversals appreciably, it being remarkable how great this influence is at very moderate speeds of reversal; the area of the curve increased at first and then decreased as the frequency is increased, thus

showing a maximum for some one frequency, which they say is due to the effect that the magnetization fails to penetrate sufficiently into the interior at higher frequencies; in steel these phenomena are much less apparent than in soft iron; it is not easy to say whether this time lag is due entirely to Foucault currents and suggestions are made for a test to determine this; it is suggested that the greater the amount of surface the mass of iron presents, the more quickly it is likely to take up the full amount of magnetic induction; the tests show that the ordinary ballistic tests are liable to serious error when the specimen tested is a solid bar of any considerable section, especially when the material is soft iron, unless the ballistic galvanometer has a much longer period than is usual. In conclusion, they describe some interesting experiments with groups of pivoted magnets, relating to the molecular theory and showing similarity in their behavior as compared with masses of iron.

Magnetic Property of a Static Discharge.—The "Elek. Zeit.," April 26, contains an article by Mr. Zielinske, in which he first reviews briefly the various publications on this subject, giving the references and descriptions of some observations of his own in connection with a test of lightning arresters for telegraph lines, showing among other things that the explanation of Waltenhofen of the appearance of reversed magnetism, due to a discharge, is correct; he discusses the practical application of these principles, showing among other things that the magnetic properties of a lightning discharge will not manifest themselves in the deflection of neighboring magnets; a lightning indicator should, under all circumstances, remain inactive, even to great electric currents, but should in all cases indicate a lightning discharge. He describes an ingenious lightning indicator based on these principles, consisting of a compass box attached to the lightning rod and containing a magnet in the form of a 12 pointed star with long, narrow points, magnetized so that it forms the equivalent of six or less magnets crossed through the centre; one of these is marked and there is a corresponding mark on the movable glass cover; the compass is so fastened that a current in the lightning rod would produce a deflection; it is set by having the two marks correspond; if a discharge passes through the lightning rod the magnetism in the star will be shifted, and it will afterwards be found to be differently magnetized, so that it will take a different position, which will be seen by the different relative positions of the marks; each succeeding discharge will shift it again; it was found that 0.003 coulomb is sufficient to cause this shifting, and it is therefore sufficiently sensitive, even for slight discharges, as Kohlrausch has shown that the quantity of electricity in an atmospheric discharge varies between 52 and 270 coulombs.

Hollow and Solid Cores.—In a paper by Mr. Du Bois, abstracted in the "Phil. Mag." for May, he says there is no

need for assuming that the central fibres of cores are less easily reached by temporary steady magnetization than those near the surface; such a state of things would be proved only if the same result is obtained with hollow endless rings, which is improbable. "If for cylindrical or prismatic bodies of given length and any shape of section the 'demagnetizing factor' be proportional to the latter and not too small, then the magnetic moment will be practically independent of the section for fields which are so strong as to produce an approach towards saturation."

Winding Alternate Current Magnets.—A Physical Society paper by S. P. Thompson and Mr. Walker is abstracted briefly in the English journals of May 11. When the magnetic induction does not exceed 4,000 C. G. S. units (4 kilogausses), the pull of a laminated magnet on its armature is the same whether caused by a continuous or an alternating current of equal strength, but for higher inductions the force is slightly greater for the continuous current. In alternate current magnets wound for a given excitation and for a constant voltage, they showed that the ampere turns are inversely proportional to the number of turns, as the impedance varies nearly as the square of the number of turns; such magnets have a fairly constant pull over a long range, as the current increases when the armature moves away from the magnet; the alternating voltage required for a given force is much greater than for continuous currents; with the armature in contact the ratio of the two voltages was 170, and when separated for a distance of 9.2 millimetres the ratio was 21.5. In the discussion Mr. Blakesley thought it better to fill the space of a magnetic coil full of copper rather than use a wire only just large enough to carry the current; Mr. Swinburne suggested using a condenser calculated for the same current, in connection with alternate current magnets, but other speakers thought the capacity would be impracticably large.

Alternating Currents and Hysteresis.—In the article under this heading in the Lond. "Elec. Rev.," May 11, Mr. Whitwell states that the ellipse could be used as a curve whose equation is well known and which approximates to the hysteresis curve, suggesting that some useful result might thus be obtained; he discusses the relations mathematically.

Standards of Magnetic Fields.—A paper by Mr. Du Bois is abstracted in "La Lum. Elec.," May 5, in which he discusses the use of different kinds of glass as standards for magnetic fields, based on the phenomena of polarization; a plate 1 millimetre thick is used for a field of 1,000 C. G. S. units (1 kilogauss).

Magnetic Properties at Different Temperatures.—"Comptes Rendus," volume CXVIII., No. 15, contains a paper by Mr. Curie, describing his series of researches made between 20 and 1,375 degrees C. and between 25 and 1,300 units of density.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measurement of Inductance.—The Lond. "Elec.," May 11, calls attention to a paper by Mr. Abraham in the "Jour. de Phys." for April, in which he describes a method for measuring inductance accurately within one part in a thousand; it consists in "balancing a steady current passing through one pair of coils of a differential galvanometer against a succession of induced currents sent, by means of a commutator rotating at a known speed, through the coils; the commutator then being stopped, the secondary circuit, containing one pair of coils of the galvanometer, is connected with the extremities of a resistance, r , in the primary circuit; the value of r , is altered till the galvanometer is undeflected, then from a knowledge of the value of r , and the speed of rotation of the commutator, the value of the mutual induction can be calculated.

Standard of Light.—The "Bul. Soc. Int." for April abstracts a paper read before the Berlin Academy of Sciences by

Messrs. Lummer and Kurlbaum, based on experiments made at the Imperial Technical Institute. A strip of platinum is heated by an electric current to a high temperature, the temperature being measured and adjusted by the radiation from the surface; this is measured by a bolometer, first directly and then after the rays have passed through a layer of water of 2 centimetres thickness; the desired temperature is attained when the ratio of these two radiations is as 10 to 1; the light emitted by one square centimetre of platinum is then taken as the standard; a brief description of the apparatus is given, and it appears that the measurements are of a delicate character. A somewhat more complete description is given in "La Nature," May 5.

Frequency and Phase Indicator.—According to the French journals, Mr. Janet described before the Academy a simple graphical method, based on the record left by the current in passing through a band of paper saturated with ferro-cyanide of potassium, as in the Bain electro-chemical telegraph.

Absolute Electrometer.—The Guglielmo electrometer, based on the application of a manometer, to measure the electrostatic pressure, is described and illustrated in "La Lum. Elec.," May 5.

Conductivity of Pure Water.—According to a paper in the "Phil. Mag." for April, the calculated electrical conductivity of pure water at 25 degrees (C. degrees?) is 0.56×10^{-11} .

Acidity Meter.—The Colette meter is described in "La Lum. Elec.," May 5; it consists simply of a plate of zinc and one of copper, secured in a support and placed in the liquid whose degree of acidity is to be measured, the couple being connected to a galvanometer; it is said to have been used with success in a number of sugar factories.

ARC AND INCANDESCENT LIGHTS.

Incandescent Lamp Manufacture.—In the continuation of Mr. Bainville's article in "L'Elec.," April 28, he discusses the subject of the filament and its manufacture; a translation of this series of articles is being given in abstract in the Lond. "Elec. Rev."

Lamp Pendant.—A new form of flexible pendant is described in the Lond. "Elec. Rev.," May 11; it consists of telescopic tubes secured at the top by a spherical joint, the wires passing through it in the form of a loose coil.

Searchlights for Canals.—The portable plant used in the Manchester Canal is described and illustrated in the Lond. "Elec. Eng.," May 4; it is similar to that which has been in use in the Suez Canal for over a year; the searchlight is mounted on a portable cage, which may readily be placed on the vessel.

Cored Carbon Litigation.—A communication on this subject is contained in the "Elek. Zeit.," May 3.

TRANSMISSION OF POWER.

Long Distance, High Tension Transmission.—In the "Elek. Zeit.," May 10, Dr. Behn-Eschenburg describes an experiment made at the Oerlikon Works of transmitting power by means of a simple alternating current to a distance of 27.6 miles at 33,000 volts and accompanies the same by a comparatively simple analytical discussion of the various factors which enter, showing that the various factors can be calculated qualitatively and approximately quantitatively by comparatively simple computations based on data determined by the constructor; the agreement of the calculated and observed results is shown to be sufficiently close for practical purposes, even when the hysteresis effect is only estimated. The transmission took place over four overhead wires leading from the factory to a neighboring town and back, thus enabling all the tests to be made at the factory; the line was supported by 920 oil insulators about 30 feet above the earth, and was 4 millimetres (about a No. 6 B. & S. wire) in diameter, the line being the one in use regularly for transmitting the water power from Beulach to the factory by means of a three-phase current; a 50-h. p. alternator of 2,000 volts was used, the current being transformed

up to 33,000 for the line, thence down to 2,000 volts, and was consumed in inductionless resistances, after having been again transformed to 200; the measurements were made in both the 2,000-volt circuits. The loss in the line was only 1,000 watts, representing a current of 0.03 ampere, or an insulation resistance of 3 megohms, and it appears that a direct measurement gave the same insulation resistance; other interesting deductions are made, but they do not admit of being abstracted, as they depend on the specific conditions. In conclusion, he states that as the current at no load exceeds the capacity of the dynamo and transformer, an installation at such high voltages should be used only with large loads in order to be efficient.

Electric Motive Power.—A paper by Mr. Selby-Bigge, read at the recent meeting of the Iron and Steel Institute on "Electricity as a Motive Power in the Iron and Steel Industries," is abstracted in the Lond. "Elec. Eng.," May 11. He discusses the application to mining and the utilization of heat from blast furnaces, the greater part of the paper being devoted to short distance transmission and concentration of power; a table of tests is given, in which the power required by various machines used in the iron industry is given, when driven by a steam engine and when this is replaced by an electric motor, the tests having been made at the works of a large company; the saving of coal effected on these tools amounted to 30 tons per week, after the adoption of the electric motors. Another table is given, in which the results are calculated, comparing the efficiencies for varying loads, both for electrical and mechanical transmission; at full load they are equivalent, but become very different as the load diminishes; with one-fifth of a load the electrical transmission still yields 47.2 per cent., while the mechanical transmission, with shafting, etc., had all its power absorbed in the constant frictional loss of 206 h. p., the original power being taken as 1,000; the author is greatly in favor of electrical transmission for short distances and the consequent concentration of power.

ELECTRIC RAILWAYS.

Electric Traction in England and Germany.—In a comparison made by Mr. Paisley in Lond. "Lightning," May 3, he gives an itemized table of the roads in the two countries, showing that in Germany there were in March, 1894, 130 miles of single track, while in England there were only 71 miles, and that in Germany the mileage was increasing rapidly, one company alone having contracts for no less than 100 miles; but while most of the lines in Germany are simple overhead lines, some of those in England are of a much more expensive character, the total capital involved in the English lines being almost ten times as much as in Germany.

Electric Traction in Tunnels and on Mountain Roads.—The advantages of electric traction are pointed out briefly by Mr. Lea in the Lond. "Elec. Eng.," May 4; in comparing rack roads with adhesion systems, he states that the ratio of tractive force to engine weight in adhesion systems can rarely be allowed to exceed one in five, it being usually less; with a rack, however, the ratio is nearly reversed, as the engine weight need only be about one-quarter of the tractive force to overcome the tendency of the rack pinions to climb out of gear.

Suspended Railway in Vienna.—One of the proposals for a road in Vienna was an overhead line with suspended cars at a sufficient height not to interfere with traffic on the streets.

Conduit Road at Blackpool.—In an article on electric traction in England, by Mr. Wilkinson in the Lond. "Elec. Plant" for May, he states that the Blackpool line, which has been running for over eight years more or less unsatisfactorily, has now completely broken down, and that it was,

until bought by a corporation, in 1892, earning a handsome dividend on a capital of about \$77,000 per mile.

Series Conduit System.—"Cosmos," May 5, contains an illustrated description of the system of Captain Cattori, installed in the city of Borghese; cars are connected in series and the current is taken from an inverted rail suspended in a conduit near one of the tracks, the slot being only one-half inch wide.

Novel Overhead System.—The "Elek. Echo," May 12, describes the system mentioned in the Digest May 19, giving in addition several illustrations; it is concluded in that article that this system is entirely impractical.

Accumulator Traction.—Mr. Walker, in the Lond. "Elec. Rev.," May 11, makes the statement that it is impossible to place sufficient accumulators on a fully loaded car to enable it to start on a wet day if the gradient is over one in twenty.

Accumulator Road in Paris.—"L'Elec.," May 5, contains a well illustrated article, giving a rather complete description of this road, together with data and a profile; a translation is given in abstract in the Lond. "Elec. Eng.," May 11.

Electric Vehicles.—In the continuation of the article on electric traction on common roads, "Industries and Iron," May 11, gives an illustrated description of an electric omnibus and a carriage.

Mountain Railway.—A short description of the Stanserhorn railway in Switzerland is given in the Lond. "Elec. Eng.," May 11.

Oil Engines for Railways.—In the "Lond. Elec. Rev.," May 11, Mr. Walker discusses the probability of the Connelly motor becoming a serious rival of electricity for traction purposes, and expresses his opinion that it will not; this motor consists of a pair of oil engines developing about 12 brake horse power, an oil tank being carried on the car, the oil being heated by the cooling of the water; a variable speed friction gearing is used, which is an essential feature and which Mr. Walker believes will fail.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Central Station Statistics.—An interesting table of statistics, compiled by Mr. Uppenborn for the leading German electrical society, is published in the "Elek. Zeit.," May 3, together with an analysis of it; the table gives quite completely certain data for a number of the stations in Germany and a few in other countries on the Continent; they are divided into groups according to the population of the cities; the table gives almost exclusively an analysis of the output of the station, including a percentage distribution between certain classes of consumers, certain comparative data, such as the output per thousand inhabitants, per metre of house frontage, the consumption per thousand inhabitants, the maximum consumption, and the relation of this maximum to the installed capacity; under the latter heading the relation is 46.4 per cent. in Berlin, in Vienna 60.2 per cent. the highest being 87.3 per cent. in the small town of Innsbruck, the general average being perhaps about 50 per cent. or a little over, the figures varying considerably. In the analysis he states that no returns were obtained from quite a number of important stations and that the table is therefore by no means complete; by far the larger number of stations use the continuous current; in the city of Elberfeld the average yearly efficiency from the poles of the dynamos to the meters of the consumers is nearly 99 per cent., which is a remarkable case, but it is explained by the fact that the losses in the lines are exceedingly small, and that in the day time so little current is used that the loss is practically nothing. Although not complete, the table is of considerable interest to central station designers.

Automatic Fault Indicators.—In a paper by Dr. Passavant, in the "Elek. Zeit.," April 19, he describes briefly the automatic indicators used in the Berlin station, showing how reliable they have been, and adding that their introduction

in stations should now be considered a necessity. The descriptions of these devices have already been referred to in the Digest; they are briefly as follows: The test wires of the outer wires of a three-wire system are used to indicate the faults; the test wires of the distributing mains are connected radially with those of the feeders but with opposite polarity to that of the core of the cable; in the junction boxes fuse wires are inserted and in the central stations a relay; if a short circuit occurs in a cable between the test wire and the core, the fuse will blow and the relay will indicate the district. In the second system, that of Dr. Kallmann, the difference of potential of the earth caused by a fault is used; the test wires of the neutral wire of the distributing mains are grounded as often as possible and in the junction boxes are connected with the corresponding neutral wire, which at the central station is connected to earth through relays, which localize the grounds. He states that it is not the faults occurring in the interior of the cables that are to be feared as much as those produced from exterior injury.

Switch for Self-Induction Circuits.—A simple and inexpensive system is described in the "Elek. Zeit.," April 19, for avoiding the sparking in opening a circuit, such as that of the field winding of a dynamo, in which there is great self-induction; an inductionless resistance which is short circuited under normal conditions is first put in circuit, the part containing the self-induction is then short circuited, after which the circuit is opened; the switch may be so constructed that these operations may be performed by one movement of the switch handle.

Cost of Electrical Energy.—The cuts of Mr. Crompton's recent paper, as also the discussion, are given in the Lond. "Elec. Eng.," May 11; the discussion is published in this journal and in the Lond. "Elec. Rev.," and is confined exclusively to the mechanical engineering features. In the latter journal Mr. Booth discusses some statements in this paper, more particularly those concerning the North of England coal.

Erding.—The small central station on the three-phase system, in this town, is briefly described in the Lond. "Elec. Eng.," May 11.

Paris Sub-Stations.—A translation of the article by Mr. Laffargue, mentioned in the Digest May 19, is given in the Lond. "Elec. Rev.," May 11.

WIRES, WIRING AND CONDUITS.

Heating of Wires.—A rather complete theoretical discussion by Mr. Colard is contained in "La Lum. Elec.," May 5; in it he deduces laws based on absolute temperatures, in which he assumes that the specific resistance of a pure metal is proportional to the absolute temperature.

Cables.—In a Dewers cable, illustrated in "La Lum. Elec.," May 5, powdered chalk is introduced at intervals between the wires and the lead casing, the object being to absorb the last traces of moisture in the cable and to keep it dry.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Multiple Telephony.—A paper entitled "A Revolution in Telephony," by Mr. Nissl, is abstracted in the "Zeit. fuer Elek.," May 1, describing a system, in which a number of subscribers have separate lines to a nearby centre, from which centre there is only one connection to the central station, and in which each subscriber can connect himself with the station independently of the others; a clockwork at this common point drives a contact drum, connecting each subscriber in turn with the station, say, once a minute, and notifying the subscriber of the exact time of connection by a sound in the telephone; at the moment of contact the subscriber can stop the revolution of the drum and be in communication for a limited time, say, about five minutes; during this conversation it is not possible for any others to interrupt; a signal is automatically given one-quarter of a min-

ute before the five minutes are up; it is stated that three wires are necessary for each subscriber, as well as from the common point to the station, and an additional wire in case earth connection is not used (the latter feature would seem to more than balance the advantages gained).

Safety Fuses for Telegraph and Telephone Purposes.—In the "Elek. Zeit.," May 10, Mr. Uppenborn mentions that he has made experiments with fine fuses in vacuum tubes, the idea of the vacuum being to prevent the loss of heat and therefore to produce fusion with less current; manganin wire and tinfoil were used; in vacuum they fused at between 0.17 and 0.2 amperes, while without a vacuum the ranges were from 0.19 to 0.23; greater constancy could be obtained by greater care in their manufacture. In the discussion, Dr. Strecker states that the Morse apparatus will stand at most 0.25 to 0.3 ampere continuously and telephones 0.15 ampere; he gives a table of the fusing and exploding point of wires of various metals; Mr. Uppenborn believes that these fuses can be made for as low as 0.10 to 0.13 ampere.

Legal.—The case of Muirhead vs. The Commercial Cable Co. in London, regarding the "Duplex" patent, has been decided in favor of Muirhead; the English journals of May 4 contain the reports and comments. Some of the points in this litigation are discussed by Mr. Dykes in the Lond. "Elec. Rev.," May 11.

Telephone Annunciator.—The automatic annunciator used with Paris telephones, as also those of Hall and Pickernell, are illustrated and described in "La Lum. Elec.," May 5.

Time Distribution.—In the "Elek. Zeit.," May 3, Mr. Kohlfuerst gives a well illustrated description of the automatic time distributing clock of the Government railways at Berlin.

Water Level Indicator.—"La Lum. Elec.," April 28, abstracts from "Engineering," Feb. 2, a description of a device made in England.

Telegraph Pole.—A new device for that part of the pole which is in the earth is illustrated in "La Lum. Elec.," April 28.

ELECTRO-CHEMISTRY.

Electrolysis of Fused Salts.—In a paper by Mr. Vautin, abstracted in the Lond. "Elec.," May 11, he describes a process in which the cathode is made of some heavy metal, such as lead for the electrolysis of sodium chloride, and tin for potassium chloride; the metal whose chloride is electrolyzed appears in the form of an alloy of these heavy metals; this alloy is then treated with water or steam to produce caustic soda or potash. Advantages are claimed over the wet method, such as avoiding the necessity of evaporation, the absence of a diaphragm and the low resistance of the electrolyte; the efficiency claimed, as deduced from recent experiments, is given as 80 per cent., but no estimate of the manufacturing cost has yet been given; a plant is soon to be started; a high current density, up to several hundred amperes per square foot, can be adopted; the minimum voltage is slightly less than two volts. In a discussion the advocates of the wet process claimed an efficiency of 85 per cent. and stated that the salt would cost more in the solid form: doubt was expressed as to the perfect freedom of the caustic soda from lead. Editorially, attention is called to the fact that the calculated voltage for the decomposition of solid sodium chloride is a little over four volts, and that therefore the heat required for the fusion appears to supply a portion of the energy absorbed in the decomposition, or that in the fused state sodium chloride is about halfway to the point at which it would be dissociated; the efficiency of 85 per cent. for the wet process is questioned.

Electrolysis of Alkaline Salts.—The Lond. "Elec. Rev.," May 11, calls attention to a recent paper by Mr. Arrhenius in the "Zeit. Phys. Chem.," volume XI., page 805.

Electrolyzers.—"La Lum. Elec." frequently contains short illustrated descriptions of various electrolyzers, which

will hereafter not be noticed in these columns, as they appear to be taken from patent specifications without regard to merit or practicability.

Electrolytic Iron.—In a recent paper before the Iron and Steel Institute, by Prof. Arnold, he stated that traces of carbon and sulphur appear even in electrolytically deposited iron.

Hermite Process.—According to "La Lum. Elec.," April 28, Mr. Landin reports to the municipality of Paris that the process appears to be costly, that the disinfecting action of the liquid is not demonstrated, that the liquids after treatment contain more bacteria than those treated with the city water, that the sterilization is not sufficiently rapid, and that there is therefore not a sufficient guarantee.

Chloride Accumulator.—In an article by Mr. Andreoli, begun in the Lond. "Elec. Rev.," May 4, he criticises very severely the recent statements made by Mr. Gibbs in the American papers; he gives great credit to the E. P. S. Company in developing the present accumulator in England; he asks what the "new principle" is, stating that it cannot be the casting of chloride of lead, as this was known for years; he claims that he is in a better position than any one else to say who discovered this principle; he believes no judge in England or America can be found who will agree with the French judges in declaring that fused and cast chloride of lead constitutes an infringement of the Faure battery; he denies the statement of Mr. Gibbs that the French company did not pay the Faure company, and states that they did pay about \$270,000.

Peyrusson Accumulator.—An illustrated description of this accumulator, which has already been described, is given in "La Lum. Elec.," May 5; it is of the Plante type and consists of two cylinders made of laminated lead foil; a capacity of 12 to 15 ampere hours per kilogram of plates is claimed, as also a permissible discharge current of 5 to 10 amperes per kilogram.

Porous Peroxide of Lead for Accumulators.—Mr. Fitzgerald, in the Lond. "Elec. Rev.," May 11, states that the deca-hydrated sulphate of soda in very fine crystals is much more suitable than sulphate of magnesia, but that there are some inconvenience and uncertainty in using it, and that anhydrous sulphate of potash is preferable; he claims that it is better to make only the surface of the plates porous so as not to sacrifice mechanical strength.

Concentration of Sulphuric Acid.—The Lond. "Elec. Rev.," May 11, states that according to the "Chemiker Zeitung" electrical heat has been adopted for the concentration of sulphuric acid; in order to produce 100 kilograms at 66 degrees, it is necessary to concentrate 117 kilograms at 60 degrees of the acid, which is the strength at which it is usually produced; a calculation of the calories required, including all the losses, is given, and is 32,679 calories, from which it is calculated that it is equivalent to 44.2 h. p. per (1) hour, or allowing for radiation losses, about 50 h. p. per (1) hour (by which is meant that 32,679 kilogram centigrade calories per hour are equivalent to that power, and not that that power per hour is equivalent to that much heat); to accomplish this by electricity will cost about \$5 per ton at one cent per hour horse power, which is said to represent a great saving over the usual methods; platinum wire is used and is raised to 480 degrees C. by 365 amperes at 5 volts, the wire being 0.5 centimetre in diameter and 77 centimetres long; in five hours 24 kilograms are concentrated.

Formation of Floating Metallic Leaves.—A paper by Messrs. Mylius and Fromm from "Wied. Ann.," volume LI., page 593, is abstracted in the "Elek. Zeit.," April 26. A zinc disc 5 square centimetres is made the anode in the bottom of a shallow vessel containing a 50 per cent. zinc solution 2 centimetres deep; if a fine wire is barely dipped in the solution over it and made the cathode and a current of three volts is passed through it, an arborescence will be formed

which will float on the liquid, especially if oil, such as turpentine oil, is poured over the top, in which case it will form between the two liquids; the experiment may be made with silver, copper and other easily oxidized metals, but not with difficultly oxidized metals, such as nickel, gold and platinum.

Chemical Industry.—An article by Mr. Rigaut in "La Lum. Elec.," May 5, discusses briefly several processes and gives an index to all the papers on electro-chemical subjects in that journal for a number of years past.

Electrical Production of Chemicals.—"La Lum. Elec.," May 5, describes briefly the production of chloral, chloroform and other chemicals by means of electricity.

Capacities of Polarization.—A paper by Mr. Bouty is abstracted in "La Lum. Elec.," May 5.

MISCELLANEOUS.

Compass for Automatic Steering.—An interesting device by Mr. Bersier is described and illustrated in "L'Ind. Elec.," April 25; the object is to operate the rudder of large vessels automatically by the compass directly without the use of the usual seaman. Attention is called to the fact that the errors in the ordinary method are scarcely less than from 1 to 2 degrees, corresponding to a lateral error of about 12 miles per day; with the present method greater accuracy is said to be possible; the standard compass is used and a current from a Ruhmkorff coil is passed from the pivot of the needle to the north pole extremity, whence sparks of 3 millimetres' length pass to one of two semi-circular pieces of aluminium insulated from each other, the gap between them being set to the desired sailing direction; when the spark passes to one of these, the current, by means of a relay, starts a motor in one direction, which in turn operates the rudder, while if the spark passes to the other piece, it moves the rudder in the other direction; the apparatus has been in use for two months on the steamer Neptune, and it operated very successfully; an additional device is mentioned, in which these sparks pass through a strip of paper, by means of which the record is automatically kept.

Electrical Engineering.—Prof. Kennedy's address, the first part of which was noticed in the Digest May 19, is concluded in the Lond. "Elec. Eng." and continued in the Lond. "Elec.," May 4; it is devoted almost entirely to the mechanical engineering features of lighting stations and includes a number of diagrams of loads of different stations and for different periods; among other things he states that in an electric lighting station the cost of coal averages not far from four-tenths of the total working expenses; regarding the losses in the electric transmission, he mentions that in a certain low tension system calculated for a maximum loss of 20 per cent. in the feeders, the actual average loss throughout a whole year amounted to 10 per cent., while in the mains and transformers of a high tension alternating system they are not less than 25 per cent. of the energy generated, which he thinks will be considerably reduced if banked transformers are employed, but he believes that the losses will never be as low as with a low tension system.

Relation of Mathematics to Engineering.—The Lond. "Elec. Eng.," May 4, reprints a lecture by Mr. John Hopkinson on this subject; it is discussed editorially in the Lond. "Elec." and "Elec. Rev.," May 11.

Artificial Rubber.—In an article in "Revue Universelle," mentioned in "La Lum. Elec.," May 5, it is stated that a material serving all the purposes of natural rubber may be made by passing the vapors of the essence of turpentine from below up, through a heated tube of 2 to 3 millimetres in diameter and by passing a jet of atomized hydrochloric acid over the mouth of this tube; the acid with these vapors is said to form small particles of solid rubber.

Electric Smelting.—In a brief article in the Lond. "Elec. Rev.," May 11, some recent improvements are mentioned, among which are that of Mr. Wilson, in which he mixes with the metallic ore finely divided or pulverized carbon, in

order to avoid the intermittent sputtering, foaming and boiling up of the mass which short circuits the arc and produces irregular action; the improvement of Mr. Niewerth is to use an airtight furnace to avoid the contact of air with the heated mass, the atmosphere in the furnace being then composed of carbon monoxide, which absolutely prevents oxidation; favorable mention is made of a review of the recent progress in the electro-metallurgy of aluminium in "Dingler's Journal," volume CCLXXXIX., page 129, and another in the "Zeit. fuer Ang. Chemie," volume XVII., page 515.

Ancient Lightning Rods.—The "Elek. Zeit.," May 10, calls attention to the fact that several of the Egyptian temples were provided with true lightning rods, mentioning the one at Dendrah, which is provided with several pointed wooden poles covered with copper, the purposes of which were found recorded in inscriptions on stone; another, at Medinet Abu, built by Rameses III., about 1300 B. C., in which the points of the rods were gilded.

Height of the Aurora Borealis.—"Cosmos," April 25, quotes from the Transactions of the University of Toronto of 1893, stating that from two observations made of the aurora borealis July 15, 1893, it was found that its height above the earth was about 160 miles.

Gangrene.—According to "L'Elec.," April 28, a Russian chemist, Prof. Allorossoff, has found a simple means to check the progress of gangrene without resorting to amputation, consisting in a simple application of an electric current.

Antwerp Exhibition.—A brief article of a general character by Mr. Bathurst is given in the Lond. "Elec. Rev.," May 11, from which it appears that it is yet far from being completed.

Capstan.—The "Elek. Zeit.," May 10, abstracts from "Engineering" an illustrated description of a form used in England.

Phonograph.—The "Elek. Zeit.," May 10, publishes an illustrated description of the phonograph of Mr. Koeltzow, of Berlin, which is said to be very much simpler than the Edison phonograph and quite as good.

The Postal Telegraph-Cable Company's Celebration.

The jubilee of the telegraph was appropriately celebrated by the Postal Telegraph-Cable Company by the formal opening of its magnificent new building on the corner of Broadway and Murray street, New York City. The Postal Telegraph-Cable and Commercial Cable companies called together as many of the superintendents, managers and heads of departments from all of their more important stations as could be spared from their posts, and after giving them an opportunity for a thorough inspection of the most important office of the combined systems, entertained them at a banquet on the evening of May 24 in the new building. The dinner was prepared in the kitchen of the Hardware Club, at the top of the Postal Building, and served in the large room on the second floor overlooking City Hall Park and Murray street.

Nearly 150 of the officers and employes of the two companies and their allied companies were present. Mr. John W. Mackay presided and Mr. A. B. Chandler, president and general manager of the Postal company, and Mr. George G. Ward, vice president and general manager of the Commercial Cable Company, from their places on Mr. Mackay's right and left, assisted him by acting as toastmasters. The dinner was a most excellent one and thoroughly enjoyed by every one present.

When Mr. Mackay arose to speak, he was greeted with a most flattering ovation, which evidenced his great personal popularity. He introduced Mr. Chandler, who made a most graceful and pleasing address. He briefly traced the history of the telegraph, ascribing to Prof. Morse the title of

"Father of the Telegraph," while recognizing the work of Henry, Vail and others. He paid a handsome tribute to the part Mr. Mackay had played in the development of the telegraph, and said a few words about the splendid new home of the company.

Mr. Ward followed with a happy speech. He stated that he had disclaimed any connection between the Commercial Cable Company and the Postal company until Mr. Chandler assumed charge of the latter. Since then he had been proud to claim relationship. He called attention to some of the difficulties that the Cable company had to contend with and made recognition of the immense benefit the Postal company had proved to them. In closing he proposed the health of Mr. Mackay, which was most heartily responded to. Mr. Mackay spoke briefly, as is his wont, expressing his pleasure in welcoming the visitors and his appreciation of the devotion of all the employes to the interests of the companies. Speeches were also made by Mr. John W. Mackay, Jr.; General E. B. Fowler, Messrs. Phillips, of London; W. H. Baker, of New York; J. Furze, of Liverpool; L. D. Parker, of Chicago; C. R. Hosmer, of Montreal; L. W. Storrer, of San Francisco; T. J. Wilmot, of Waterville; Tuttle, of Minneapolis; J. G. Ogden, of Montreal; R. S. Gough, of Chicago; S. S. Dickinson, of Canso; L. Lemon, of Baltimore; H. J. Kinnucan, of Detroit; E. J. Nally, of Chicago; F. W. Jones, George Clapperton, G. H. Usher, E. C. Platt and Charles Cuttriss, of New York.

The American Street Railway Association.

The Executive Committee of the American Street Railway Association announces that Machinery Hall, of the Piedmont Exposition Company, of Atlanta, Ga., has been secured for the exhibition of street railway supplies and manufactures, in connection with the thirteenth annual meeting of the association, to be held in the city of Atlanta, commencing the third Wednesday in October (the 17th), 1894, and lasting three days. The building has been engaged for two full weeks, beginning Oct. 10 and ending Oct. 24, thereby giving ample time for the removal of the largest exhibits. Several intending exhibitors at Milwaukee were sadly disappointed by the non-arrival of their goods until after the meeting was over. This was in large part due to the congested condition of freight traffic on trunk lines, owing to the World's Fair and the nearness of Milwaukee to Chicago. It is advisable to secure a time limit delivery; better still, to ship in plenty of time. The convention hall is in the same building on the ground floor, and the railroad facilities for freight purposes cannot be surpassed, inasmuch as the tracks on one side run the entire length of the building. It may be mentioned that some of those who exhibited at Milwaukee have already applied for space at Atlanta. This is, perhaps, the best evidence of the value of making exhibits at these annual meetings, where street railway men gather in large numbers from all over the United States and Canada.

Those desiring to secure space should apply as soon as possible to Mr. N. W. L. Brown, chairman of exhibits, Equitable Building, Atlanta, Ga., or to William J. Richardson, secretary, 166 Montague street, Brooklyn N. Y.

Electric Motors vs. Steam Engines.

According to a writer in the London "Electrical Engineer," 30 tons of coal were saved per week in the iron works of Messrs. Dorman, Long & Co., Middlesbrough, by replacing the individual steam engines by electric motors.

Ethereal Draughts.

"The ether blows through the solid mass of the earth like the wind through the trees."—Tyndall.

Variable Speed Motors.

To the Editor of The Electrical World:

In your Digest for May 19, under the title "Variable Speed Motor," you note that "L'Elec." for March 31 describes and illustrates an installation in a French factory, in which both the generator and motor fields are separately excited, and the motor field is kept constant, and the speed of the motor varied by varying the strength of the generator field.

This is one modification of my method of control, and is fully patented in France as well as in the United States. The United States patent is No. 463,802, of Nov. 24, 1891. I call attention to this, as it is apparently described in "L'Elec." as something new.

In your Digest for May 26, under the title "Variable Speed Motors," you note that in the "Elek. Zeit." of April 19, Mr. Baumgardt describes a system of distribution for factories in which two generators of different voltages, say, 50 and 100 volts, are connected in series, making a three-wire system, and motors connected across the three voltages, 50, 100 and 150, in order to secure variations in speed. This system is another modification of my method of control, and is fully covered by my United States patent, No. 478,344, of July 5, 1892. Since the matter is spoken of as though Mr. Baumgardt were the original inventor, I call your attention to my patent.

New York City.

H. WARD LEONARD.

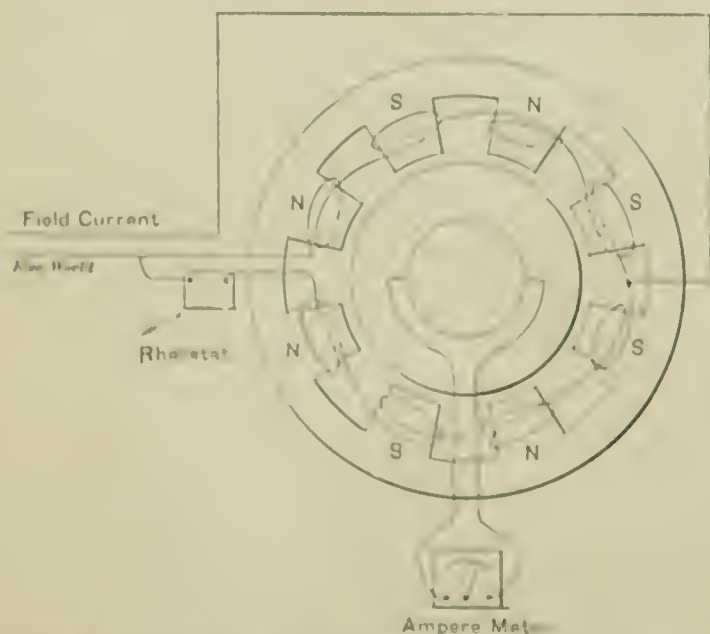
Simple Method of Testing Large Dynamos.

BY G. M. WARNER.

A scheme I have often used for testing large dynamos but have never seen in print may be of interest. The name of the originator of the method has slipped my memory.

We often wish to know the effect of a run at full load on the temperature of a dynamo, and in the case of very large machines a long run is very expensive. By this method, any multipolar machine with series wound armature can be so tested, using only about 3 per cent. of its rated horse power.

The accompanying illustration gives the connections, the fields being separately excited and so connected that half of the poles are reversed from their normal polarity. With the machine at full load and normal current in the fields, we get



SIMPLE METHOD OF TESTING LARGE DYNAMOS.

no potential at the brushes, for the voltage generated in one-half of the armature is equal and opposite to that generated in the other half. If we weaken the current in one-half of the poles by a very little, the opposed E. M. F's. are no longer equal and we get a potential difference of a few volts.

Hence, driving our machine at full speed and exciting the fields with their normal current, being careful that the adjustments are right to give zero potential, we short circuit the

machine by an ampere meter, then very slowly weaken half the fields until full load current flows in the armature. So we have full load currents in the armature and fields, the amount of weakening being negligible, nearly the same iron losses, and only have to supply energy for hysteresis and resistance losses.

With alternators, the weakening of the fields is somewhat more, as we have to supply the self-induction voltage of usually 800 volts, still the results obtained are accurate for most commercial purposes.

A Large Southern Water Power.

BY H. C. MIDDLETON.

Augusta, Ga., has the largest water power of any Southern city, having available for manufacturing purposes the entire Savannah River, the eighth river in size in the Union, being next larger than the Hudson. In 1872 the Augusta Canal and Water Power Works were completed at a cost of nearly \$2,000,000, consisting of a massive stone dam, thrown entirely across the river seven miles above the city, and a canal seven miles long to the city with two miles of levels within the city. From this construction 14,000 h. p. were made available in the city for manufacturing purposes, which fact has made Augusta the first manufacturing city in the South. She is the largest cotton and the largest lumber manufacturing city of the South, besides manufacturing heavily in numerous other lines, beer, fertilizers, flour, machinery, glass, clothing, liquor, tobacco, etc. Only 10,000 of the horse power made available is yet taken, though the remainder will doubtless soon be absorbed. When that is done, the raising of the dam will throw perhaps 15,000 h. p. more into the city, and this will be taken by new manufacturing establishments, which are constantly coming to the South to manufacture for this market.

The point in this development that is of especial interest to the readers of The Electrical World is this: here is a great manufacturing city, with a still greater future, with a vast water power, owned by the city and leased out indefinitely at the remarkably low rate of \$5.50 per horse power per year. The canal and water power have, however, up to this time concluded only to the building up of large manufacturing plants, the power, on account of the cost of tapping the canal, constructing wheel pits, etc., not being available for small industries. By the construction of an electrical plant these industries would teem throughout the city. Factories would also be enabled to start up and be built in suburban spots and at points without the city that cannot do so on account of the unavailability of power.

An Electric Elevated Railroad.

The officers of the Baltimore and Randellstown Railroad Company, of Baltimore, Md., after a thorough examination into the Barrows elevated railway system, the invention of Mr. C. D. Barrows, of Willimantic, Conn., have decided to give the system a trial on a 4 1-2 miles road that will be built under their charter, from Randellstown to Pikesville, Baltimore, Md. Mr. L. E. Walkins, of Baltimore, states that the rolling stock of this system is much lighter than other storage battery systems, the driving mechanism being 50 per cent. less in weight. He professes great confidence in the Barrows system, and states that the line will be built at once, the money having been raised.

An Electric Carriage.

In the description of the Cummings electric carriage in our columns last week we omitted to state that the batteries used for the propulsion of this vehicle were the cells of the well-known chloride accumulator type made by the Electric Storage Battery Company, of Philadelphia.

Power Brakes for Electric Motor Cars.

BY EDWARD C. BOYNTON.

A system of power brakes for electric cars entirely under the control of the operator is not a difficult thing to devise, provided the same general plan adopted in steam roads and some cable roads be followed. But the conditions entering into the problem, as applied to electric cars, are widely different.

Perhaps the principal difference is the question of economy. In most places where power brakes are used, no notice is taken of the cost of generating the brake power, and yet in most brake systems this power is to a greater or less extent being constantly generated and wasted when the brakes are not in use. It is not likely that this condition of things would suit the manager of a power station operating a large number of cars when he saw its effect on the load diagram of the station.

In short the conditions under which a power brake system may be applied to electric cars are these: (1.) It must be under perfect control of the operator, so that he may vary the brake pressure by degrees throughout its whole range. (2.) It must not consume any electric power (if such power is used at all), except when the brakes are in use. These two conditions seem to point immediately to an electric brake controlled by a switch and rheostat, but there are other methods which also fulfill the conditions.

The two best known brake systems are worked immediately by compressed air or vacuum. The former is obtained either by the well-known steam actuated air pump, or by a simple air pump connected by an eccentric to the axle of the car. The latter is commonly obtained by a steam ejector, the exhaust from which is familiar to those who have seen the cloud of steam rise from the tin-can-like object on top of the cab of an elevated railroad locomotive when entering a station. This latter system, which is not automatic (that is, it will not set itself if the train parts), is an example of a brake that only uses power when it is in use, and requires no cumbersome reservoirs under the cars. The same system could be applied to an electric car with no change except that a small electric motor direct connected to an air pump, possibly a centrifugal pump, be used to take the place of the steam ejector and exhaust the air from the brake diaphragms. The whole apparatus could be placed under the car and enclosed to keep out dust and dirt. This small motor, probably of 2 or 3 h. p., could be series wound, and with a very small rheostat and a release valve, the brake would be under perfect control.

Such a system of vacuum brakes as is in use on the Brooklyn Bridge cars would not be economical, as it consists of a reciprocating pump worked by an eccentric on the axle. This pump exhausts the air from a large reservoir under the car, and is always at work when the car is in motion.

The same objection applies to a compressed air system worked the same way, except that the pump compresses air in a somewhat smaller reservoir.

Steam railroad men have had a wide experience with various brake systems at the annual brake tests on the C., B and Q. R. R., at Burlington, Iowa. Among those tested in past years have been several so-called electric brakes, consisting of what is really a momentum brake applied and released by an electric current furnished by a few cells of battery on the locomotive. Upon the axle of the car is mounted a drum, to which is attached a sort of a clutch, which, when a small electromagnet releases a catch, engages the drum and starts to wind up a chain, which in turn pulls on the brake levers. A powerful spring, which can be adjusted along a central rod, is arranged to pull against the drum, so that the apparatus can be adjusted to give any predetermined pressure at the brake shoes, the clutch slipping when the pressure

is reached and is thrown out of gear and the brake released by the electromagnet.

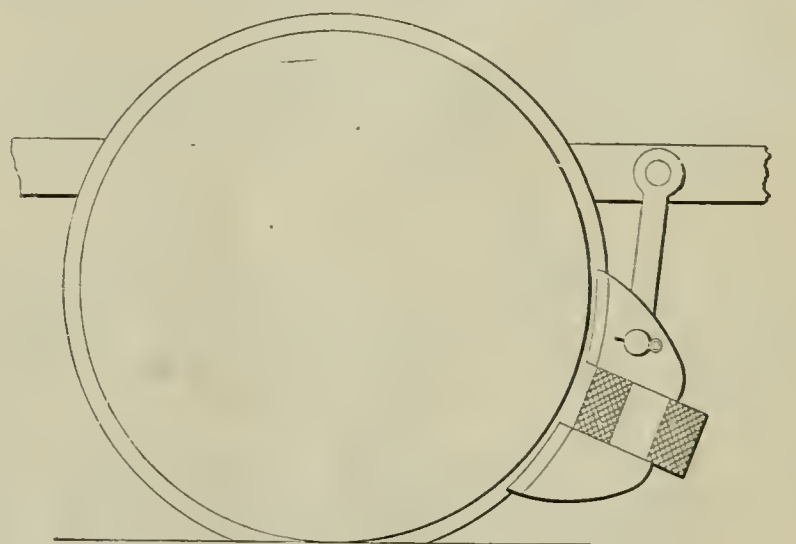
This works very well with one exception; it is not under complete control, and there is no means of graduating the pressure. If the car or cars are light, the pressure for which the brake is set may be meant for a loaded car, consequently the wheels skid, producing the railroad man's bugbear, "flat spots" on the wheels.

The principal objection to this brake was its liability to get out of order, and that the "engineers were not electricians," and so could not keep it in working order. Neither did they understand the wonderful airbrake now in common use until they had been trained in its operation and repair. However, this objection hardly applies to an electric car, for there are always a number of men connected with the road who could readily understand such an appliance.

But there is no doubt that the utilization of the momentum of an electric car to apply the brakes would be the most economical and the best method if it could be properly controlled, and it is certainly possible to do it on one car.

Whatever the system of power, an electric car should have a brake shoe upon each wheel with the leverage so proportioned as to give an equal pressure on every shoe. The writer recalls a locomotive tender brake worked by air which always wore out two pairs of rear wheel shoes to one pair in front. Such things used to be quite a puzzle to the round house foreman.

In locomotive driver brakes, it is the common practice to make the brake pressure attainable equal to from 60 to 70 per cent. of the weight on the wheel. This is usually suffi-



ELECTRIC BRAKE.

cient to lock the wheels on a dry rail, so that the brake has some surplus power. It is well known that a car with locked wheels will slide considerably further than one will run with its wheels turning and the brake on as hard as possible. In order to stop in the shortest distance, the brake must be applied as strongly as possible at first and the pressure gradually reduced as the speed lessens to prevent locking the wheels. We see this done, or rather feel it, on every steam railroad we travel on.

The best stop and the one that motormen should practice when power brakes come into use, is called a "uniformly accelerated stop." The name defines it, but perhaps the following expresses it: It is a stop which, after the first application of the brake, will not disturb the equilibrium of a person standing in the car. It is evident that the most delicate control of the brake power is necessary to do this, and on steam roads it is rarely done.

An electric brake, pure and simple, is perfectly practicable in the writer's opinion, and would probably consist of powerful electromagnets rubbing on a revolving keeper.

If these can be made powerful enough they would undoubtedly work well. The first form that naturally suggests itself is shown in the sketch.

This, if the writer is not mistaken, appeared in one of the late Mr. Van Depöele's early patent specifications.

The theory of the brake and of rolling friction, as laid down in many text books on mechanics, rarely agrees with results obtained from actual experiments with a train, for the reason that the humidity of the atmosphere and even the height of the barometer, greatly affect the results obtained.

Frankfort (Ky.) Electric Railway.

In the great distillery district of Kentucky, or "Blue Grass" region, as they call it, little or no attention has been given to the matter of transporting the output or supplies of

capacity, boiler plant, with heater, boiler feed pumps, etc. Fig. 2 illustrates the engine and dynamo room, in which two 100 h. p. Jenney dynamos are driven by one of the latest type of Dick & Church tandem compound engines of 200-h. p. capacity.

The switchboard is of the improved Jenney type, with marble panels, and all connections are made from rear of board. The instruments used are of the Weston make. The electrical station equipment was furnished and installed by the Jenney Electric Motor Company, of Indianapolis.

Tests of the generating plant have been made with very



ENGINE AND DYNAMO ROOM.

the distilleries, their whole idea in the location of these plants being given to a pure and sufficient supply of limestone spring water, this being one of the prime causes that has made this section so famous for its output of superior whiskeys, and the Capital Railway, of Frankfort, is to be congratulated on being the initial enterprise in Kentucky to give these distilleries cheap transportation for their grain, coal and wood to their plants and their output of whiskeys to the steam railway connection. In the city of Frankfort, daily, long lines of heavy wagons could be seen handling this

heavy overloads, the apparatus showing remarkable results in the way of regulation and capacity.

The freight motor car is of a special design, 28 feet in length, mounted on a pair of heavy trucks, with five-foot wheel bases, the body being extra heavy, built to withstand the severe strain of having loaded freight cars as trailers, and in appearance is very much like an ordinary baggage car, as used on steam roads. Fig. 4 illustrates this car hauling three box cars around a curve.

Four 25-h. p. motors, controlled by a single specially de-



ELECTRIC FREIGHT CAR.

business, which is now being done in an entirely satisfactory manner by the little "Lightning Bug," shown in Fig 1.

The power house is a substantial brick building, 52 by 125 feet, with a double track car barn 26 by 125 feet attached. The boiler room, which is separated from the engine room by a brick partition, is 35 by 52 feet, and contains 200 h. p.

signed controller, are attached one to each of the four axles of this car, making each wheel a driver. The total weight when empty of this car and equipment is 15 tons, and when not used for handling full loads is used for handling small shipments, barrels and boxes.

Besides the freight motor car described above, three 18-

foot closed passenger cars, handsomely finished, painted a light and attractive color, are used. These cars are equipped with 25-h. p. motors and haul trailers. The cars were made by the Barney & Smith Car Company, of Dayton, Ohio.

The track is a 56-pound T rail, laid on 6" by 8" by 8' white oak ties, two feet between centres and ballasted with crushed blue limestone rock. Heavy cuts and fills are numerous, the nature of the country through which this road runs being mountainous and the grades severe, being in some instances as heavy as 8 per cent., and in one instance a reverse curve was necessary on a 7 per cent. grade, but even here absolutely no difficulty was experienced in handling from one to three heavily loaded box cars with the freight motor car.

The overhead line is of the Creaghead flexible side bracket construction, specially made for high speed roads in the suburbs, but in the city is of side pole and span wire construction, using No. 0 trolley wire.

Frankfort is a city of about 10,000 people, capital of the State, with numerous manufacturing establishments, and so situated that it covers a large area, making the four miles of track used for passenger traffic very profitable, in addition to which the management has a beautiful park, containing about 40 acres, situated on an elevation of about 500 feet, overlooking the city and river, with a baseball and football ground and grand stand, dancing pavilion, band stand and numerous summer houses, nice walks, rustic seats and other attractions.

The design and construction of this road were done for the contractor, Frank Whitley, of Springfield, Ohio, by the Creaghead Engineering Company, of Cincinnati, under the personal supervision of George B. Scrugham. The stockholders of the local company are the principal business men of the city. Patrick McDonald is president, and John T. Buckley is secretary and general manager.

The Gillette Interior Telephone System.

In the description in our issue of May 19 of the Gillette interior telephone system, we omitted the name and address of Mr. Alexander S. Williams, 120 East Thirteenth street, New York, who is placing the apparatus on the market.

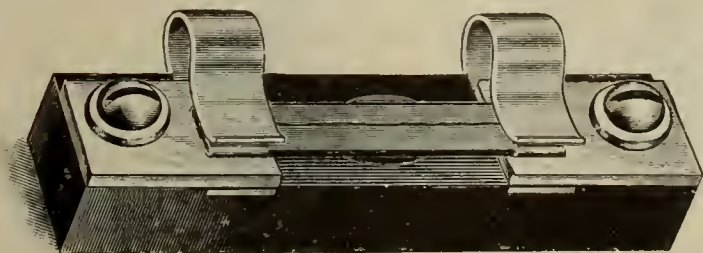
Fuse Link and Block.

The question of protection for fine wire, such as used on delicate and costly instruments and fuses, which would be of service for telegraph and telephone work, has long re-



FUSE LINK.

mained without satisfactory settlement. It has seemed to be impossible to produce a wire from fuse metal by ordinary means which would fuse at as low a current as one-half an ampere. Copper wire drawn to .002 inch is found to carry more than one ampere of current without melting. Various means have been resorted to for making low melting



FUSE LINK AND BLOCK.

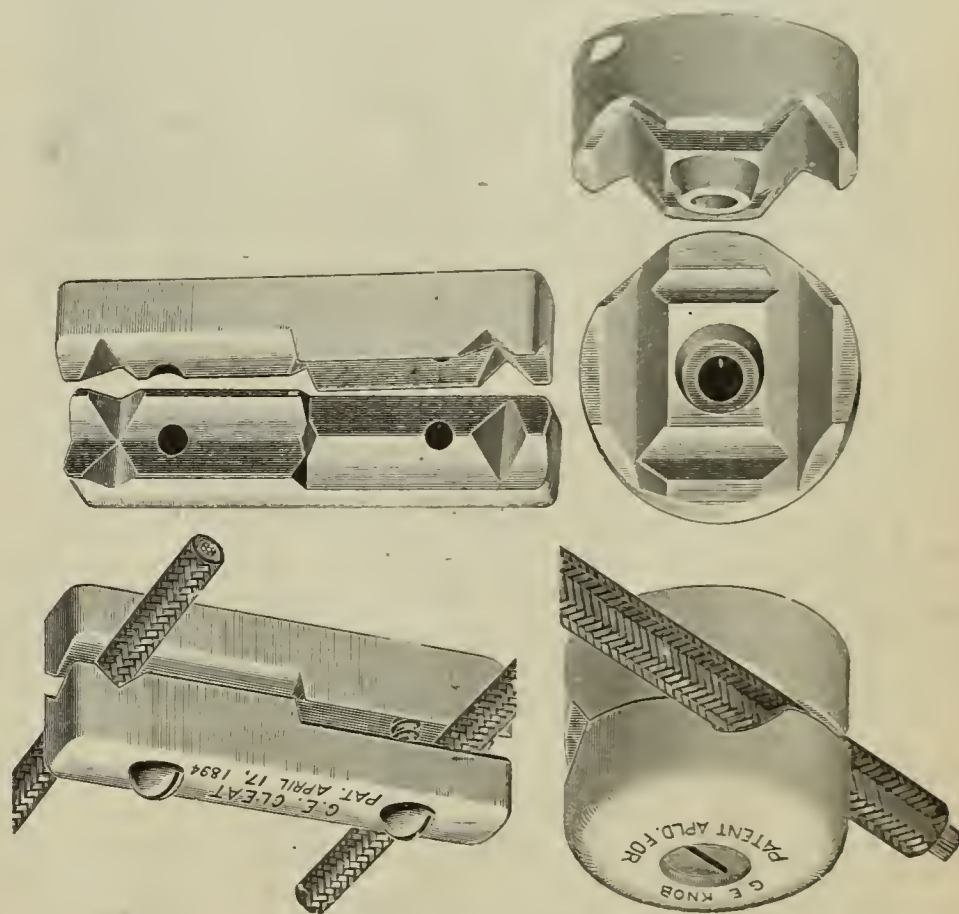
fuses, such as slitting up tinfoil, etc., but all such fuses have proved to be inaccurate and unsatisfactory.

The accompanying cut illustrates a new fuse link from the laboratory of the Independent Electric Company, 39th street and Stewart avenue, Chicago, which is claimed by

them to be as true to size and rating as other samples of their well-known tested fuse wire. The wire used in these fuses is produced by a new process from a special alloy, and although very expensive, both for the jewel dies and cost of making, it is found to perfectly accomplish the much desired end. They are now making fuse links in this form, in commercial quantities, which fuse respectively at 1-2, 3-4 and 1 1-2 amperes of current. We also illustrate a block designed and made by this company for holding these fuses.

Porcelain Electric Fittings.

The General Electric Company has lately designed certain new porcelain wiring appliances to meet the insurance requirements. The cleat is formed of two pieces exactly alike, in which the groove is so shaped that it will take a wire up to 5-16 inch in diameter, and the wires are 2 1-2 inches apart, as specified in the insurance rules. The knob is designed to hold wires from 3-16 to 1-2 inch, and do away with the unsightly tie wire. The top and bottom are each provided with



PORCELAIN FITTINGS.

four grooves of different dimensions, that any wires within the range given may be firmly secured. This knob is 1 1-2 inches high and 2 inches in diameter, the wire being held 1-2 inch from the ceiling. The floor and window tube has a central hole 5-8 inch in diameter and a head 2 1-4 inches in diameter. It is 1 3-8 inches outside diameter and 3 3-4 inches long. These porcelain appliances are of the best, hard white vitrified non-absorbent porcelain of highest resistance.

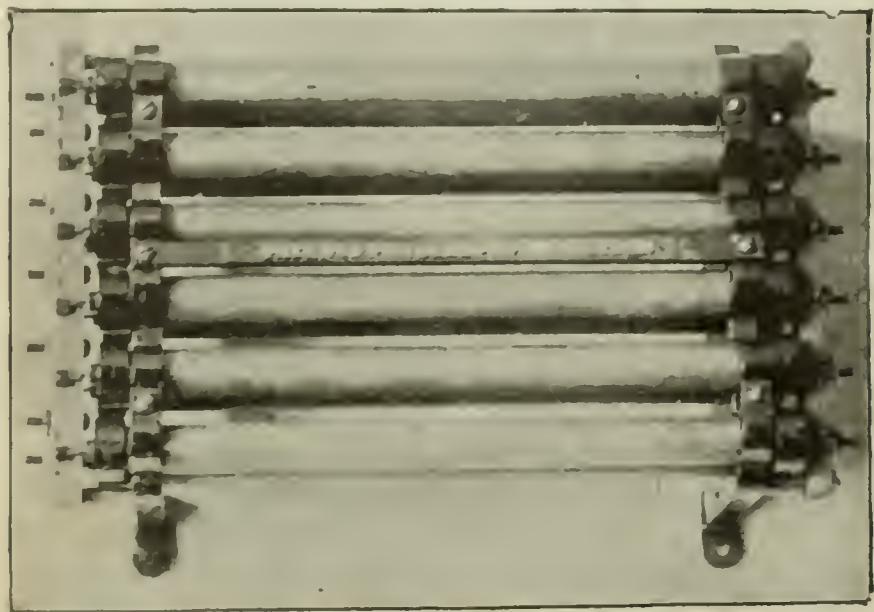
A New Rheostat.

We illustrate herewith a new form of rheostat, designed by Mr. Whittingham, and recently patented by the Automatic Switch Company, of Baltimore, Md. The principle followed in the construction is that of enclosing each resistance coil in a tubular heat radiating casing, the space between the wire and the tube being filled with a good heat conducting medium, and the grouping of a sufficient number of tubes in such manner as to allow a perfectly free circulation of air among them.

In appearance the rheostat is not unlike a small steam radiator, and its area, in proportion to its bulk, is very great. The rheostat shown in the photograph measures over all 10

by 15 inches by 2 1-2 inches thick, but its radiating area, in square inches, is something over 625.

Each tube of the rheostat is a complete ironclad resistance with a connecting terminal at each end. It is 15 inches long by 1 1-8 inches in diameter, and has an area of 52 square inches. One tube is capable of absorbing and radiating safely 250 watts of energy, and the method of construction is so flexible as to allow a single tube to be wound to stand a pressure of 500 volts. It will be seen from the figures given that the full capacity of the rheostat illustrated is a continuous radiation of 3,000 watts, but for work of an intermittent character, such as motor starting, the amount of energy can be more than doubled with perfect safety.

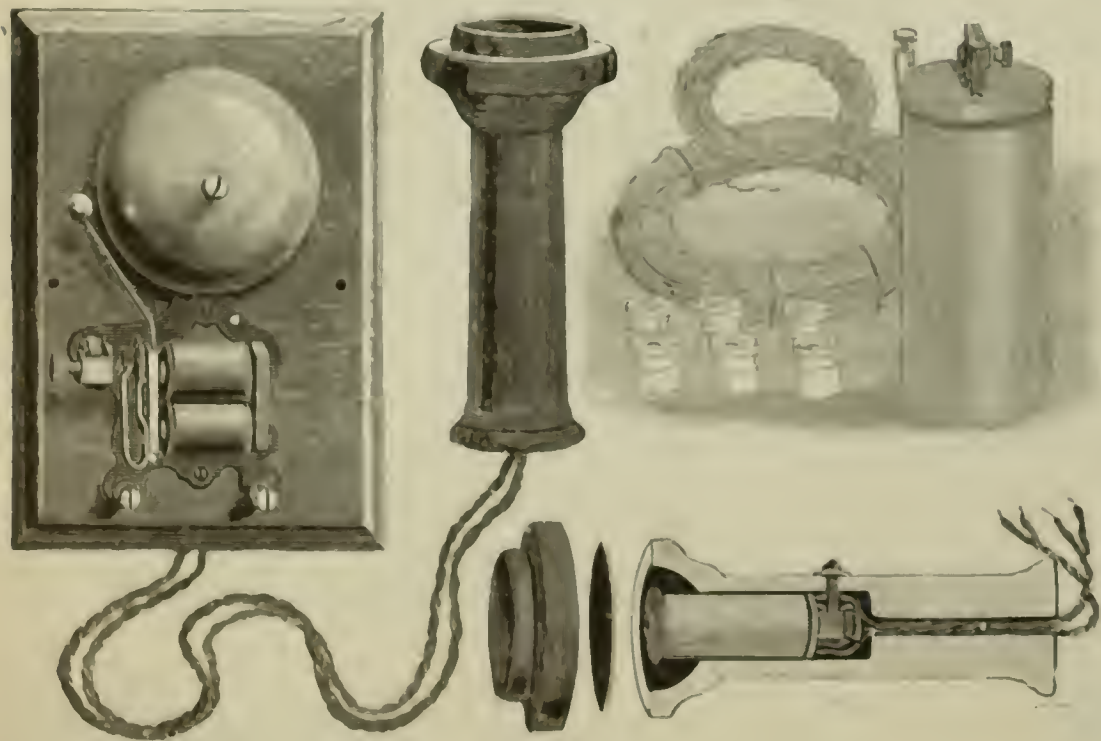


A NEW RHEOSTAT.

It is very evident that the tubular jacketing exposes, in comparison with the actual area of the resistance wire, an enormous surface to the cooling action of the air. The arrangement of the tubes, with air passages between them, has the effect of producing a strong draught as the hot air rises, which forces a continuous supply of fresh, cool air through every part of the rheostat. So perfect is this circulation that it requires nearly 800 watts to maintain a single tube at a dull red heat.

Telephone Outfit.

The telephone outfit we illustrate, made by R. H. Ingersoll & Brother, 65 Cortlandt street, New York, consists of

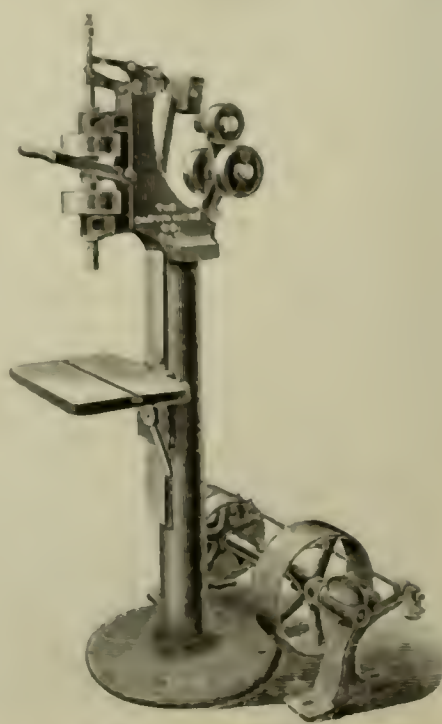


TELEPHONE OUTFIT.

ceived. It is made in substantially the same manner as regular "Bell" receivers, and will do exactly the same work in ordinary use. The call bell is of a special type, made solely for this outfit, and is capable of very fine adjustment, so as to be operated over long distances. That ordinarily furnished with the outfit is constructed to ring for a distance of one mile and under, but bells of greater capability are furnished for longer distances. The bell is mounted on polished hard wood backboard, and the whole handsomely finished. From the board, the receiver and transmitter is suspended by a telephone cord and at the back of the board, concealed from view, are the switches and connections, which are automatically operated by two push buttons at the side of the board, one to ring up and the other to connect the telephone with the line wire and battery. The batteries are of the best "dry" type, made especially for the outfit, with a view to long life and strength.

An Automatic Tapping Machine.

We illustrate herewith an automatic tapping machine recently placed on the market by the Garvin Machine Company, of Lighthouse and Canal streets, New York, which is adapted especially for use in the manufacture of hardware specialties, electrical goods, etc. In designing it the object has been to combine lightness, strength, ease and rapidity of manipulation, together with accuracy and uniformity of the work produced. The spindle is fitted with two loose friction pulleys, driven in opposite directions by one continuous belt. Between these pulleys is a friction clutch keyed to the shaft, which is thrown into the driving pulley by the downward pressure of a hand lever at the right. The tapping then proceeds, and is tripped and reversed automatically at any point in the operation by an adjustable stop on the upper end of the spindle coming into contact with a reversing lever at the top of the machine or by moving this lever by the hand. The spindle is balanced and fitted with a chuck for holding the taps. The table is rectangular, has an oil groove around it, and is adjustable up and down the column to suit the work. A feature in this tool is that it operates satisfactorily at high speed and will trip and reverse after being set, even though the operator should continue to press down the starting lever. The principal dimensions of the machine are: Diameter of spindle, 1 inch; diameter of the largest hole that can be tapped, 5-16 inch; motion of spindle, 2 1-2



AUTOMATIC TAPPING MACHINE.

a receiver transmitter, call bell and battery for each end of the line, with material for a short line and connections.

The receiver and transmitter is a combined instrument, into which the message is delivered and from which it is re-

inches; dimensions of table, 12 by 18 inches; adjustment of table on column, 20 inches; tight and loose pulleys on countershaft, 6 by 2 1-2 inches; speed of countershaft, 200 revolutions; net weight complete, 300 pounds.

THE O. C. WHITE COMPANY, Worcester, Mass., capital stock \$16,000, has been formed to manufacture and sell adjustable electric lights and other articles. The organizers are O. C. White, G. E. Francis and David Harrower, Jr.

THE INDIANA ELECTRIC RAILWAY COMPANY, Goshen, Ind., capital stock \$25,000, has been formed to operate and construct a road from Goshen to Elkhart, Ind. J. J. Burns, J. H. McIlhenny and W. L. Stone are interested.

THE WATERPORT ELECTRIC LIGHT AND POWER COMPANY, Waterport, N. Y., capital stock \$40,000, has been formed to supply electric light, heat and power. L. Beecher, C. A. Seaver and E. C. Long, all of Batavia, N. Y., are the promoters.

THE HONESDALE ELECTRIC RAILWAY COMPANY, Honesdale, Pa., capital stock \$100,000, has been formed to construct, maintain and operate an electric railway. W. H. Dimmick, W. N. Alberty, Honesdale, and M. M. Treadwell, Hawley, Pa., are the promoters.

THE AMERICAN CONSTRUCTION COMPANY, Lancaster, Ky., maximum capital stock \$500,000, has been incorporated to construct and operate electric light and power plants, etc. W. H. Kinnaird, R. H. Tomlinson and J. T. B. Twiner, Lancaster, Ky., are interested.

THE NATIONAL SCHOOL OF ELECTRICITY, Chicago, Ill., capital stock \$100,000, has been formed to teach the principles of electrical and allied sciences, and to transact all business incident thereto. The incorporators are Walter C. Jones, Geo. L. Cragg and Geo. S. Buell.

THE VAN CHOATE ELECTRIC COMPANY, Portland, Me., capital stock \$6,000,000, has been incorporated to manufacture and deal in electrical appliances and machinery of all kinds. S. F. Van Choate, F. W. Willey, Boston, and W. L. Knox, Winchester, Mass., are interested.

THE PEOPLE'S TELEPHONE AND CONSTRUCTION COMPANY, Wheeling, W. Va., maximum capital stock \$100,000, has been formed to construct and operate telephone and telegraph systems, etc. J. J. Woods, W. D. Johnson and J. B. Somerville, Wheeling, W. Va., are interested.

THE NONPAREIL ELECTRIC COMPANY, Philadelphia, Pa., maximum capital stock \$3,100,000, has been organized to manufacture and sell storage batteries, dynamos, motors, etc., construct electric plants, etc. G. O. Corbron, Jr., T. J. Crosier and E. C. Paramore, all of Philadelphia, are the incorporators.

THE GARDNER ELECTRIC STREET RAILWAY COMPANY, Gardner, Mass., capital stock \$50,000, has been formed to construct and manage a street railway through Gardner, South Gardner and West Gardner, length of same to be $3\frac{1}{2}$ miles. L. A. Greenwood, J. A. Stiles and Chas. Heywood, all of Gardner, are the promoters.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, New York, May 28, 1894.

MR. MALCOLM DONALD PECKHAM, brother of Mr. Edgar Peckham, of the Peckham Motor Truck and Wheel Company, who was assaulted by a former employe on May 15, died last week from the effects of the injuries received.

THE CITIZENS' ELECTRIC ILLUMINATING COMPANY, of Brooklyn, has been presented a bill of \$9,954 by the water purveyor of Brooklyn for water said to have been surreptitiously taken from the city mains during the last four years.

THE GENERAL ELECTRIC COMPANY has closed the contract for the Poughkeepsie and Wappinger's Falls Railway, of Poughkeepsie, covering two 200-kw. direct connected generators, 40 G. E. 800 motors and type K controllers.

THE NEWTON ELECTRIC COMPANY, 39-41 Cortlandt street, has absorbed the Imperial Manufacturing Company, formerly of 143 Liberty street, and the line cut-outs and indicators of that company will hereafter be made by the Newton Electric Company.

BRIDGE LIGHTING.—Plans and estimates will be received by the chief engineer of the New York and Brooklyn Bridge, at 179 Washington street, Brooklyn, to noon, June 15, for lighting the bridge cars, as per details to be had of C. C. Martin, chief engineer and superintendent.

THE METROPOLITAN TELEPHONE AND TELEGRAPH COMPANY has offered its subscribers the choice of two plans of paying for telephone service. They can pay \$240 and get the latest improved metallic circuit for a year, or they can pay \$150 a year if not more than 1,000 messages are sent. If they send more they must pay for the excess on a sliding scale, beginning with 15 cents a message, and gradually decreasing to 5 cents. The new plan is to induce persons who have no great use for the telephone to subscribe at a cheaper rate. The company now has 10,053 stations in New York, including the pay stations, and 75 per cent. of these use the long distance telephone. The company hopes to greatly increase the number of long distance stations by the new plan.

Pittsburgh Notes.

PITTSBURGH, May 26, 1894.

THE SUB-COMMITTEE ON PUBLIC LIGHTING, of Allegheny City, met yesterday and awarded the contract for an addition to the municipal central station plant. The new building will cost \$26,000.

THE IRONWORK for the machine shop and warehouse of the new factory of the Westinghouse Electric and Manufacturing Company at Brinton is now completed, and the power house is being put up.

THE ANNUAL MEETING of the stockholders of the Pittsburgh, Allegheny and Manchester Traction Company was held last Tuesday. The report of President John H. Dalzell showed that the gross receipts of the company for the year were \$450,912.97, operating expenses and fixed charges \$361,146.71. Dividends to the present time \$257,110.56, and the net income from the time of the reorganization of the company up to the present time \$296,760.24, leaving a balance of \$39,849.68. The cash on hand April 30, 1894, was \$45,509.24. The general manager reports cost of operating the power station at 1.3 cents per car mile; the cost of electrical energy per kilowatt hour somewhat above 1 cent. The old board of directors was re-elected as follows: John H. Dalzell, Joshua Rhodes, G. B. Hill, Fred. Guinner and Wm. Eberhardt.

TO GET RID OF THE WIRES from the inside of central station plants is a problem that has at one time or other confronted every manager, especially in large plants where the number of wires rapidly accumulates, and thus the risk of fire grows correspondingly as the difficulty of keeping the wires apart increases. The Allegheny County Light Company, operating one of the largest electric light stations in the country, has just completed an arrangement whereby all the wires inside the plant have been placed underground. The company has in operation nine 4,000-light Westinghouse alternators, 26 60-light Brush arc dynamos and two 250-h. p. Westinghouse direct current power generators. The alternators supply incandescent lighting to private consumers and business houses, the arc dynamos supply light to the streets of Pittsburgh as well as business places, and the Westinghouse power generators are used for the supply of power to elevators, sewing machines, printing presses, fans, etc. To abolish the wires from the interior of the station, the company built subways for the wires from the dynamos to the marble switchboard, and also subways for the wires from the switchboard to the outside of the building. For this purpose there are constructed four subways—two from the dynamo to the switchboard, and two from the switchboard to the outside of the building. Two of them contain the incandescent wires, and the others the arc wires and the wires from the power generators. The subways from the dynamos are each 180 feet long. They are constructed of 13-inch brick walls with an arched roof, and the dimensions of the subway are 6 by 4 $\frac{1}{2}$ feet. The floor is composed of cement, and any water which occasionally accumulates is taken out by steam siphons. The subways are lighted by electric lights, and the cables are carried upon brackets, which are fastened in the side walls. Each bracket carries four cables, allowing ample space for workmen to pass to and fro. The subways are connected with sewers, on account of the close proximity of the station to the river. The subway for the incandescence circuits from the switchboard to the outside terminates in an 8-foot manhole, and from here the wires go to two 65-foot poles, on which the cables are carried to the overhead circuits. The subway for the arc and power circuits, from the switchboard to the street, is constructed the same way as the other, leading also into a manhole, and from there to two 65-foot poles. The pole line, extending from the station to the downtown district, is composed of 65-foot poles, 10 inches at the base and 16 inches at the top. Each pole has 15 six-pin cross arms, which means 90 wires, the latter ranging from No. 6 to 0000 wire.

Canadian Notes.

OTTAWA, Ont., May 26, 1894.

NIAGARA FALLS.—Notice is given that, under the Ontario Joint Stock Companies' act, letters patent have been issued, whereby the capital stock of the Niagara Falls Electric Light and Power Company, Ltd., has been increased from the sum of \$40,000 to \$75,000.

CARLETON PLACE, ONT.—Application is being made to the Ontario Government for incorporation of the Lanark County Electric Railway Company, Ltd., capital stock \$100,000, to build and operate a line from Perth to Lanark. The applicants are John B. Riley, of Plattsburg; Alex. Wendler, Carthage, N. Y.; Thomas Henry, Montreal; A. H. Edwards and James Fowler, Carleton Place. A preliminary survey has already been made with a view to obtaining a direct line, and as the individuals in the company are all practical business men, the project is expected to go forward at once. The towns interested will probably be asked to assist the enterprise.

OTTAWA, ONT.—Lord Aberdeen, Canada's Governor-General, has purchased an electric yacht from the Electric Launch Company of New York. The launch is 35 feet 10 inches over all in length, and 31 feet 6 inches on the water line. The beam is 6 feet 2 $\frac{1}{2}$ inches, and the draught 27 inches. It carries 20 people with plenty of room and comfort, and indeed can seat 30. The motor is underneath the flooring of the boat, where it turns the propelled shaft. One man in the bow controls both the motor and the steering. The storage batteries, which can be charged from any trolley or lighting wire, are under the seats. Fully charged, the batteries can give the launch a run of 70 to 80 miles. The ordinary speed is about 6 miles an hour, but a turn of the lever can put this up as high as 10 miles an hour. The cost of running the launch, as far as electricity is concerned, is only about 6 cents an hour at the ordinary rate of speed.

English Notes.

(From our own Correspondent.)

LONDON, England, May 17, 1894.

COST OF ELECTRICAL ENERGY.—The discussion on Mr. Crompton's paper on "Cost of Electrical Energy," recently read before the Institution of Electrical Engineers, has been adjourned to the 24th, the date of the last meeting of the session. The discussion has so far been in keeping with the value of the paper. Mr. Raworth, of the Brush company, as I before stated, opened the discussion on the evening of the reading of the paper. On Thursday last the adjourned discussion was opened by Mr. Crompton, who drew attention to a diagram giving the results of a 24-hour test of a boiler at his Chelmsford station. He showed that when a careful run was made, the pounds of water evaporated per pound of coal rose to a little over 9, although on the year's run the figure only came out at 5.2 pounds. Major-General Webber threw some doubt on the possibility of Mr. Crompton's hypothetical estimates. Mr. Mark Robinson, of Willans & Robinson, hoped that Mr. Crompton's prediction of a consumption of only 2.5 pounds of coal per unit sold might some day be realized, and pointed out that the prediction rested on three factors; viz., the evaporation by the boiler of 12 pounds of water per pound of coal, the consumption by the engine of only 12 pounds of steam per I. H. P. hour, and a very small amount of friction. With regard to the boiler factor, he could only say that Mr. Crompton's figure was beyond present practice. Mr. Robinson, however, corroborated Mr. Crompton's assertions as to the dryness of the steam obtained from water tube boilers. His own company had taken up a water tube boiler from which they hoped great things, and which, in spite of its being forced to double its original capacity, continued only to give $\frac{1}{4}$ per cent. of moisture. As regards the engine consumption, Mr. Robinson pointed out that the figure of 12 pounds of steam per I. H. P. hour had only so far been obtained by the horizontal slow speed Sulzer engine. The best experimental figure of the Willans engine was about 12.8 pounds, and the best guarantee the firm had ever given was 13 pounds for a large marine engine. Coming to the subject of engine friction, Mr. Robinson controverted some remarks made at the previous meeting by Mr. Raworth, who had stated that the brake efficiency of the Willans engine was only about 89½ to 90 per cent., whilst any double-acting vertical engine could be made to show 92 per cent. Mr. Robinson pointed out that cards taken from an engine running light were really no criteria, at any rate, in the case of the Willans engine, as to its efficiency when running loaded, since, in the case of the Willans engine, two of the four sources of friction were absent, and the remaining two sources of friction were in the Willans engine constant, whilst they tended to increase in ordinary double-acting engines as the load came on. Mr. W. Geipel, who has charge of the central station design department of the Brush company, was of opinion that engineers should have a good deal to do in the matter of controlling the first cost of electric light stations. In his opinion the present high price of electric supply was due mostly to an insufficient consideration having been given by engineers to this very question of first cost. What was the use of providing coal or labor saving apparatus if the apparatus cost more than the saving it was proposed to effect. He did not see how the coal consumption could possibly be reduced to 2½ pounds per unit sold, but believed that 4 pounds might be reached even with ordinary English coal. He also cast doubts on the possibility of Mr. Crompton's figure of 12 pounds of water being evaporated per pound of coal. Mr. Geipel then described to the meeting two methods of setting boilers, which he had designed with a view to reducing the losses due to radiation. The one applied to the Babcock-Wilcox boiler consisted in a thermal insulator in the form of an air space effected in the middle of the brick side walls. The other consisted in passing the gases after they had been through a large side flue round each boiler consecutively to the chimney, so that whatever number of boilers happened to be out of use at any time, they were kept warm by the waste gases coming from those in use. Mr. Geipel did not agree with Mr. Crompton that the Lancashire boiler was unsuitable in all cases for electric lighting purposes. He was of opinion that if bituminous coals were used, the figure of merit of the Babcock-Wilcox and Lancashire boilers would probably be reversed, and bituminous coal was not to be thought altogether out of the running for electric lighting stations, since it had been demonstrated that it could be burned under proper conditions without causing smoke. Several purely mechanical engineers then addressed the meeting, one of them causing considerable amusement amongst the assembled electrical engineers by solemnly giving his vote against the use of high-speed engines for electric lighting purposes.

THE PACIFIC CABLE QUESTION.—The question of the proposed Pacific cable still continues to occupy the attention of submarine telegraph circles in this country. Within the last few months quite a shower of colonial representatives has descended upon this country, and have all with one accord endeavored to catch the public ear and open the public pocket on behalf of a British cable connecting Australia with Canada. The latest episode is a long letter to the "Times" from Sir John Pender, controverting certain statements recently made by Sir Charles Tupper, a colonial representative, at the Royal Colonial Institute. Sir Charles Tupper, as an instance of the long life which might be expected of a cable, stated that 30 per cent. of the present cables of the Eastern Extension Company were more than 20 years old.

Sir John Pender points out that nearly the whole of that company's cables have been renewed in a considerably shorter period than 20 years. He also shows by actual instances that it is impossible to rely upon a normal annual increase of 12½ per cent. in the volume of traffic. The fact is that this proposed cable has next to no commercial *raison d'être*, at present scarcely any strategic value, and, letting alone the probability of there being colonial politicians with axes to grind, sentiment, no doubt estimable, is alone the reason for the outcry for this new imperial toy. The great depth of the Pacific, which is so frequently held up as a source of safety in case of war, does not really add very much to the security of the cable should a determined enemy be intent upon cutting it. A cable can only be picked up with any degree of readiness, at depths over a few hundred fathoms, by men who have devoted their whole lives to the care of cables. Any greater depth, therefore, than a few hundred fathoms does not, from a strategic point of view, add appreciably to the value of a cable. The Canadian and Australian ends of this cable will not run immediately into deep water, so that the shore ends of this Pacific cable need to be watched by the ships of the nation owning it, in order to secure it immunity from irruption.

ENGINEERING AT CAMBRIDGE.—Professor Ewing's laboratory was opened at Cambridge on Tuesday by Lord Kelvin.

THE HEILMANN LOCOMOTIVE.—This much advertised locomotive is now regularly running a train from Paris to Mantes, a distance of 33 miles, performing the journey in 55 minutes.

News of the Week.

Telegraph and Telephone.

WASHINGTON, MO.—A. W. Tibbe has built a telephone line to Union.

LONDON, OHIO.—The City Council has granted to Thos. H. Roland a franchise for a magnetic telephone system.

ST. JOSEPH, MO.—The Citizens' Telephone Company is pushing its work to completion; its pole line is all set, and it has started stringing wires.

MIDDLETOWN, N. J.—R. H. Holmes, a brother of Superintendent W. J. Holmes, of the Western Union, is organizing a telephone stock company at Middletown.

Electric Light and Power.

EMPIRE, OHIO.—C. W. Nicholson will build an electric light plant.

HAMBURG, IA.—H. P. Smith is to establish a new lighting plant.

ST. JOSEPH, MICH.—The electric light plant has been destroyed by fire.

VICTORIA, TEX.—For information regarding the electric light plant address the mayor.

RACINE, WIS.—The Racine Common Council will readvertise for bids for electric lighting.

WELLINGTON, OHIO.—The matter of the municipal electric lighting plant is being discussed.

GRENADA, MISS.—The mayor may be addressed concerning the proposed electric light plant.

MOUNT AIRY, N. C.—An electric light plant is to be established, and the mayor may be addressed for information.

CUBA, N. Y.—It is stated that the proposed electric light plant for Cuba will soon be built to supply light for public and private use.

MACON, GA.—T. D. Tinsley was appointed permanent receiver on May 22 for the Macon Gas, Light and Water Company, by Judge Speer.

HOUSTON, TEX.—A resolution to issue \$100,000 in bonds to provide for a municipal electric lighting plant has been referred to the board of public works.

ST. LOUIS, MO.—Councilman Albert Arnstein, member of the subway commission, reports to the commission that it would cost \$1,000,000 to build suitable conduits.

HILLSBORO, TEX.—The electric light company, composed of local capitalists, has come to terms with the authorities, and will, within 45 days, begin work on its proposed electric light plant.

MONROE, LA.—The Monroe Waterworks and Light Company is putting in additional power in the shape of a 150-h. p. Armington & Sims engine, and will operate a new incandescent circuit at once.

WASHINGTON, IOWA.—The electric light plant has been leased by G. W. Benedict for a company in Liberty, Ind. It will take possession Aug. 1, and will rebuild and improve the present plant.

JAMESTOWN, N. Y.—A resolution has been passed authorizing the board of public works and the municipal lighting commission to make plans and specifications for the proposed additions to the municipal electric lighting plant.

READING, MASS.—The town of Reading has voted to reject the

offer of the Woburn Electric Company to supply electric light to the town, and will instead build a plant with a brick power station and 41 miles of wire, to cost \$41,000.

ST. AUGUSTINE, FLA.—The General Electric Company, capital stock \$50,000, has applied for incorporation to build and operate an electric light, heat and power plant. Wm. A. MacWilliams is president and J. A. Enslow secretary and treasurer.

MOUNT HOLLY, N. J.—The Citizens' Water Company, capital stock \$75,000, has been formed, and the following are the committee in the matter of the proposed waterworks and electric light plant: Thomas J. Alcott, John D. Johnson, A. A. Anderson and Dr. C. R. C. Barrington.

SPRINGVILLE, N. Y.—It is stated that an artificial lake will be made here, and that power will then be supplied to the manufacturing industries of the town. An electric light plant is one of the probabilities. Messrs. King, of Delevan, and Scott, of Springville, are interested.

DU BOIS, PA.—The council of the borough of Du Bois wishes to contract for electric lighting, to be 40 or more electric lights of 1,200 candle power each, for a term of six years from Jan. 1, 1895, as per plans in the possession of the borough attorney, G. A. Lukehart. All bids are to be in by July 6, at 7 P. M. H. McCullough, D. J. Carson and F. A. Hatfield are the light committee.

ST. JOSEPH, MO.—Walter C. Stewart, formerly electrician of the People's Street Railway, Electric Light and Power Company, has been appointed electrical inspector. Heretofore St. Joseph has been without an inspector. His salary is paid partly by the city and partly by the Board of Fire Underwriters. William H. and Oliver Harriman, of New York, stockholders of the St. Joseph Traction and Lighting Company, are in the city seeing about increasing the lighting capacity of the plant this fall.

The Electric Railway.

RED BANK, N. J.—An electric road is proposed from Red Bank to Seabright.

SANDLAKE, N. Y.—The survey for the Troy and Sandlake Railway has been completed.

NEWARK, N. Y.—The Village Board is considering an application for right to build an electric railway on the streets here.

ELMIRA, N. Y.—The West Side Street Railway will in a few days begin the work of laying its lines in the eastern part of the city.

GRAND RAPIDS, MICH.—The North Park Street Railway Company has raised \$75,000 on mortgage, to be devoted to improvements.

NEW BRITAIN, CONN.—Superintendent Breed, of the Electric Traction Company, will make extensions and improvements this spring.

OPELIKA, ALA.—The Opelika and Auburn Electric Railway Company is in the market for equipments. Address C. I. Daughtry.

KANSAS CITY, MO.—W. J. Smith is organizing a company to reconstruct and extend the East Fifth street railway. Electricity will be the motive power.

GREEN ISLAND, N. Y.—The petition of the Troy City Railway Company to change its motive power from horses to electricity is receiving many signatures.

APPLETON, WIS.—F. S. Maxwell, representing the Tillotson interest, is pushing the scheme for an electric road between Neenah and Kaukauna, via Appleton.

COHOES, N. Y.—Residents of the first, fourth and fifth wards met in Houlihan's Hall and discussed the matter of establishing a belt line railway over the hill.

WHITE PLAINS, N. Y.—A special committee, consisting of S. L. H. Ward and James B. Lockwood, are looking into the matter of a street railway for White Plains.

NEW BRUNSWICK, N. J.—The Board of Trade has expressed itself in favor of having the electric railroad ordinance, now pending, passed over the mayor's veto.

PUNXSUTAWNEY, PA.—There is a scheme being talked of to build an electric railway between Punxsutawney and Indiana, but no definite move has yet been made.

WILKESBARRE, PA.—The directors of the Wilkesbarre and Wyoming Valley Traction Company have decided to build the road up over the heights within 30 days.

WASHINGTON, D. C.—The Washington, Alexandria and Mt. Vernon Electric Railway Company has been authorized by Congress to lay tracks on certain streets.

PEEKSKILL, N. Y.—The New York "Mail and Express" states that the proposed electric street railway line for Peekskill has been abandoned, as the necessary capital could not be raised.

SOUTH KINGSTON, R. I.—The taxpayers have decided to oppose any attempt to locate an electric road in their town. They think it will injure the quiet humdrum respectability of the place.

WASHINGTON, MO.—A. W. Tibbe, proprietor of the Washington electric light plant, has extended his incandescent circuit to the neighboring town of Union, 10 miles distant, and will light up June 2.

AKRON, OHIO.—A company has been formed by Gen. Sam. Thomas, of New York; the Hon. Calvin S. Brice, U. S. Senator, and others, with a capital of \$3,000,000, to build an electric line from Akron to Pittsburgh.

NEWBURGH, N. Y.—The petition of the Newburgh and Orange Lake Railway for right to build a street railway, will be heard May 29, at 7:30 P. M., in the common council's room. D. J. Countant is clerk of the council.

HONESDALE, PA.—In the matter of the proposed electric road between Honesdale and Hawley, D. J. Duncan, of Johnstown, who is connected with the Carbondale Traction Company, states that he will put \$5,000 into the venture.

BLOOMFIELD, N. J.—The Bloomfield township committee has referred to a special committee the application of Frank W. Child, on behalf of the Suburban Traction Company, for leave to change its motive power from horses to electricity.

LEWISTON, N. Y.—It is stated on reliable authority that Contractor West will soon begin work on an electric line from Lewiston to Youngstown. A large number of Italian laborers now quartered in Lewiston gives color to the rumor.

SKOWHEGAN, MICH.—The matter of the proposed electric road from Skowhegan to Norridgewock is again being agitated. Amos F. Gerald, Hon. I. C. Libby and S. A. Dinsmore have been looking over the ground, and steps will soon be taken.

ST. AUGUSTINE, FLA.—The St. Augustine Electric Railroad Company is preparing to build an electric plant at North Beach to operate its road. The company will extend the road 4½ miles, and is in the market for cars and electric supplies.

BALTIMORE, MD.—President Nelson Perin, of the City and Suburban Railway, has asked the authorities for permission to extend the company's tracks from the present terminus at Point Breeze to Sparrow's Point, and the matter is under deliberation.

PINE BLUFF, ARK.—The Citizens' Street Railway Company has been sold to a Cincinnati company, of which K. P. Bradford will be president and general manager, but the board of directors will be chosen in Pine Bluff. The entire line will be improved and electric power adopted.

BLOOMFIELD, N. J.—At a meeting of the Bloomfield township committee the Central Jersey Traction Company asked for a franchise to build a trolley line from the Montclair line to the Newark line through Bloomfield avenue, and the petition was referred to the committee on franchises.

PITTSBURGH, PA.—The committee on corporations, of Allegheny, Pa., has granted to the Union Line permission to extend its line from Wood's Run avenue to Watson Park. The Allegheny Traction Company has also been granted permission to build an electric line on Spring Garden avenue.

PHILADELPHIA, PA.—The Manayunk, Roxborough and Wissahickon Inclined Plane Railway Company has awarded to Stern & Silverman the contract for building the new power house at Shawmont, and the full equipment of the road from Wissahickon to Barren Hill, the work to be finished within 60 days at a cost of \$60,000.

HACKENSACK, N. J.—Alfred C. Zabriskie is before the Hackensack Improvement Commission in the matter of getting a franchise for his proposed street railway, but he refuses to specify the power, barring only steam, which he guarantees not to use. He has been asked to make a definite request, and the matter will then be considered.

WASHINGTON, D. C.—Sealed proposals will be received at the office of the commissioners of the District of Columbia to 2 P. M., June 7, for relaying with grooved rails so much of the Columbia Railway tracks as may be necessary, in accordance with specifications and blank forms of proposals on application to J. W. Ross, Geo. Truesdell and C. F. Powell.

ELIZABETH, N. J.—The Suburban Electric Street Railway Company, through its attorney, B. V. Lindabury, has applied to the Board of Freeholders for permission to lay tracks between Elizabeth and Plainfield and Westfield. At the next meeting of the board a date will be fixed for a public hearing, and there is no doubt that much opposition will arise.

NASHVILLE, TENN.—General Jackson, president of the Nashville Street Car Company, states that he has made a five-year contract with the Cumberland Electric Light and Power Company, by which the company will furnish power to operate the street cars. The Cumberland Electric Light and Power Company will take over the plant of the old United Electric Company, and improve and extend the same.

HARTFORD, CONN.—D. F. Keenan, of Meriden, Conn., has signed a contract with the Hartford Street Railway Company to build extensions to Windsor, Pequomock and Rainbow, and perhaps to South Windsor. His contract does not call for doing the overhead work. Mr. Keenan is one of the owners of the Meriden Railway system.

APPLETON, WIS.—D. W. Stroud, Norman McCarthy, T. S. Maxwell and F. E. Cole contemplate building an electric railway

from Oshkosh to Kaukauna, via Neenah and Appleton. The County Board of Outagamie County will pass on the matter of a franchise at a special meeting in June, and work will be begun at the earliest possible moment.

WILMINGTON, DEL.—The Wilmington City Electric Company is negotiating for the purchase of the Riddle's Mills site, on the Brandywine, $1\frac{1}{2}$ miles from the centre of the city, and the present lighting station for the generating of electricity for light and manufacturing needs. The water power at the location is 300 h. p., which is considered ample for the company's needs. The city lights will get their electricity from the new plant. The company has secured the city lighting for another term at a reduced rate.

Miscellaneous Notes.

THE CORRESPONDENCE SCHOOL OF TECHNOLOGY, of Cleveland, Ohio, has issued a catalogue containing a description of the various courses taught, with portions of correspondence papers to illustrate the methods pursued. A full explanation of the scope and object of the school is given, and its manifest advantages pointed out. The high technical standing of the members of the faculty, and the fact that all are engaged in commercial work, are two points of importance brought out.

THE ROSE POLYTECHNIC INSTITUTE, Terre Haute, Ind., though one of the youngest of the institutions which have established electrical departments, has enjoyed unusual success. While its plan of education insists upon and fully develops the theoretical side of the instruction, and includes the modern languages as well, it lays especial emphasis on the practical side of technical education, as it is able to do throughout the whole course of four years by reason of ample shops, drafting rooms and laboratories, and an exceptionally complete outfit of instruments of precision.

PENNOCK AGAIN.—The "Universal Magazine," a new monthly publication of Boston, discounts its future by devoting a page and a half of its April issue to G. B. Pennock, accompanied by a full page portrait—and a full page advertisement. It is announced that "the Pennock system can put 20 h. p. in a boat and deliver 100 h. p.; yes, 200 h. p.—at the propeller shaft." The advertisement concludes with a statement that a limited amount of the Pennock stock is now offered in lots to suit investors, and we learn that Riverton, N. J., is now one of the bases of operation.

FREE ELECTRICITY.—Mr. Fremont Wilson, in a letter to the "Standard," a journal devoted to the underwriters' interests, states that in Brooklyn there are places where people are using escaped current from the trolley lines and ground connections for the purpose of running motors and furnishing current to lights, attaching their wires to the water pipes for one connection and to the elevated railway structure for the other. He says that in a store window in that city there is a motor running connected in this manner, and that it has been brought to his attention that one of the telephone exchanges in a suburban district intends to use a motor dynamo for the purpose of running the telephone exchange, it being intended to use the ground connections and escape current from the trolley line for the purpose of operating the motor, and then use the current which is developed from the generating end of the armature of the motor dynamo for the purpose of supplying current to the telephone exchange, thus doing away with batteries. Mr. Wilson adds that it has been broadly intimated to him that this plan is being tried in a telephone station not a very great distance from New York City.

ELECTRIC HEATING.—In a paper recently read by Mr. W. S. Hadaway, Jr., before the New York Electrical Society, on "Electric Heating from the Engineering Point of View," it is shown that electric street car heaters only cost 5 cents per day more than coal stoves, the figures being 20 and 15 cents, respectively. It is stated that present installations of cooking apparatus demonstrate the success of electric cooking, both as regard cost and simplicity of operation. An installation in this city operating since Jan. 1 has proven conclusively that theoretical deductions are not far fetched, and that electric cooking can no longer be regarded as an experiment or a fad. This plant consists of oven of two compartments, broiler of three sections, portable stoves of various sizes, tea-kettle and farina boiler, which have heaters directly attached to them, and plate warmer. The cooking operations are carried on beneath a hood ventilated by a fan driven by a motor, and the kitchen is very comfortable as a dining room. At the rate of 5 cents per horse power hour, the cost per person per day is about 2 cents. At the rate of $2\frac{1}{2}$ cents per horse power hour, which may be considered a fairly representative price from water power stations, cost per person per day would be about 1 cent, and from an isolated plant, directly operated, cost per person per day would be about 2-5 cent. Electric cooking is therefore far cheaper than cooking by gas or stoves, excluding the water boiling factor, which is more expensive. Heating houses by electricity is pronounced impracticable, and it is stated that for space heating coal at \$5 per ton, burned under a good boiler, and distributed throughout the building by direct steam, is on a parity with the electrical horse power at \$4 per year, while there is no instance where power can be sold at this rate; in fact, interest cost on an electrical plant usually equals this amount.

Trade and Industrial Notes.

THE CHICAGO INSULATED WIRE COMPANY has moved its office to Rooms 414 to 416, Northern Building, corner of Lake and La Salle streets, Chicago.

CHAS. C. CALDWELL, electrical and mechanical engineer, has removed from Springfield, Ohio, to Shelbyville, Ind., where his address is 82 West Broadway.

THE AMERICAN CIRCULAR LOOM COMPANY announces that it removed its offices to its factory, Highland and Suffolk streets, Chelsea, Mass., on May 22, 1894. The present postal address is Chelsea Station, Boston, Mass.

THE PECKHAM MOTOR TRUCK AND WHEEL COMPANY, Havemeyer Building, New York, has accepted the resignation of A. W. Field as vice president, and elected H. C. Soop, of Kingston, to the vacancy thus created. Mr. Field will take charge of the Boston office.

THE BOSTON GEAR WORKS, 31 Hartford street, Boston, has issued its 1894 catalogue, containing 40 pages of lists, illustrations and information relating to gears. A specialty of this firm is that of cutting all kinds of gears to order and furnishing gears for experimental work.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, 50 Broadway, New York, has issued a revised price list of the Fleming woven wire gauge dynamo brushes, which are so largely used in central stations, and have been adopted by the United States, English and Brazilian navies.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, has devised a special globe net for arc lamps to meet the requirements of underwriters. The company also reports the sale of a large number of complete Mogul lamp equipments for theatre and hall lighting during the past week, in addition to several outfits for outside work, as a substitute for arc lamps.

THE ELECTRICAL ASSOCIATION, INC., of Waterbury, Conn., has placed the contract for its new power station with the Berlin Iron Bridge Company, of East Berlin, Conn. The building will be 66 feet in width and 183 feet in length, the side walls of brick and the roof covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron.

THE PRICE RAILWAY APPLIANCE COMPANY, 125 South Fifth street, Philadelphia, have recently placed on the market a new copper bond, which affords 90 square inches of contact with the two rails, and which is offered as a substitute for the inadequate bonding with rods from $\frac{1}{2}$ to 9-16 inch in diameter, and of a length varying from 10 to 30 inches.

THE WESTON ENGINE COMPANY, Painted Post, N. Y., sends us a handsomely printed and bound catalogue containing an unusually clearly written technical description of the various parts of the Weston automatic engine, and illustrated by a number of beautifully executed cuts by Bartlett. Rules for calculating the horse power of indicator cards and a list of Weston engine constants are appended.

THE BUILDERS' IRON FOUNDRY, Providence, R. I., has recently successfully cast one-half of the General Electric Company's 450,000-watt alternating current dynamo. This is a difficult piece of work, as 10 laminated iron pole pieces have to be cast in, and it is essential that they be absolutely united with the cast iron and accurately spaced. The Builders' Iron Foundry is particularly successful with this class of work.

THE CREAGHEAD ENGINEERING COMPANY, 296 Plum street, Cincinnati, Ohio, has issued a catalogue, consisting of 24 large pages, and containing illustrations, descriptions and prices of electric railway overhead parts. A very complete line of trolley fittings is shown, as well as station and line switches, lightning arresters, line material and arc lamp pulleys. A complete cipher code is given for ordering material by telegraph.

M. T. DAVIDSON, 43-53 Keap street, Brooklyn, has issued a handsomely bound volume of 118 pages, containing descriptions and cuts of the numerous types of Davidson pumps. The variety of uses to which this design of pumps is adapted is illustrated by a list of no less than 34 different kinds that are manufactured. Some 20 pages of the book are devoted to useful information for engineers, including table of areas of circles, friction losses in water pipes and steam data.

THE CORLISS STEAM ENGINE COMPANY, a newly organized corporation, has purchased the extensive works of the Geo. H. Corliss Steam Engine Company, of Providence, R. I., and the business, which has been partly suspended since the death of Mr. Corliss, about 18 months ago, will again be actively resumed. The company will build the Corliss engine in all of the different styles, i. e., condensing, non-condensing, single or in pairs, compound and triple expansion, in sizes from 50 to 3,000 h. p., and also the Corliss patent vertical tubular water leg boiler. The new organization has retained all the heads of departments employed and trained by Mr. Corliss. The officers of the company are: D. M. Thompson, president and treasurer, for the past 12 years general manager of B. B. & R. Knight's mills; Stephen A. Jenks, vice president, treasurer Fales & Jenks Machine Company, Pawtucket, R. I.; Wm. B. Sherman, secretary; L. H. Wattles, superintendent, and Charles E. Giles, agent, formerly superintendent and agent of the Corliss Steam Engine Company.

THE OERLIKON COMPANY, of Switzerland, has issued a handsome pamphlet concerning its alternate current machines, with stationary armatures, for both single phase and multiphase currents. The advantages of such dynamos and motors are briefly pointed out, and quite a number of illustrations are given, not, as is usual, showing simply the external appearance of the machine, but giving instead sections and detailed views, as also a large 600-h. p. high tension alternator of a horizontal type, driven directly by a turbine. A table of the principal data is given for single phase and three phase alternators, the normal frequency for which appears to be 50. The efficiencies reach 94 and 95 per cent. in the largest machines, which for the three phase current had an output of 700 kw. A list of the principal installations of these large machines is given, among which are 17 for the three phased current, aggregating 24 machines of a total of 3,710 h. p., in several of which 5,000 volts are used, including one in which 750 h. p. is transmitted.

The single phased system is used chiefly for lighting, while the three phased is used almost exclusively for power transmission.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 DeKalb St., St. Louis, Mo.

Illustrated Record of Electrical Patents.

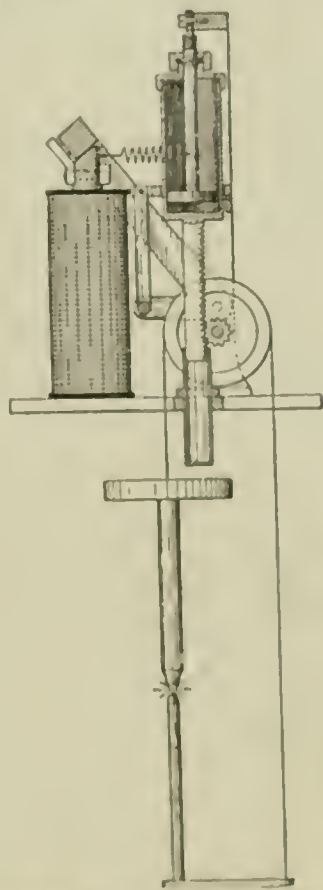
U. S. PATENTS ISSUED MAY 15, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

519,726. **ELECTRIC ARC LAMP;** W. Mathiesen, Leipsic, Germany. Application filed May 29, 1893. This comprises a fixed piston, a rack bar attached to one end of the cylinder, a pinion operated by the rack, and a carbon holder actuated by the pinion. (See illustration.)

519,794. **ELECTRIC RAILWAY SYSTEM;** D. Mason, Schenectady, N. Y. Application filed June 27, 1893. This comprises main and branch conductors connected with switching levers in alignment with the rails of the track, and adapted to be actuated by the wheels of the vehicle, and short sectional conductors provided with circuit connections for connecting them to the branch conductors.

519,813. **ELECTRICALLY GOVERNED SWITCH;** E. H. E. Klatte, Freiburg, Baden, Germany. Application filed Feb. 29, 1892. The combination of a railway track, a switch tongue, an electric motor connected with the switch tongue for actuating it, a pole changer for the motor, an electric switch disposed near the pole changer, a circuit breaker, mechanism connecting the breaker with the switch mechanism and conducting wires leading from the pole changer and reversing switch to the motor and circuit breaker.



NO. 519,726—ELECTRIC ARC LAMP.

519,837. **TROLLEY WHEEL;** V. N. Cruser, Flatbush, N. Y. Application filed Feb. 13, 1894. A trolley wheel formed of two parts mounted for movement in the same direction at different rates of speed.

519,849. **ALTERNATING CURRENT ARC LIGHTING SYSTEM;** T. Spencer, Philadelphia, Pa. Application filed Feb. 12, 1894. This comprises a switch for coupling a variable number of turns of a transformer winding in the lamp circuit, and means for lowering the voltage after the lamp has been thrown into action. (See illustration.)

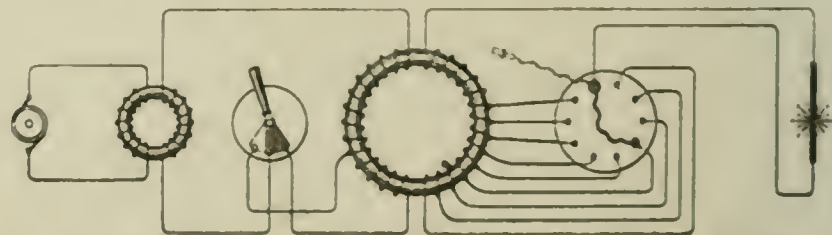
519,858. **CONSTANT CURRENT DYNAMO;** W. H. Elkins, Cambridge, Mass. Application filed Feb. 3, 1894. This comprises a compound wound field, positive and negative terminals and means for moving the brushes about the commutator.

519,862. **METHOD OF, AND MEANS FOR, STARTING SYNCHRONOUS MOTORS;** B. G. Lamme, Pittsburgh, Pa. Application filed April 5, 1893. The combination of a constant po-

tential alternating current system, and a multiphase self-exciting synchronous motor; with a converter for each phase of the current having its primary in circuit with the main leads and its secondary in circuit with the motor armature and means whereby the potential of the secondary circuits may all be symmetrically varied.

519,863. **ELECTRIC MECHANISM FOR GIVING RECIPROCATING MOTION;** H. S. McKay, Boston, Mass. Application filed March 12, 1892. This comprises a movable contact, fixed contacts for engagement therewith and electric connections between the contacts.

519,870. **MAGNETIC ENGINE FOR RECIPROCATING TOOLS;** H. S. McKay, Boston, Mass. Application filed July 5, 1892. This consists of two or more solenoids and a plunger adapted to be reciprocated by them.



NO. 519,849.—ALTERNATING CURRENT ARC LIGHTING SYSTEM.

519,876. **TELEPHONE CIRCUIT;** C. E. Scribner, Chicago, Ill. Application filed Sept. 28, 1893. This comprises induction coils having secondary helices connected in parallel branches of the telephone circuit, two in each branch, and their primary helices in circuit with a common microphone, a receiver having one terminal connected to each branch between the two induction coils thereof, one secondary helix in each branch, upon opposite sides of the telephone terminal, being constructed to have high impedance.

519,881. **DEVICE FOR REGULATING ELECTRICITY GENERATED BY MEANS OF WIND POWER;** T. A. Willard, Norwalk, Ohio. Application filed April 6, 1893. This consists of a regulator consisting of a soft wound core, a cross bar, an armature pivoted to the cross bar, switch lever movable with the armature, a spring engaging the pivoted end of the switch lever, segments over which the switch lever moves and with which its free end contacts, and resistance coils connecting the segments.

519,912. **ELECTRIC ARC LAMP;** J. F. Kester, Buffalo, N. Y. Application filed Oct. 23, 1893. This comprises a frame and magnet, carbon rod, armature lever hinged to the frame, a spring to elevate the lever, a gripping plate suspended from the armature in such manner as to permit one end to raise and descend, and a cam stop rotatably secured on a post for limiting the elevation of the armature lever.

519,932. **ELECTRIC RAILWAY SIGNAL;** R. M. Strong and C. F. Reed, Omaha, Neb. Application filed Sept. 5, 1893. This comprises two pairs of independent conductors and means whereby a current in any section of the first pair will open-circuit breakers in a corresponding section of the second pair.

519,938. **ELECTRIC RAILWAY SIGNAL;** F. Beattie, Leete Island, Conn. Application filed April 2, 1894. This comprises an alarm bell, a reciprocal and rotatable rod controlling the making and breaking of the circuit of the bell, a plunger, a button secured to the lower end of the rod and connecting the plunger thereto, and a pivotal trip adapted to be operated upon by a tripping device applied to the railway and constructed to be coupled with the rod through the medium of the button.

519,945. **ELECTRIC INDICATOR;** W. E. Garey, Chicago, Ill. Application filed Oct. 13, 1893. The combination of an electromagnet and an armature having a portion pivoted to the field of one pole of the magnet, and a portion located in the field of the other pole of the magnet and extending laterally from the first portion.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., 253 Broadway, New York.

The Electrical World.

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NEW YORK, JUNE 9, 1894.

No. 23.

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1883 " 63 " "	1890 " 289 " "		
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The first issue of 1894 contained 320 different Advertisements.

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THE MEASUREMENT OF ENERGY TRANSMITTED BY POLYPHASED CURRENTS.

In this issue we print the first section of an article on the measurement of energy transmitted by polyphased currents. While polyphased currents have already begun to enter largely into use, as shown by the accounts of applications which have been recently appearing in our columns, there has not yet been published in English any other than fragmentary mention as to the methods necessary to be employed in making power measurements. Owing, however, to the complication of making such measurements of alternating currents differing in phase with each other, or when the current is not in phase with the E. M. F., by the use of any of the methods so far proposed which employ voltmeters or ammeters, it is not likely that any of these will be practically employed, in view of the fact that readings can be directly taken from wattmeters. There is, consequently, a large field for the latter in this branch of electrical application, and it is probable that some of those invented in the past but not utilized may now come before the public for this purpose. An incidental benefit of their introduction for use with alternating currents will probably be their more general adoption also for continuous current measurements, where their great convenience does not yet seem to have been fully appreciated.

THE SMALL BOY AND THE RAILROAD TRAIN.

Once upon a time a mischievous small boy escaped from the back yard to which his activities had theretofore been confined and where his sole pleasure had consisted in the bombardment of the windows of a neighboring property with pebbles. Wandering forth into the great world, of which vague though enticing glimpses had been obtained through occasional peeps over the top of a fence, he saw many sights which had previously been beyond the limits of his circumscribed vision and finally spied a railroad train coming in his direction. Our doughty small boy was not of the kind, however, to be frightened by an apparition even as unaccustomed to him as this one, for had he not the recollection of his triumph over the neighboring property which had so meekly borne his constant volleys of pebbles and without even once entering his back yard and spanking him as he knew he ought to have been spanked? So, running in the direction of the approaching train, he assailed it with the same menacing cries that he had found successful in harassing the poultry in his back yard. The fact that his "shoos" did not produce any effect at first, but rather the reverse, mattered not to our rather stupid small boy, and when the train finally passed him and began to recede into the distance, his delight knew no bounds, for had he not put it to a most ignominious flight? And so puffed up is this small boy with his great achievement that as he now struts about his back yard, the neighboring property has lost all interest to him and its windows are free from the quondam pattering of pebbles. Which veracious history is recalled by the boasts of an amusing contemporary in regard to a somewhat similar triumph over a certain programme of the A. I. E. E.

NEW TELEPHONE RATES.

We print elsewhere the new schedule of telephone rates adopted by the Metropolitan Telephone Company, of New York City, based upon the number of calls made by sub-

scribers. While considerable friction may at first result from the new system of charges, there can be no doubt but that it is a rational one and therefore to be preferred to the irrational one of "flat" rates. Under the new schedule the subscriber pays only for the service he receives; if he used a telephone for only a small number of calls he does not have to help to pay for the service of a large user who, in perhaps most cases, is most able to pay for a telephonic service and yet heretofore has not paid his proportionate share of the charges. As to the prices charged per message, they are presumably based upon what the telephone company thinks the public will stand and with little or no relation to the actual cost of the service. Entrenched as the company now is, the public will apparently have to continue to "stand and deliver" whatever this monopoly may demand, though its existence depends upon the grant of franchises by this selfsame public. The hope of relief from the Legislature past experience has demonstrated to be very remote, unless it should happen that sometime this body may contain a membership, a majority of whom will not be susceptible to the influences which so far, it is broadly hinted, have prevented any legislative action.

HYSTERESIS.

In another column Mr. C. P. Steinmetz very clearly shows the distinction which should be made between hysteresis, or magnetic lag, and molecular magnetic friction. These have been confounded by some writers, but it is shown that their values are only coincident and represented by the area of the hysteretic loop when the iron is neither receiving nor giving out energy externally. Dr. Duncan has shown that if a transformer is vibrated the magnetic lag is reduced, and Mr. Steinmetz states that in this case the loop may not only entirely collapse but even give a negative value, which is equivalent to a magnetic "advance" instead of "lag." On the other hand, if energy is expended, as when a transformer "hums," the area of the loop becomes greater by an amount corresponding to the energy thus used. The observation of Prof. Fessenden, in an article elsewhere in this issue, that the law of Steinmetz expressing the value of hysteresis has been shown to be only approximately true by the experiments of Prof. Ewing and Miss Klaassen may be just, but we are not aware that Mr. Steinmetz claimed that his formula expressed a law, and the same may be said of the expression of Mr. Kennelly for ferric reluctivity. We understand that both were put forth merely as formulas to express as nearly as they may the results of experiments, and not as the mathematical expression of a physical law. The expression found by Prof. Fessenden for the area of the hysteresis curve is interesting on account of furnishing another relation between the various quantities concerned. Every addition of this character, though it have no apparent practical value, yet adds another vantage point from which a phenomenon may be viewed, and thus increases the chance of at length determining its true physical significance.

COST OF ELECTRICITY.

In our issue of May 19 we referred editorially to some English data on the cost of generating electrical energy in central stations, from which the conclusion was drawn that six cents would probably more nearly represent, exclusive of capital charges, the cost per horse power hour of generating current in the central stations of this country than four cents, the figure usually quoted. In the valuable annual reports of the Massachusetts Board of Gas and Electric Light Commissioners, of which that for 1893 has just been issued, extensive official data and information are given of all the central stations in that State, and while not in a form to be directly applicable to calculations on the entire cost of generating current, yet they will enable approximate results

to be arrived at. Almost all of the companies in the State do both arc and incandescent lighting, and some also supply current for motors, which renders it difficult to fix on a rate which will represent the average cost at which electrical energy is sold. The charge for incandescent lighting is almost uniformly one cent per 16-c. p. lamp hour, and it is probable that, as usual, where flat rates are given, they are based upon the same figure; assuming that the prices received for arc current are also based upon incandescent charges, we have twelve cents as the approximate price received per hourly horse power. This figure would be too high for motor rates, but as that assumed for arc light charges is probably too low in many instances on account of the "scaling down" of current for public arcs, we may assume twelve cents per hourly horse power as the average received for all electrical energy sold, which, however, will include carbons for arcs and trimming. In looking over the result of the operation of the various stations for the year ending June 30, 1892, we find that of 60 companies, 26 did not declare any dividend and six did not earn expenses. Of the 28 companies which paid dividends, 19 paid from 6 to 8 1-3 per cent., the remaining nine paying from 5 to 1 per cent. It will be thus seen that over half of the central stations of Massachusetts found no profit in operating, or, under our assumption, it cost them twelve cents or more to generate an electrical horse power. The stations which operated at a profit were the larger ones, and of these we have tabulated below the ten largest, arranged according to the plant investment, with the largest station first:

	Investment, per kilowatt.	Operating expense. Income from sales per cent.
1.....	\$600	58
2.....	730	69
3.....	680	55
4.....	635	63
5.....	520	63
6.....	700	60
7.....	635	66
8.....	465	52
9.....	510	64
10.....	255	68
Average.....	573	61.8

Opposite to each in the first column is the cost of plant per kilowatt, obtained by dividing the investment in steam and electrical machinery, distributing system and real estate, by the maximum dynamo capacity, which data are given in the report. The second column contains the ratio of the operating expenses to the income from the sale of current, the former including management, and, apparently, maintenance repairs. The investment in plant is extremely high per kilowatt, and it would be interesting to know how much less any one of the stations could be built for at the present day. Assuming 60 per cent. as the average ratio of operating expenses, if the current was sold for twelve cents per horse power hour, the cost, exclusive of investment charges, would be 7.2 cents, or if sold at ten cents, would be six cents, which would seem to be as low a figure as should be used to base calculations upon.

India Rubber.

The "Madagascar News" of March 17 announces that a rubber concession has just been granted to the Hon. John L. Waller, ex-United States Consul for Madagascar. The concession area measures 15 miles square, in the district of Fort Dauphin, on the southeast coast, and is conceded to be one of the richest rubber districts in the island. The discovery of rubber in this district is of recent date, and the article is of excellent quality. Mr. Waller states that he will stop the destruction of the rubber trees and vines by the natives so far as his concession is concerned, and preserve the product by having the milk extracted in a scientific manner.—London Electrician.

Magnetic Friction and Hysteresis.

BY CHARLES PROTEUS STEINMETZ.

Friction is a universal phenomenon of nature. Wherever motion, molar and molecular, takes place, energy is consumed by friction and dissipated as heat.

Thus, when iron is alternately magnetized and demagnetized, in the cyclic motions of the molecules, which represent the change of magnetism, energy is consumed.

This energy of magnetic molecular friction is converted into heat; the iron gets hot.

Since in almost all electro-dynamic machinery periodic changes of magnetism in the iron take place, it is obvious that the consumption of energy by this change of magnetism, i. e., *the molecular magnetic friction*, is of the utmost importance as one of the fundamental factors determining the efficiency and the output of the apparatus. Thus, the predetermination of the molecular magnetic friction becomes necessary.

If a piece of iron is magnetized and demagnetized alternately, it has been found that during the rise of M. M. F. the magnetism is lower than during the decrease of M. M. F., so that during the rise of M. M. F. the same value of magnetism is reached at a higher M. M. F. than during the decrease.

This phenomenon is called *hysteresis*, i. e., magnetic lag.

Thus, if a piece of iron is exposed to alternating M. M. F., the magnetism, as function of the M. M. F., describes a closed curve, the loop of hysteresis.

The change of magnetism induces in the magnetizing circuit E. M. Fs., which consume energy, and it has been proven that the energy consumed by these E. M. Fs. is proportional to the area of the hysteretic loop. This loss of energy in the magnetizing circuit during the alternation of magnetism is called the loss of energy by hysteresis.

As seen, the loss of energy by hysteresis has directly no relation to the loss of energy by molecular magnetic friction.

But the energy consumed by magnetic friction must be furnished somewhere, and if no external source of energy is applied, the hysteresis furnishes the energy of molecular friction.

But even then the hysteretic loop need not be equal to the energy of the magnetic friction, but hysteresis may, besides molecular friction, furnish mechanical energy also.

Some cases may illustrate this.

In the alternating current transformer, energy is neither supplied to, nor expended by, the iron, except in the magnetizing circuit. Thus, in this case, the hysteretic loop equals the energy of magnetic friction, i. e., hysteretic energy and molecular magnetic friction are identical.

If, however, the iron pieces of the transformer are loose, so that they are set in vibration by the alternating field, the mechanical energy of vibration has to be furnished by hysteresis, and the hysteretic loop increases, representing now the sum of the energy consumed by molecular magnetic friction and by mechanical vibration.

On the other hand, if the iron of the transformer is set in violent vibration by an external mechanical force, a part of the energy of magnetic friction is supplied by mechanical power and not by the M. M. F., and thus the hysteretic loop collapses more or less, representing now only that part of the magnetic friction supplied by the M. M. F. In this case the loop may even become negative, that is, energy may be put into the electric circuit by the magnetic circuit as an electric generator.

The conclusion from all this is that hysteresis can be used for measuring the energy consumed by molecular magnetic friction only, when care is taken to exclude any external source or expenditure of energy. But if external transformation of energy takes place, as in revolving machinery, no conclusion can be drawn from the hysteresis with regard

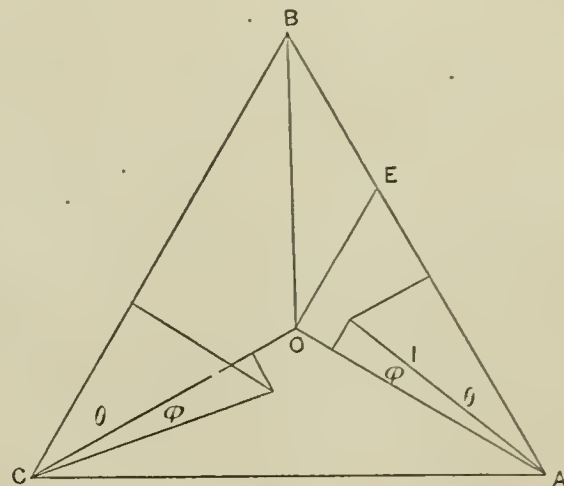
to the magnetic friction, and especially *disappearance of hysteresis does not mean disappearance of molecular magnetic friction*, but means that the energy of magnetic friction is supplied from another source.

A Proof of the Two Wattmeter Method of Measuring a Three-Phase Current.

BY J. D. E. DUNCAN.

In testing a two-phase three phase transformer, built at Sibley College laboratory, according to the plans of Mr. Charles F. Scott, the two-wattmeter method was used for measuring the three-phase current. Thinking that it might be of interest to the reader a short proof is here given.

Consider the case of an equally balanced three-phase circuit as shown in the figure. Let AO , BO and CO be the



THREE-PHASE WATTMETER MEASUREMENTS.

lines which represent the E. M. Fs., the sum of the instantaneous values of which is zero. Let the currents be equal to each other and lag behind the E. M. Fs. by an angle, ϕ . Then by the ordinary method of measurement the power in each branch is equal to $E I \cos \phi$, or the total power in the circuit is

$$W = 3 A O I \cos \phi.$$

If we use the two-wattmeter method with the wattmeters placed in circuits A and C , we will have the pressures represented by the lines AB and CB . Let the angle BAO be called θ . Then we will have the power in one wattmeter measured by $A B I \cos (\theta - \phi)$ and in the other by $C B I \cos (\theta + \phi)$, or the total power is

$$W = A B I \{ \cos (\theta - \phi) + \cos (\theta + \phi) \}$$

since $A B$ is equal to $C B$. This by expansion becomes

$$W = 2 A B I \cos \theta \cos \phi.$$

But by similarity of triangles in the figure

$$A B = \frac{3}{2} A E,$$

also

$$A E = \frac{A O}{\cos \phi},$$

whence

$$W = 3 A O I \cos \phi.$$

An analytical proof for a perfectly general case is too complicated to be followed out easily, but it has been shown graphically that this method is accurately correct for any three-phase currents, at any voltages, with any form of curves, so long as the sum of the instantaneous E. M. Fs. is zero, and the sum of the instantaneous currents is zero.

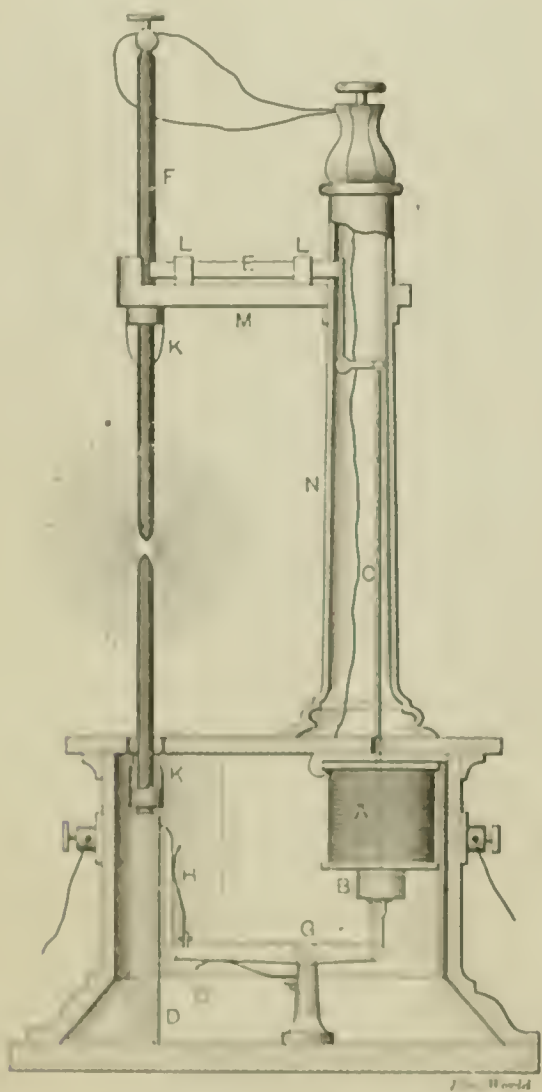
Wire Made of Ice.

In one of the recent lectures by Prof. Dewar, "On Solids and Liquids," he stated that under the pressure of 30 to 40 tons to the square inch ice behaves like a viscous solid and may be forced through a narrow orifice in the form of a fine wire.

An Early Arc Lamp.

We have received from Mr. Charles H. Fisk, of Detroit, Mich., a copy of the "Rural Intelligencer," published in Augusta, Me., and dated Jan. 27, 1855, and the following description of an arc lamp, taken from its columns, may be of interest, on account of the early date of the paper.

"We give below an engraving of an electric lamp, which we had the pleasure of seeing several times while in London. We have no faith in electricity as a motive power, either for decomposing water, propelling machinery, or furnishing light, for the obvious reason that no *force* is eliminated without a corresponding destruction of matter. And it is well known that six pounds of carbon (coal) are equal to 32 pounds of zinc for producing heat or other force, while in the one case we burn with air, which costs nothing, and in the other with sulphuric acid, which is and ever will be expensive. And in all probability coal will ever be much cheaper than zinc. While such are our views, we cannot but say that this electric light astonished every one by its brilliancy and power. It was exhibited one dark night on the Duke of York's monument, one of the highest places in London, from whence, it is said, it could be *distinctly perceived* at a distance of nine miles. The light was thrown on to a building on which we were standing, and though it was a quarter of a mile distant, we could see clearly to read. Such was the effect that it was gravely proposed to have an



AN EARLY ARC LAMP.

electric light and a vast reflector suspended over the city, and which it was confidently expected would furnish an artificial sun to turn night into day and render street lamps unnecessary. The following description will enable the reader to form a correct idea of the nature of the lamp.

"The electromagnet is at *A*, and its armature, *B*, which is beneath, is shown in contact, so that the brass rod, *C*, passing through the centre of the magnet, is in its elevated position. The rod thus—by means of the bell crank lever *D* bearing against the loose sliding bar, *E*—holds the main vertical sliding rod *F* in a fixed position. The armature, *B*, is screwed on to the lower end of its link rod *C*, so as to admit of easy adjustment; and it is connected by a link on its

lower side, with the shorter arm, of the double *G*, the opposite longer arm of which has a spring catch, *H*, jointed to it and arranged to work in the finely toothed sliding ratchet piece, *J*.

"The ratchet terminates, as also does the upper sliding rod *F* in a steel or platinum spring clip *K*. The loose overhead bar *E* works in small guide eyes, *L*, on the bracket *M*, and this bracket slides down with stiff friction upon the main pillar *N*. When from the consumption of the electrodes, the distance between their points is increased so much as to stop the current, the spring *O* draws down the armature *B*, and lifts the ratchet at the same time that the upper sliding rod, *F* is released. The electrodes thus simultaneously approach each other, and the requisite distance being attained, the consequent instantaneous renewal of the current fixes them both by the upward jerk of the armature."

New Telephone Rates.

The Metropolitan Telephone and Telegraph Company announces the following schedule for exchange service and message rates, to take effect June 1, 1894, and apply to New York City south of 116th street:

Number of messages.	Two-party line.	Direct line.	Excess messages.
700	\$100	...	\$15 per 100
800	110	...	12 " "
900	120	...	12 " "
1,000	130	\$150	12 " "
1,100	138	158	10 " "
1,200	146	166	10 " "
1,300	154	174	10 " "
1,400	161	181	9 " "
1,500	168	188	9 " "
1,600	175	195	9 " "
1,700	182	202	9 " "
1,800	188	208	8 " "
1,900	194	214	8 " "
2,000	200	220	8 " "

For more than 2,000 messages direct lines only will be used, and the rate of advance will be \$5 per hundred, with \$7 per hundred for excess messages. For these rates, lines will be metallic circuit and equipped with long distance transmitters (wall or desk sets only). For a cabinet set (wall or desk), \$10 per annum additional will be charged. An installation charge of \$15 will be made for each station. Where an established station is brought under a message rate contract the installation charge will not be made.

Simple Remedy for Trouble in a Telephone.

We have received the following communication from Mr. J. M. Kent, of Kansas City, Mo., describing how a trouble in a telephone was remedied in a very simple manner:

"A friend of mine in a neighboring establishment has a telephone containing three ordinary Bell receivers, which are used both as transmitters and receivers. They gave trouble constantly. One would be reported as 'not talking,' and he would take off the cap and find nothing wrong, would put the cap back again and it would work all right. Perhaps in an hour or so it would again refuse to act. This was kept up for several months. He tried varying the distance of the diaphragm from the magneto, and also examined the circuit time and again, but with no better success. One day we noticed that the edge of the orifice in the cap came very close to the diaphragm, and I suggested that perhaps a drop of saliva might lodge against the diaphragm and the edge of the orifice and impede vibration. This was found to be the case, and a ring of thick cardboard placed between the cap and the diaphragm remedied the trouble completely."

The Berliner Telephone Suit.

The Berliner telephone suit will come up for trial before the United States Circuit Court at Boston next week.

SWITZERLAND AS THE PRESENT ELECTRICAL CENTRE OF EUROPE

BY FREDERICK BATHURST.

Having seen the generating plant, it is necessary to return to the centre of the town to the distributing house, distant 1 1-2 miles, for three pairs of concentric cables convey all the current generated in the station to this point. This house is as near the lighting centre of the town as it is possible to place it: It is situated by the side of the river on the Rathhaus quay. A wooden construction 10 feet by 20 feet, with tiled roof, it resembles a small Swiss chalet, and no one, unless initiated, would imagine that such a



TRANSFORMER BOX.

quiet, unpretending looking structure represented the vital centre of the town lighting.

From here distributing cables radiate to each of the twelve sub-districts placed in the centre of their respective lighting fields. As new quarters of the town adopt electricity, other cables branch out for the purpose of conveying the needful current. When laying these distributing cables the ultimate wants of the district are anticipated as far as possible, so that the expense of relaying extra ones and the interruption of the town traffic, due to the opening of the trenches, are minimized, and the work is carried out without presenting a nuisance. To the larger centres it is found advantageous to lay two or three cables of moderate sectional area in preference to a single one of equivalent area; the smaller cables are more easily handled and can be made to assist the operator in keeping better regulation for the varying loads. Every high potential cable laid in the town has an end in this house, so that should a breakdown occur, they can be tested out and the fault located at once. Each cable has also double pole switches and safety fuses, these latter consisting of a 7-inch length of tin-alloy wire enclosed within a glass tube. The switches and fuses are neatly arranged on the opposite walls of the house, those for the outer conductors being on one side and those for the inner on the other. This makes it impossible to accidentally short circuit any cable and keeps exposed high potential terminals apart from one another. An ammeter shows the total am-

peres being used on the whole system, and test can be made for each sub-centre.

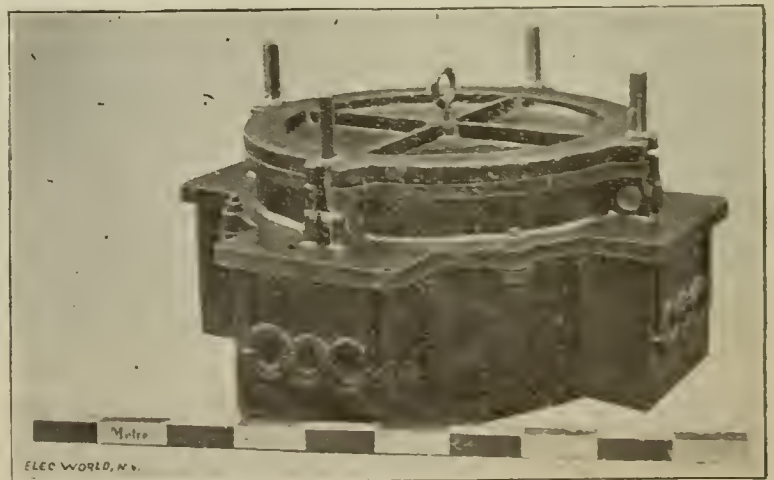
Volt lines return from each sub-centre to advise the attendant of the voltage at those points. A recording voltmeter shows the voltage fluctuation on the system, while records are kept of the current output by day and by night. A telephone in this house enables either the public or an employe to report immediately any trouble that occurs on the lines. The house itself serves as a sub-centre for the district immediately around it, while the farthest is distant some 1,700 yards.

The size of distributing cables is calculated upon the basis of 3 per cent. drop allowance for full load.

It is perhaps a transforming centre that takes one most by surprise and confirms the opinion already formed as to the high grade engineering ability displayed in the design of this installation. In all continental towns, as the European traveler knows, the local authorities exercise a strict supervision over the placing of advertisements; to the English or American mind, they would appear to act almost arbitrarily in their effort to have their town look well. The axiom of a "place for everything" becomes truly an aphorism and advertisements are kept in their "proper place." Upon the corners of the streets or in the centres of the squares the Kiosque de Publicite, or the Anzierger, is a conspicuous object that by those who are desirous can be readily scanned. In Zurich they are utilized as a thing of usefulness as well as beauty! They serve the double purpose of holding the flaming advertising poster and harboring the quiescent electric converters. The cut shows such a sub-centre of electrical distribution.

Within the sheet iron shell, an angle iron frame is built up, so as to form a series of racks or tiers, each tier serving to support a converter.

One standard size of converter—20,000 watts—is employed throughout, that number being placed, one above

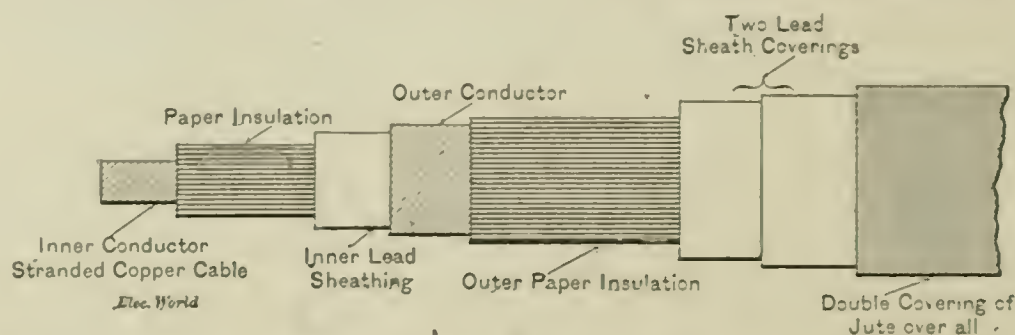
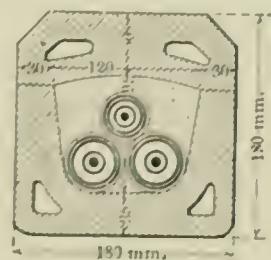


CLOSED CABLE BOX.

the other, as will suffice to supply the district around the Anzierger, more being added as the district grows. There are 33 single converters placed in the 14 sub-stations, so that each averages two, although some contain six or seven or eight converters. They transform from 2,000 volts to 200 volts, but the secondary coil has a centre connection so that 100 volts can be obtained and the dis-

tribution effected on a three-wire system, with 100 volts on each side. Marble connection boards, fitted on the side of the frame, serve to carry the terminal ends of the cables coming into the Anzierger and permit of all the primary coils being connected in parallel and the secondary connected to the three-wire bus bars.

Motors, arc lamps and incandescent lights are supplied from these centres, but in order to keep the system properly



METHOD OF LAYING CABLES AND CONSTRUCTION OF CONCENTRIC CABLES.

balanced a rule is made that any load over 1,800 watts must be taken from the outside wires of the secondary low pressure three-wire system. In this way no trouble is experienced in equalizing the load. Each Anzierger supplies current within a radius of 400 yards.

Zurich is a typical Swiss town as regards the extent of ground it covers, and, being built on two hills on opposite sides of a river and having in addition streets which are irregularly laid out, it presents even greater difficulties to the lighting engineer than the average American town. By this sub-station arrangement, current is economically distributed throughout the town over an area 2 miles by 2 1-2 miles, or say, 6 square miles.

From the Anzierger cables pass out along the streets to be supplied to cable boxes (see cut). These boxes are of two kinds, "Offener Schacht" and "Gedeckter Schacht"—opened and closed. The closed boxes are generally used at the ends of the branch mains, or upon those lines which are either fully loaded or not likely to be disturbed. Open boxes are placed in lieu of manholes at the intersection of streets. They contain the safety fuses and permit the connecting in of additional mains for other streets. In order to lay down the network of mains with the least possible cost and to simplify examination in case of fuses blowing, as many as three blocks, or houses, are sometimes connected in one box, and where possible adjacent houses are fed from the same line, which passes through the cellars. A closed box is completely filled with compound, but the sealing up of the open box is remarkably simple and effective.

The top of the box is made watertight by means of a V groove filled with compound and a tongue ridge on the lid, while special partition pieces are fitted around the cable ends, so that they are surrounded by compound for about three inches of their length before passing out into the cable troughs. The service box for the inside of each house is a very neat and simple one, and is provided with three terminal projections, so that the house wiring can be connected on to either side or on the outer wires of the secondary system.

All the cables, where possible, are laid in stoneware troughs (see cut). These are strong, simple and cheap, and afford excellent mechanical protection to the cables. When the troughs are in position the cables are laid in the trench so formed and covered in with sand, which serves as an elastic cushion, upon which the stoneware cover can rest. No serious attempt is made to cement the trough lengths together, so as to obtain a watertight conduit, the ends merely being butted close together and "grouted" where necessary. A trough of this kind having a sectional area of 16 square inches costs about 25 cents per yard run.

A diagram of the concentric cable employed is shown.

It has paper insulation and two lead sheaths, the outer copper conductor being stranded directly on to the inner lead sheath. The secondary system has three conductor concentric cables. Something like 300,000 feet of cable has been laid into 89,000 feet of trough; about two-thirds of the cable is in the secondary system.

At first some difficulty was experienced through induction effects in the town telephone system, but a simple and

complete remedy was found for the trouble by making several good "ground" connections upon the outer lead sheaths of the electric light cables.

The present output of the station is between 600 and 700 kw.; incandescent lamp circuits have been wired equivalent to 10,000 16-c. p. lamps.

The lamp finding most favor consumes 3.5 watts per candle, or, say, 60 watts per 16 c. p. It costs 26 cents and has a good life capacity. Experiments are being made with lamps having an efficiency of 2.5 watts per candle power, but these, so far, have not shown sufficient life capacity to merit their being adopted as standard.

Are lamps to the number of 130 have been installed, 80



ORNAMENTAL LAMP POST.

being used for the streets and railway station and 50 for commercial purposes. The former take 20 amperes and are rated as 1,600 c. p. nominal, the latter 10 amperes for 800 c. p. nominal.

These lamps are run in circuits of six in series across the outside wires of the secondary system, that is, on 200 volts. When starting up they flicker slightly and take an increased current, but get down to steady work within a few minutes. Fig. 10 shows the elegant lamp post adopted for the street lighting.

In addition to the lighting by night a day load for power is being catered for and about 15 small alternating motors are at present installed. The largest motor is 2-h. p., the majority being 1-2-h. p. capacity. These all run synchronously and there is no trouble when starting them.

Nearly every lamp or motor is run on a meter basis, this method being preferred to a "contract" charge, and it is a eulogium to American electrical apparatus of no mean degree to find that nearly 300 Thomson meters are being used on the circuits.

Each 16-c. p. lamp is estimated to bring in a revenue of \$5 per year, and making a calculation upon this basis, I estimate that a return of from 5 to 6 per cent. is being obtained on the capital invested in the plant. It is almost impossible to make a direct comparison of the cost of this and a similar American plant, but the following figures are interesting as showing the relative expenditures for the various portions of the plant: Approximate cost of dynamos, switch-board and connections in station, 300,000 francs; approximate cost of cables and conduits, 500,000 francs; approximate cost of transformers, sub-stations and arc lamps, 200,000 francs; approximate cost of turbine equipment (estimated), 100,000 francs; approximate cost of engine and boiler equipment (estimated), 180,000 francs.

If other testimony were needed as to the effective, substantial and workmanlike manner in which this plant has been installed throughout, it might perhaps be found in the fact that only one mishap of any sort has happened since the day current was first switched on. This accident, it is to be regretted, was fatal, but was entirely the fault of the sufferer, who disregarded instructions as to making connections when the current was on the mains. Except this, an electric service has been given, day in and day out, without fault, and to judge from the continual and increasing demand for current, the idea has instilled itself into the minds of the towns-

impressions as to the magnitude of the Midwinter Fair. Chief Engineer W. F. C. Hasson, who is seated in the centre of the group, and his able assistants, deserve great credit for the successful execution of so great a task in the face of unusual difficulties, which would have discouraged less resolute men. The success of the Fair is in no small measure due to their exertions.

Telegraph Dynamo in Postal Telegraph Office, San Francisco.

In the San Francisco office of the Postal Telegraph-Cable Company is a dynamo giving current for telegraphic purposes, which seems to be built on the lines that will be followed for future work of this character and generally where several small currents of various pressure are required. In the main office of the company, recently opened in New York, and in other places where dynamos are used for telegraphic purposes, a group of dynamos is used, the members of which are wound for different voltages and can be connected in different ways as required.

In this case, however, one dynamo having but one winding on the armature and fitted with an ordinary commutator is used to give several currents at the different electro-motive forces required.

The method of doing this is, of course, obvious, as it is only necessary to put a series of brushes around the commutator; but the difficulty is that when such brushes are placed far from the line of commutation, the coil short circuited will momentarily have an enormous current flowing in it which will cause it to heat badly, and there will be a vicious spark when the short circuit is broken. The continuity of the current must not be broken, so short circuiting cannot be avoided by having the brush pass entirely off one bar before touching the next. In the machine under consideration the difficulty has been simply and effectively over-



ELECTRICAL STAFF OF THE MIDWINTER FAIR.

people that electricity is absolutely indispensable to the welfare of this, their rising town, the commercial centre of Switzerland.

The Electrical Staff of the Midwinter Fair.

The accompanying illustration presents the electrical staff of the California Midwinter Exposition. It will doubtless be a surprise to many that so large a corps of men were required for this work, and this fact will serve to correct false

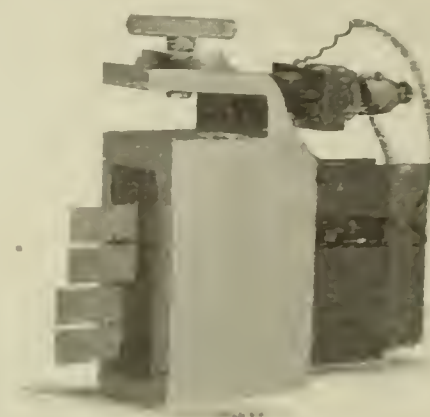
come in a manner clearly explained by the views given. The machine is a motor-dynamo, built by the Electrical Engineering Company, of San Francisco, after designs by Mr. F. P. Medina, electrician for the Postal Telegraph Company; the motor takes current from the lighting mains and drives the dynamo at 1,100 revolutions, the meter showing an average power taken of 310 watts per hour. The armatures of both motor and dynamo are elongated Gramme rings.

Instead of the ordinary rocking brush holder, the views

show the dynamo fitted with a heavy brass ring, to which the brush holders can be clamped in any position. The view of the brush holder shows it to be a heavy brass casting, in which are three pieces of insulating material. The middle piece has two broad shallow channels cut in it, one on each side, which receive the two brushes shown. The brushes consist of two strips of copper sheet, making a total thickness of about 1-32 inch, and they can move freely in the grooves. When in place on the commutator they are pressed nearly to the face of the insulating material, the necessary pressure on the commutator being secured by the elasticity of the rubber bands, of which one is shown. The insulation between the commutator sections is considerably thicker than usual, so that, allowing for the springing or displacement of the ends of the brushes, it is impossible for one brush to touch two bars and thus short circuit them. Wires from the two brushes lead to two binding posts carried by the brush holder, and from these other wires complete the circuit through an ordinary 16-c. p. lamp; thus, when the two brushes are each on a bar, the circuit for that coil is complete through the high resistance lamp and no rush of current can take place, and there is absolutely no sparking at the commutator.

In the illustration three brush holders will be seen on the left and four on the right. The lower one of the four is grounded and the other six can be put to line, giving the positive and negative currents required. The grounded brush is placed at right angles to the diameter of commutation, and the others in any desired position, according to the pressure desired. Each brush taken in conjunction with the grounded brush makes a complete circuit, but the currents from the positive and negative brushes in part neutralize each other, so the grounded brush really passes but little current, acting like the third wire of a three-wire system. As at present arranged, the armature gives six currents, but it is obvious that as many as are desired may be taken,

especially where alternating currents are to be rectified for exciting purposes; also brushes have been made gradually increasing in resistance from the leading to the following



BRUSH HOLDER.

side, so as to lessen the effect of short circuiting, but this plan of arranging a group of brushes so as to make a multiple potential machine of an ordinary bipolar dynamo with single winding and commutator is novel.

A Formula for the Area of the Hysteresis Curve.

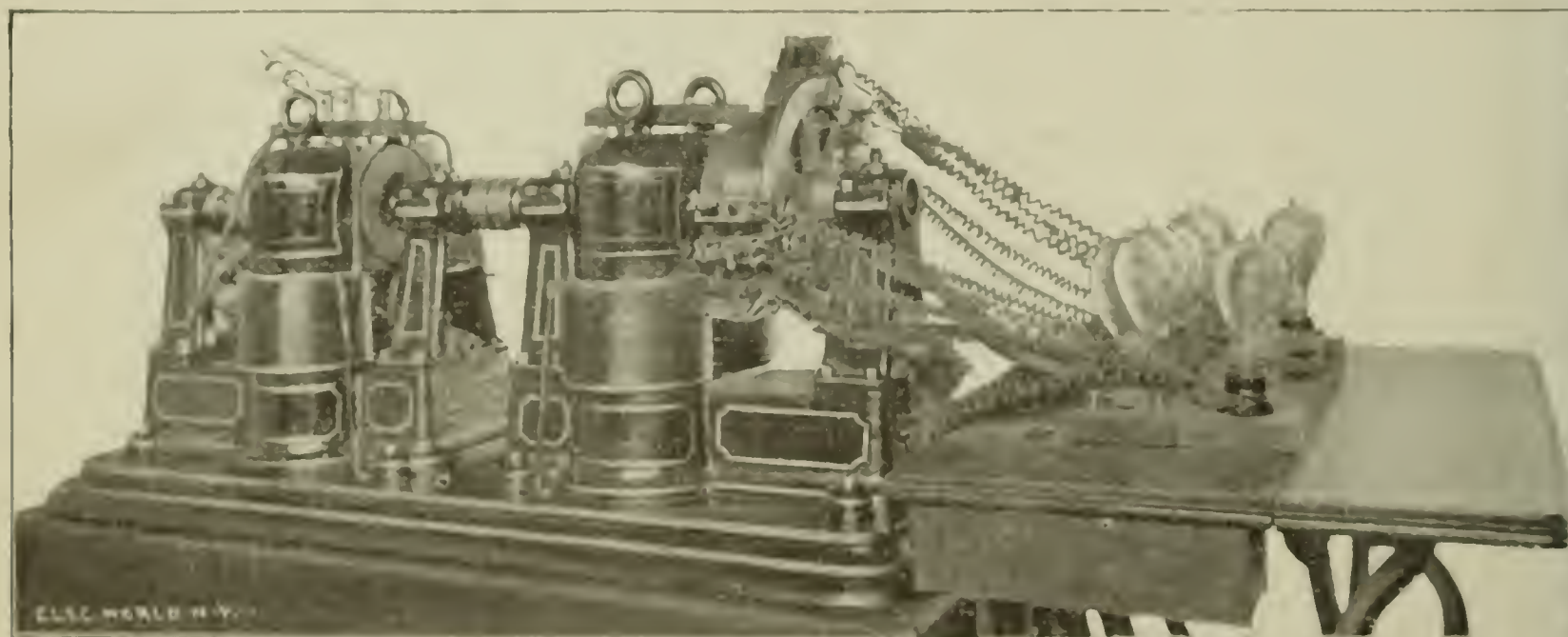
BY REGINALD A. TESSENDER.

In a recent paper, Prof. Ewing and Miss Klaassen have shown that the law of Steinmetz—that the hysteresis is equal to $\eta B^{1.6}$, is only approximately correct. This result agrees with that obtained by two of the writer's students, Messrs. King and Kleppinger, at Purdue University, who published in June, 1893, a thesis upon that subject.

From their results it appeared that:

First—If the hysteresis be supposed to vary as some power of the inductivity, this power varies between the wide limits of 1.5 and 1.8.

Second—That the curve of variation of hysteresis with



TELEGRAPH DYNAMO AT SAN FRANCISCO.

the only limit being the capacity of the commutator to receive brushes.

The dynamo is wound to give a maximum potential of 400 volts, and, as set, the upper brushes have negative potentials of 40, 125 and 180 volts.

Without the ground and for complete metallic circuits, obviously as many currents can be taken as combinations can be made of the six brushes.

There are at present operated from this machine five city lines, varying in length from one to five miles, one quadruplex and four Morse wires, varying in length from 60 to 300 miles.

The plan of using a double brush with a resistance between the parts is not new, as it has been considerably used,

inductivity does not show any simple relation, such as is given by Mr. Steinmetz, but is a much more complicated function.

These experiments were made upon the brands of sheet iron used by the principal makers of transformers in America, including the Thomson-Houston, Stanley and Westinghouse companies.

In view, therefore, of the fact that Prof. Ewing's results for the English irons give a similar result, it appears probable that Mr. Steinmetz's law, extremely valuable as it will always be as a means of making calculations where a moderate degree of accuracy is required, and where the exponent of B for the particular iron used has been previously determined, is not an exact one.

The publication of a simple relation noticed by the writer last summer may be of interest. Publication has been delayed in order that the subject might be more thoroughly investigated. As, however, a very careful checking of the results has shown that it holds, at least for all the different kinds of iron used by transformer manufacturers in this country, to within 1-2 per cent., it is given here. Even if it should prove not to hold for cast and other hard irons, it may still be of use. The subject is at present being further investigated by two of the students of this university, but the final results will not be published for some time.

The law of Kennelly, as is well known, is that the ferric

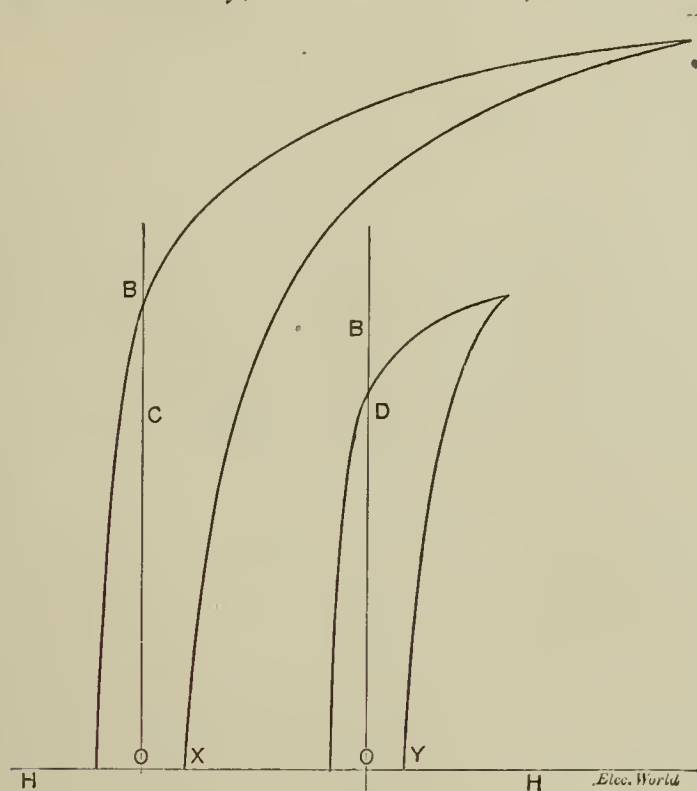


FIG. 1.

reluctivity is a linear function of the intensity of the magnetizing force,) such that $\lambda = a + b \mathcal{H}$. Experiments made by the writer and others have confirmed Mr. Kennelly's results, and show that the law holds within the limits of experimental error, except for small values of $\mathcal{H}$.

The relation noticed by the writer is, that if on an ordinary hysteresis curve we take, instead of $\mathcal{H}$, $\mathcal{H} - b$ (where b is the coercive force), then what we may call the hysteresis

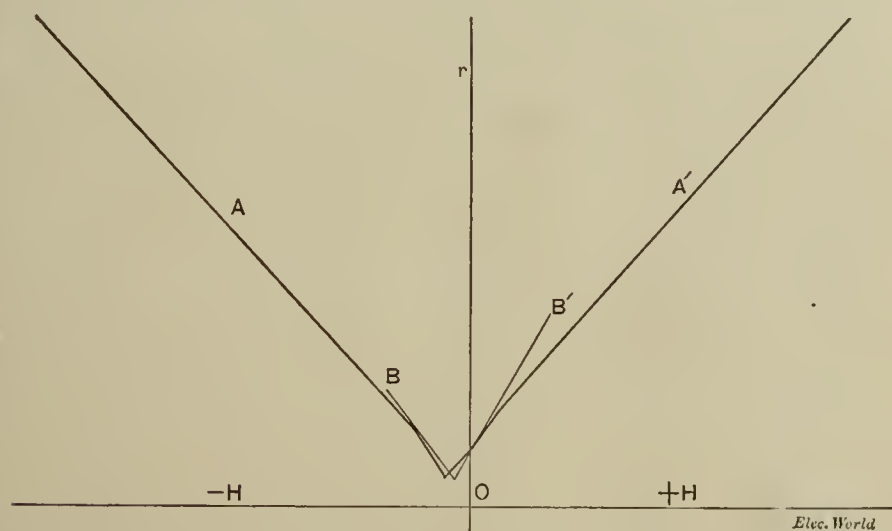


FIG. 2.

reluctivity will be given by $(\mathcal{H} - b) / \mathfrak{B}$, as distinguished from the ordinary reluctivity, $\mathcal{H} / \mathfrak{B}$, and if different values of this hysteresis reluctivity be plotted as ordinates, and the corresponding values of $\mathcal{H} - b$ as abscissae, a straight line will be obtained, but one which does not pass through the origin. Therefore, the hysteresis reluctivity is a function of $\mathcal{H} - b$, such that $C(\mathcal{H} - b) + c = r$; or $r = C(\mathcal{H} - a)$; where r is the hysteresis reluctivity, and a , b , c and C are constants.

It follows from this that for the up curve

$$B = \frac{\mathcal{H} - b}{C(\mathcal{H} + a)}$$

By taking $\mathcal{H} + b$ instead of $\mathcal{H}$ for the down curve, or for the curve from maximum positive to zero induction, we get a similar relation, or

$$B' = \frac{\mathcal{H} - b}{C'(\mathcal{H} + a')}$$

In Fig. 2, A and A' , B and B' show the lines got by plotting $\mathcal{H} - b$ as abscissae (where $b = OX$, Fig. 1) and $(\mathcal{H} - b) / \mathfrak{B}$ as ordinates to get the right limb of C , and $\mathcal{H} + b$ for abscissae and $(\mathcal{H} + b) / \mathfrak{B}$ as ordinates to get the left limb. Similarly, by plotting $\mathcal{H} \pm OY$ for $\mathcal{H}$ we get the limbs of curve D . If more curves were shown they would overlap each other so closely as to be indistinguishable from one another.

It will be noticed that the lines are straight, to within one-half of 1 per cent., except near the origin, where they come slightly out of true. This is due to two reasons: First, owing to the shape of the hysteresis curve, a mistake of 1-4 per cent in the determination of the value of $\mathcal{H}$ at points near the origin makes a difference of several per cent. in the ratio; second, there is a real departure from a straight line, because the iron is passing from one limb to the other, and as the two limbs of the hysteresis curve cannot have a common tangent at the point of intersection with the line of zero $\mathfrak{B}$, they would meet at a definite angle but for the fact that such physical changes, where a large number of molecules are concerned, cannot take place abruptly, but must shade off into one another. In doing this there is a mutual compromise, and both limbs of the reluctivity curve depart from a straight line near the origin.

These curves were made on a number of varieties of sheet iron, and in no case was the departure from the formula more than the limits of probable error, except, as mentioned, near the origin.

By integrating the area between the two limbs we get an expression for the total area of the hysteresis curve. It is

$$\mathfrak{H} = \frac{1}{4\pi C'} [\mathcal{H} - (a' - b) \log (\mathcal{H} + a')] - \frac{1}{4\pi C} [\mathcal{H} - (a + b) \log (\mathcal{H} + a)].$$

For the voltage in a transformer, when the induction is changing in a positive direction from zero, we have

$$d\mathfrak{B} / dt = \frac{(b + a) A \omega \cos \omega t}{(A \sin \omega t - b)^2} \text{ or } \frac{d}{dt} \left(\frac{1}{C \sin \omega t - d} \right).$$

These formulae are at present too complicated for practical use.

It will be seen that all of the properties of the iron are defined by five constants. One of the objects of the investigation at present under way in the hands of Messrs. Neubert and Parkinson is the determination of some possible relation between these constants by which their number may be reduced.

For the present, therefore, the writer only feels justified in saying that the relation mentioned above holds for the better kinds of sheet iron used for transformers to within 1-2 per cent and for values of $\mathfrak{B}$ less than 16,000.

It may also be of interest to mention that neither in the work of Messrs. King and Kleppinger, nor in that of the author, was any instance found where the maximum point of a hysteresis curve fell outside the ascending limb of the next larger hysteresis curve, which striking peculiarity was noticed in a number of instances by Prof. Ewing and Miss Klaassen. As mentioned above, however, these experiments were made upon a small number of kinds of iron only, i. e., only soft transformer irons.

These observations were made by the "step-by-step" method. No difficulty was found, when proper precautions

were taken, in getting the curves to close up to within one-fourth of 1 per cent.

It should be mentioned that the lines drawn in Fig. 2 were not drawn by smoothing the hysteresis curve, but taken directly from the results of the test. Even when the hysteresis curve is drawn so that its total height is 8 or 10 inches, one obtains more concordant results by taking the original observations than by attempting to draw a hysteresis curve, and then taking the observations from the curve so drawn.

In the formulae given above, the ferric inductivity has been taken as equal to the total inductivity, therefore also $(\mathcal{K} - b) / \mathcal{B}$ has been written for $(\mathcal{K} - b) / (\mathcal{B} - \mathcal{K})$. This is sufficiently correct for all cases ordinarily met with in practice, but where the inductivity is very great, the correct formula must be used.

Western University of Pennsylvania.

The Design and Construction of Power Stations.*

In the design and construction of a power station the first thing to be considered is the location. The most natural place for this is at the centre of distribution, so that the fall of potential in the lines as well as the amount of copper shall be a minimum. But other things must be considered which have a very great influence upon this position, viz., cost of the land, which is usually great at this centre; availability of coal, and, in case of a condensing engine, the water necessary for condensation. The amount of space required per horse power depends upon the size of the plant. For an output of 100 h. p., 22 square feet per horse power is necessary, this amount decreasing as the output increases, until in plants of 2,000 h. p. the space per horse power becomes 9.5 square feet. The space does not decrease appreciably with further increase of horse power. If water power is unavailable for running the generators direct, it is desirable that the station be near a railroad to minimize the cost of hauling coal, and, also, since a city water supply cannot be depended upon for condensing purposes, it is essential that the station be in proximity to a stream or a body of water. That which saves in the cost of the energy is a saving every day, so that it may be better economy to locate the station somewhat removed from the centre of distribution, although the first cost of the copper required is much greater.

After the location is decided upon, the next question to be considered is the building itself, which, in consequence of the very costly machinery placed therein, must afford the very best protection possible. In the first place, it must be fireproof, and therefore constructed of brick and iron, and in the second place it must not allow the condensation of moisture on the interior, which is liable to injure the machinery. To avoid this, the building must be provided with a double roof of slate or tile, enclosing an air space whose temperature will be intermediate between that inside and outside the building. The moisture that condenses on the interior surface of the exterior roof is carried off by the interior roof, and in consequence of the greater equality of temperature of the air space and the interior of the building, very little sweating will occur on the inner roof. The engineer is concerned only with the general principles of construction, the details being left to the architect. The estimated cost of such a building is about \$40 per horse power for 100-h. p. plants, and is reduced to \$17 per horse power for plants of 2,000 h. p. and upward.

The size of the power house, and consequently the above estimated cost, depend largely upon the type of the generating system adopted. And then again, the type of the system depends considerably upon the size of the plant.

The method of belting high speed engines directly to small units gives low economy and requires much space, and hence should be adopted only for small plants, or where a division to a small unit is necessary. Moreover, the large number of small generators requires extra attendance, and involves greater expense for commutators, brushes, etc. For large plants, it is much better to adopt a large unit with a condensing engine belted to a jack-shaft, or a low speed engine connected directly to a large unit. At present the engineer can rely upon manufacturers to fulfill the latter condition, and as a consequence, this method is rapidly coming into favor, since it obviates the necessity of belts and jack-shafts. Of course the unit should not be much larger than the minimum working load, for otherwise a waste of energy occurs whenever the load falls to the minimum.

The kind of engine which seems to be the best for railroad power stations is the compound condensing engine. The Corliss type is rated to run at quarter stroke, can be run at half stroke, can be overloaded, and is economical at light loads. The capacity of the engine should be from 20 to 25 h. p. per car operated. This will give sufficient reserve power, as the actual amount used varies per car from 15 to 18 h. p. and rises to 20 h. p. on steep grades. The cost of the complete steam plant varies from \$45 to \$55 per horse power for high speed engine, and from \$65 to \$75 per horse power for the Corliss type.

Until quite recently, it was thought impossible to construct large generators to run when coupled directly to engines of low speed, without increasing the weight per horse power of the generator to compensate for the necessarily reduced speed of the armature. But the Intramural Railway of the World's Fair demonstrates the possibility of this in a very emphatic manner. Although it cannot be accomplished by increasing the magnetic density of a bipolar machine, on account of the limit of the number of lines of force per square centimetre which iron will carry (about 14,000 to 15,000), it can be attained by increasing the number of poles, by placing the armature conductors in grooves, thus obviating the necessity of binding wires, and by using ribbons for end connections instead of the cylindrical conductor which cannot be so compactly laid and whose insulation is liable to disintegration at the points where the wires cross. The air gap should not be cut down too much for three reasons: With a very small air space the excitation is too low to maintain a stiff field at full load; Foucault currents become troublesome; and a great difficulty arises in maintaining the armature exactly centred, which is much more essential in a multipolar than in a bipolar machine.

A generator should be placed on a firm foundation of solid masonry and should be so constructed that its fields can be easily removed to admit of repairs of the armature. A dynamo for a power station must be thoroughly automatic, not only in theory but in actual practice, and should not be accepted from the manufacturers unless it proves to be so. Machines that do not give an increase of pressure proportional to increase in load work very badly when connected together. The cost of the generating system, including switchboards, is \$35 to \$40 per horse power.

The last thing to be considered, although by no means the least in importance, is the switchboard and its appurtenances. This should be constructed of non-combustible material. Slate or marble may be used, although neither is entirely free from disintegration when subjected to the heat from an arc that will occasionally be formed across its surface. All connections should be made at the back of the board, which should be large enough to admit of an increased number of connections as the plant grows. There must be a rheostat, voltmeter, and dead beat ammeter for each generator, a good, simple and reliable circuit breaker which will act at the point at which it is set, and likewise a lightning arrester which can be depended upon. Too much care

* Notes on a lecture delivered by Prof. H. J. Ryan before the Electrical Society of Cornell University.

cannot be exercised in the design of the switchboard and accessories, for it is an all important part of a station. Circuit breakers are preferable to fuses in that the fuse requires a finite amount of time to "blow," and, in the meanwhile, the powerful current is doing its damage in the armature; while with the circuit breaker the circuit is broken the very instant the current exceeds that to which the trip has been set. Another essential feature of the switchboard is the equalizing bar, which places the series coils of all the machines in parallel with each other and thereby prevents a generator, whose potential for some reason falls off, from being run as a motor—a condition of affairs which soon seriously injures the machine.

On the Measurement of the Power of Polyphased Currents.

BY ALEXANDER D. LUNT.

Polyphased currents are undeniably of great interest and value, as shown by the labor and attention bestowed upon the subject, both in theory and by practical application of the same. Considering the peculiar charm and attraction in the study of such currents, it would indeed be strange were it otherwise. Comparatively little attention, however, appears to have been paid to the methods to be followed in measuring the energy of currents of this nature, and so far as the writer is aware, the only available information on this point is to be found in a small number of contributions to several French and German periodicals, together with a few fragmentary transcriptions into English. Hence, the subject of the measurement of the power of polyphased currents, while not inherently difficult, is perhaps unfamiliar, and it may therefore not be devoid of interest or value to present a new and simple derivation of formulae applicable thereto.

In the practical application of polyphased currents the so-called two-phased and three-phased currents have found a place. But it is unlikely that currents of a higher number of phases will be used in the future, since the advantages of a larger number of phases may be obtained, if desired, by special systems of winding and connecting. For instance, the equivalent of a six-phased current may be obtained in a three-phased system by passing each current through two oppositely wound coils.

Consequently, it has been found of advantage to extend the following equations so as to include specifically any system having more than three main conductors or supply wires. It is perfectly obvious, however, as will be seen later, that currents of any number of phases may be comprehended in the equations by a mere addition of similar terms, so that the equations given are quite as general, so far as principles are concerned, as though they covered any polyphased system whatever.

Any discussion of the properties of polyphased currents is of course beyond the scope of this article, but in so far as it may bear on the subject of power measurement, it is not out of place to consider such principles as form the groundwork of results to be deduced therefrom.

A polyphased current, so-called, may be defined as a system of simple alternating currents of the same period chained together or superposed upon one another in such a manner that the respective currents are shifted in phase one behind the other, according to some known and generally simple law.

If a ring armature with n equidistant spaced coils be revolved in a uniform field of force, then the sum of the E. M. Fs. of the n coils will be

$$\Sigma \varepsilon = A \left[\sin \theta + \sin \left(\theta + \frac{2\pi}{n} \right) + \dots + \sin \left(\theta + \frac{n-1}{n} 2\pi \right) \right]$$

where A is a constant depending on speed of rotation, di-

mensions of coils, intensity of field, etc., and θ the angular distance of coil 1 from the neutral line.

It follows easily that

$$\Sigma \varepsilon = 0.$$

But as this conclusion depends on various assumptions, it is consequently only approximately approached in practice.

It is customary to show in the same manner that

$$\Sigma i = \frac{A}{\text{Impedance}} \left[\sin (\theta - \varphi) + \sin \left(\theta - \varphi + \frac{2\pi}{n} \right) + \dots + \sin \left(\theta - \varphi + \frac{n-1}{n} 2\pi \right) \right]$$

where φ equals the angle of lag of each of the currents i in the line wires. By a combination of analytical and geometrical methods it can easily be shown that this expression like the one above becomes zero whatever be the value of n and whether φ be positive or negative.

But this conventional manner of demonstrating the con-

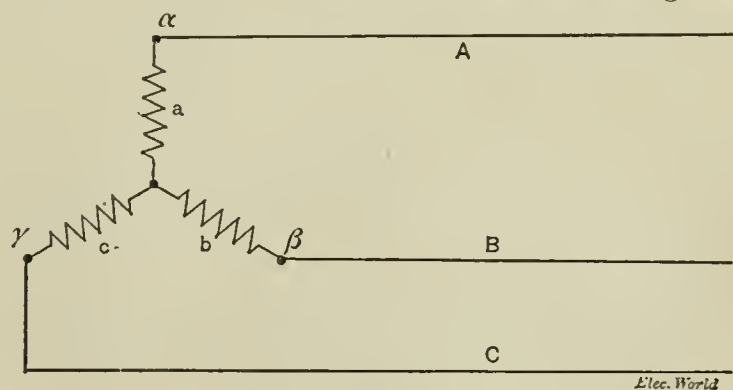


FIG. 1.

tinuity of polyphased currents is seriously lacking in generality, and hence it might be concluded that the principle of continuity is of limited application with respect to such currents. Such is, however, far from being the fact, as will be readily seen from the following.

In the linear conductor carrying current it is self-evident that at any instant the current leaving any point in that conductor is the same in value as that which arrives at the point, and since the current arriving at the point is to be considered of opposite sign from that which leaves the point it of course follows that the algebraic sum of the said currents is zero. Uncertainty as to this fact at one time existed, owing to the erroneous supposition that dynamic electricity accumulated on the surface of conductors. If the

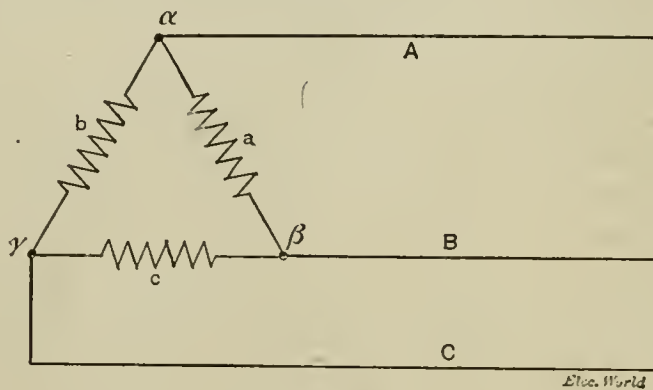


FIG. 2.

point selected were the junction of several currents it would still be evident that as much current must arrive at the point as departs from it. Starting with this fact as a basis, it is apparent that the algebraic sum of the line wire currents of a polyphased current of the "star" form (Fig. 1) is zero at any instant. This fact while equally correct in the case of currents of the "mesh" form (Fig. 2) is possibly not quite so obvious, but will, however, be made clear by a simple consideration. It is evident that the sum of the currents at each junction in such a system is zero at any instant, and hence, referring to Fig. 2 for illustration of a simple case, we may write

$$\begin{aligned} \pm a \mp c &= C, \\ \pm b \mp a &= A, \\ \pm c \mp b &= B, \\ A + B + C &= 0. \end{aligned}$$

whence

(To be continued.)

Practical Notes on Dynamo Calculation—IV.*

BY ALFRED E. WIENER.

b.—Armature Insulations.

According to the size and the voltage of a dynamo the thicknesses of the insulations in its armature vary in very wide limits.

The coating of the armature conductor, if single wire is employed, usually is effected by a double cotton covering ranging in diametrical thickness from .012 to .020 inch, according to the size of the wire and the voltage. If stranded cable is used for winding the armature, either bare or single cotton covered wire is used to make up the cable, and the whole is covered with two or three layers of cotton. The thickness of the single cotton insulation in this case varies from .005 to .010 inch in diameter. For very thin wires, from No. 20 B. W. G. (.035 inch) down, a double silk covering from .004 to .005 inch diametral thickness is applied.

In case of rectangular or wedge shaped conductors, according to their size and to the voltage of the machine, either a double cotton covering, as with wires, is used, or oiled paper, cardboard, asbestos, or mica is employed for their enwrapping or separation. The thickness of the insulation in the latter case varies between .010 and .020 inch, each side.

Besides this coating of the single conductors, sometimes—particularly in high voltage machines—a sheet of insulating material is employed to separate the layers from one another. The thickness of this insulation, for which either oiled paper, rubber tape or silk is used, ranges from .007 to .030 inch.

The insulation of the conductors from the iron body in smooth armatures is effected by serving the core with one or two coatings of enamel or japan and then covering it by either oiled paper, cardboard, canvas, silk, tape, sheet rubber, cotton cloth, asbestos, or mica, varying in radial thickness between .012 and 3-16 inch.

For toothed and perforated armatures this core insulation is carried out in form of paper, or cardboard, or vulcanized fibre tubes or channels, fitted into the grooves, or—especially in large toothed core machines—by means of mica troughs lining the bottom and the sides of the slots. The thickness of this lining ranges from .010 to .125 inch, proportional to the size of the slots, and according to the voltage of the dynamo.

11.—Arrangement of Armature Winding.

By "arrangement" of the armature winding is understood the grouping of the conductors into a number of armature coils, each containing a certain number of turns, or convolutions, of the armature wire, and each one corresponding to a division of the collector or commutator.

The E. M. F. generated by the combination of a series of convolutions, or by a coil, while under the commutator brushes, is not constant, but fluctuates with the rate of its cutting lines of force in the different positions during that period. This fluctuation of the E. M. F. of a dynamo, consequently, increases with the angle which is embraced by each coil of the armature, and can be mathematically determined from the measure of this angle. In a 10-coil armature, for instance, the angle embraced by each coil is 36 degrees, and the fluctuations of the E. M. F. are calculated to amount to ± 2.4 per cent. of the total E. M. F. generated. With a 12-division commutator the angle enclosed by each armature coil is 30 degrees and the fluctuations figure to

± 1.7 per cent. For an 18-bar commutator, the coil angle is 20 degrees, and the fluctuations are found to be reduced to ± 1 per cent. For 24 divisions in the commutator, the angle is 15 degrees, to which correspond fluctuations in the amount of about $\pm \frac{1}{2}$ of one per cent. With 36 bars the angle is 10 degrees, and the fluctuations $\pm \frac{1}{3}$ of one per cent. For 48 divisions the angle is 7 1-2 degrees, and the fluctuations $\pm \frac{1}{6}$ of one per cent. For 90 divisions, the angle is 4 degrees, and the fluctuations $\pm \frac{1}{100}$ of one per cent. With a 360-division commutator, finally, the angle enclosed by each coil is one degree, and the fluctuations of the E. M. F. reduced to but $\frac{1}{1000}$ of one per cent.

From these figures it is apparent that the fluctuations become practically insignificant, or the potential of the machine practically steady, if, for bipolar dynamos, armature coils of an angular breadth of less than 10 degrees, or, what amounts to the same thing, if commutators with from 36 divisions upward are used. For low potential machines—up to 300 volts—it has been found good practice to provide, per pair of poles, between 40 and 60 divisions in the commutator.

For high potential dynamos the voltage itself determines the number of commutator bars. For, in these, the self-induction set up in the separate coils, and the sparking at the commutator caused by the potential of this self-induction between two adjacent commutator divisions, are more important considerations than the fluctuation of the E. M. F.

No potential below 20 volts is able to maintain an arc across even the slightest distance between two copper points. The potentials above this figure necessary to carry an arc over a certain distance depend upon the intensity of the current. In order to maintain, between two copper conductors, an arc of .040 inch length—the usual thickness of the commutator insulation for high voltage machines—according to actual experiments made by the author, imitating as nearly as possible the conditions of a commutator, a current of

100 amperes takes	20 volts
50 "	21 "
20 "	23 "
10 "	25 "
5 "	30 "
2 "	40 "
1 "	50 "

From this it can be concluded that, in order to prevent the commutator of a high voltage machine from becoming unnecessarily expensive, allowances have to be made as follows:

TABLE XVI. DIFFERENCES OF POTENTIAL BETWEEN COMMUTATOR DIVISIONS.

Current Intensity per pole.	Difference of potential between commutator divisions.
Over 100 amperes	10 to 20 volts
100 to 50 "	12 " 21 "
50 " 20 "	15 " 23 "
20 " 10 "	20 " 25 "
10 " 5 "	25 " 30 "
5 " 2 "	30 " 40 "
2 " 1 "	35 " 50 "

The respective minimum numbers of commutator divisions, consequently, are:

$$\begin{aligned}
 \text{For over 100 A. p. Pole} \dots n_{min} &= \frac{E \times 2 P}{20} = \frac{E \times P}{10} \\
 \text{For 100 to 50 A. p. Pole} \dots &= \frac{E \times 2 P}{21} = \frac{E \times P}{10.5} \\
 \text{For 50 to 20 A. p. Pole} \dots &= \frac{E \times 2 P}{23} = \frac{E \times P}{11.5} \\
 \text{For 20 to 10 A. p. Pole} \dots &= \frac{E \times 2 P}{25} = \frac{E \times P}{12.5} \\
 \text{For 10 to 5 A. p. Pole} \dots &= \frac{E \times 2 P}{30} = \frac{E \times P}{15} \\
 \text{For 5 to 2 A. p. Pole} \dots &= \frac{E \times 2 P}{40} = \frac{E \times P}{20} \\
 \text{For 2 to 1 A. p. Pole} \dots &= \frac{E \times 2 P}{50} = \frac{E \times P}{25}
 \end{aligned} \quad (15)$$

Having thus determined the minimum number of divis-

* The following typographical errors occurred in the section of this article published in these columns last week: Page 740, second column, seventh line from top, "In the average values . . ." should read, "In Table III, the average values, . . ." In Fig. 1, page 740, the expression for the pitch of the slots should be $\frac{d_s}{n}$, instead of $\frac{d_s \times d}{n}$; for the width of the slot, in Figs. 1 and 3, pages 740 and 741, the letter s should be used instead of S ; in Fig. 2, page 741, the diameter of the hole should be designated by δ_h instead of δ_r .

ions that can be used in the commutator without excessive sparking, the actual number, n , to be employed has to be chosen by comparing this value of n_{min} with the total number of conductors on the armature, found by multiplying the rounded result of equation (8), (9), or (10), respectively, with that of formula (11), and dividing the product by the number, p , of armature wires stranded in parallel.

The number of turns, m , of armature conductors per commutator division, or the number of convolutions in each armature coil, is then readily obtained by dividing the total number of armature convolutions by the number of coils, n . The number of armature convolutions, in ring armatures, is identical with the number of armature conductors, while in drum armatures it takes two conductors to make one turn, and, therefore, the number of turns is but one-half the number of conductors. Hence we have:

For ring armatures:

$$m = \frac{o \times u}{n \times p}, \quad (16)$$

and for drum armatures, or drum wound ring armatures:

$$m = \frac{o \times u}{\frac{o}{2} \times n \times p}. \quad (17)$$

If the armature is to have spacing strips, or driving horns, the number of the armature divisions for this purpose depends upon the number of armature coils, n , the number of turns per coil, m , and the number of conductors in parallel, p .

In ordinary machines the number of armature divisions is usually made equal to the number of coils, n , and sometimes—especially in drum armatures—double the number of coils, $2n$, is taken. For high current output machines often a greater number of armature divisions than that given by the number of coils is chosen. In such a case the total number of single wires, or cables, $m \times n \times p$, is to be suitably arranged in groups. The number of these groups is to be a multiple of the number of coils, n , and since the number of turns per coil, m , in high current dynamos, is usually $= 1$, the problem of grouping, in this case, amounts to subdividing the number of parallel wires, p .

12.—Radial Depth of Armature Core. Density of Magnetic Lines in Armature Body.

Diameter and length of the armature core being determined, its proper radial depth can be readily found by the cross-section to be provided for the passage of the magnetic lines of force.

The density of lines permitted per unit area of armature cross-section is limited by the heating of the armature due to hysteresis and eddy current losses. The heat, generated by either of these causes, increases with the density of the lines, and with the number of magnetic reversals per second. The latter number is the product of the number of revolutions per second and the number of magnet poles, and therefore it is obvious that, in order to keep the temperature increase of the armature in its practical limits, in dynamos where this product is great, larger sectional areas of the armature core are to be allowed than in machines having a small number of magnetic reversals, or a low "frequency," as half the number of reversals, or the number of complete magnetic "cycles," is called. The former—high frequency—is the case for high speed and multipolar dynamos, the latter—low frequency—for slow speed and bipolar ones. On the other hand, large multipolar machines generally have well ventilated ring armatures, and in these an even considerably larger amount of heat generated will produce a smaller temperature increase than in drum armatures of equal output.

According to these considerations, the following values of the densities of lines of force in the armature core are recommended:

TABLE XVII.—CORE DENSITIES FOR VARIOUS KINDS OF ARMATURES.

	Kind of armature.	—Density of lines of force.—	
		Per square inch.	(Gausses.)
Slow speed bipolar drum.....		50,000 to 80,000	8,000 to 12,500
" " " ring.....		80,000 " 120,000	12,500 " 18,500
High " " drum.....		40,000 " 70,000	6,000 " 11,000
" " " ring.....		60,000 " 90,000	9,000 " 14,000
Slow " multipolar drum.....		30,000 " 60,000	4,500 " 9,000
" " " ring.....		50,000 " 80,000	8,000 " 12,500
High " " drum.....		25,000 " 50,000	4,000 " 8,000
" " " ring.....		40,000 " 70,000	6,000 " 11,000

The cross-section of the magnetic circuit in the armature core is the product of the net length, and the net radial depth of the core, and of the number of poles; and this product, divided into the total magnetic flux through the armatures, gives the density of lines per unit area. In order to obtain the net radial depth, or breadth of the cross-section of any armature core, therefore, the total armature flux is to be divided by the product of the armature density, of the net length of the body, and of the number of poles:

$$b_a = \frac{\Phi}{2P \times \mathfrak{B}_a \times l_a \times k_1}. \quad (18)$$

The symbols used in this formula denote:

b_a = radial depth, or breadth of cross-section of armature core, in inches;

Φ = useful flux, in webers, or number of useful lines of force cutting armature conductors, the calculation of which will be the subject of a subsequent chapter (Part II., chap. 1); for determining the radial depth of toothed and of perforated armatures, this is to be multiplied by the factor of core-leakage (see Table XI., chap. 8);

$\mathfrak{B}_a$ = density of magnetic lines in armature body, in lines of force per square inch, given in Table XVII.;

P = number of pairs of magnet poles;

l_a = length of armature core, in inches, from formula (12);

k_1 = ratio of net iron section to total cross-section of armature core, see Table XVIII.

The constant k_1 depends upon the material, and the manner of building up, of the armature core. In order to prevent excessive losses and resulting heating of the armature due to eddy currents in the iron, it is necessary to laminate the body perpendicular to the direction of the active armature conductors. In case the active pole faces embrace either the outer, or the inner, or both circumferences of the armature, the active conductors are those parallel to the shaft, and the lamination of the core is to be effected perpendicularly to the shaft; while in case of the poles being at the sides of the armature (flat ring type), the active conductors run perpendicular to the shaft, and the lamination is to take place parallel to the shaft. In case of the pole pieces embracing three sides of the armature section, finally, the active conductors are partly parallel and partly perpendicular to the shaft, and the lamination, in consequence, is also to be carried out in both directions. The materials for effecting these various laminations are iron *discs*, iron *ribbon* and iron *wire*, respectively. The insulation of these laminae, in the majority of machines, has been, and is yet, effected by inserting sheets of thin paper, asbestos, etc., between them, although it has been repeatedly shown by practical experiments* that such an insulation is not only entirely unnecessary, but, on the contrary, even disadvantageous. For, in order not to lose too much of the available sectional area of the body, the lamination in such armatures is usually made rather coarse, but it is just the fineness of the lamination, and not the thickness of its insulation, that avoids in a higher degree the generation of eddy currents. The oxide coating created by heating the iron is a very

* Ernst Schulz, "Elek. Zeit.," Dec. 29, 1893. See The Electrical World's Digest, "Iron in Armatures," volume XXIII., page 91, Jan. 20, 1894, and page 248, Feb. 24, 1894.

effective and suitable insulation of the armature core laminæ.

In the following table, values of the ratio k_1 , of the net to the total core section are given for various thicknesses of the iron, and for the different modes of insulation now in use:

TABLE XVIII.—RATIO OF NET IRON SECTION TO TOTAL CROSS-SECTION OF ARMATURE CORE.

Material.	Thickness. in inches.	Insulation.	Value of k_1 .
Sheet iron (discs or ribbon) ..	.080	Paper or asbestos	0.95 to 0.90
" " ..	.040	" " "	.92 " .88
" " ..	.020	Paper or enamel	.90 " .85
" " ..	.010	" " "	.85 " .80
" " ..	.010	Oxide coating	.95 " .90
Square wire	.080	Cotton covering	.90 " .80
" " ..	.040	" " "	.85 " .75
" " ..	.020	Enamel or varnish	.80 " .70
" " ..	.020	Oxide coating	.90 " .85
Round wire	.080	Cotton covering	.80 " .70
" " ..	.040	" " "	.75 " .65
" " ..	.020	Enamel or varnish	.70 " .60
" " ..	.020	Oxide coating	.85 " .80

In large ring armatures, for the sake of ventilation, air spaces are provided in modern machines by means of light brass frames inserted in certain intervals between the core discs. In calculating the radial depth, b_a , of the body, the sum of these distance-pieces is to be deducted from the total length, l_a , of the core, the reduced length so found being used instead of l_a in formula (18).

(To be continued.)

The Practical Importance of Resonance in the Transmission of Electrical Power.—V.

BY F. W. DUNBAR.

Figs. 7 and 8 are graphical representations of the resonance of a line 800 miles in wire length, of .2 ohm resistance per mile and of a mutual capacity of .010 microfarads per mile—the approximate value which would result from a wire separation of 12 inches on an ordinary pole line. The frequency is 80 ~ per second.

Fig. 7 shows the current, power factor, and energy de-

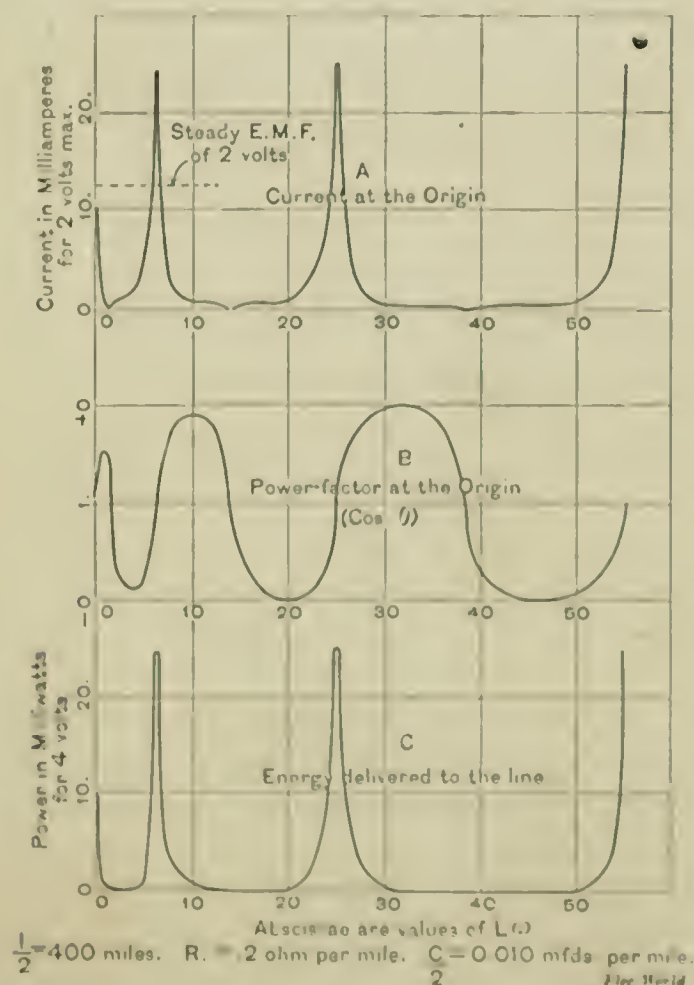


FIG. 7.

livered at the transmitting end of the line, and Fig. 8 shows the current, power factor and energy per unit (or, in this case, per 4 units) drop in voltage which result at the distant end of the line.

It will be noticed that at the origin the power factor varies

through unity and is equal to unity both when the current is a maximum and when it is a minimum—the latter case, of course, simply indicating that the reflected wave is in direct opposition to the direct, and consequently the only energy transmitted is the small amount due to the imperfect elasticity or imperfect *resiliency* of the line. As the value of $L\omega$ increases it will be noticed that the power factor at the

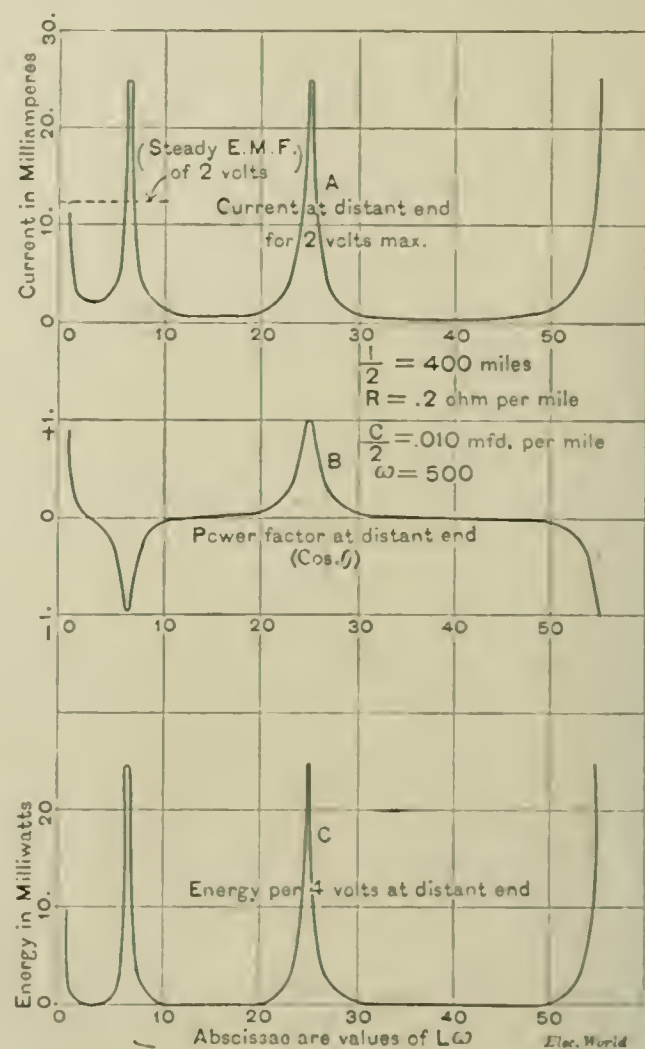


FIG. 8.

origin more nearly reaches the values of $+$ and $-$ zero at points corresponding to the maximum difference in phase between the current and E. M. F., and that it becomes more and more difficult to force the circuit to respond in any degree to any vibration other than that rate to which it is tuned.

At C, Fig. 7, the energy which can be forced out upon such a circuit is shown. This curve is found by taking the product of A and B, and consequently gives the energy in milliwatts for every four volts (maximum) of E. M. F. applied.

It will be noticed that at a value of $L\omega = 1$, corresponding to a value of $L = .002$, which is approximately the value which would naturally occur if the present methods of line construction were employed, it is practically impossible to force any energy out upon the line at this rate of alternation. But if the inductance be increased from .002 to .012 henrys per mile, then the line becomes perfectly resonant and will transmit a thousand or more times the amount of energy than it would be able to were the line constructed with no reference to the capacity and inductance. This example was chosen to illustrate the fact that long lines of low copper resistance are naturally resilient and that it will become *necessary* to introduce additional inductance into circuits which are to conduct a large current or power to great distances.

Curve C, Fig. 7, farther shows that as the resiliency of the line increases, the amount of energy which can be forced upon the line by any period other than that period for which it is in resonance becomes so small that it is represented by zero on the scale of the plot.

Fig. 8 represents the conditions at the distant end of the circuit.

It will be noticed that at this end the power factor varies

through zero and reaches a maximum at each maximum value of the current. The negative maximum (-1) indicates, as we have previously seen (Figs. 1 and 2), that there are an odd number of wave lengths in the circuit, while the positive maximum ($+1$) indicates that there are an even number.

The energy curve at the distant end is exactly similar and practically equal in value to the energy curve at the origin, indicating, as we have already shown (Fig. 4), that when the circuit is in resonance the line loss due to the "electrostatic absorption" is practically zero.

It is obvious that if a higher rate of alternation had been assumed in place of this comparatively low rate, 80 ~ per second, then *natural* resonance could have occurred on this comparatively long circuit, and also that by even a slight increase in the inductance complete resonance would be possible on much shorter circuits.

Thus if the rate were increased to 800 ~ per second, the inductance to .1 henry and the capacity kept constant at its natural value, then complete resonance would be possible at a distance of less than 10 miles.

Fig. 9 is designed to show that even where comparatively

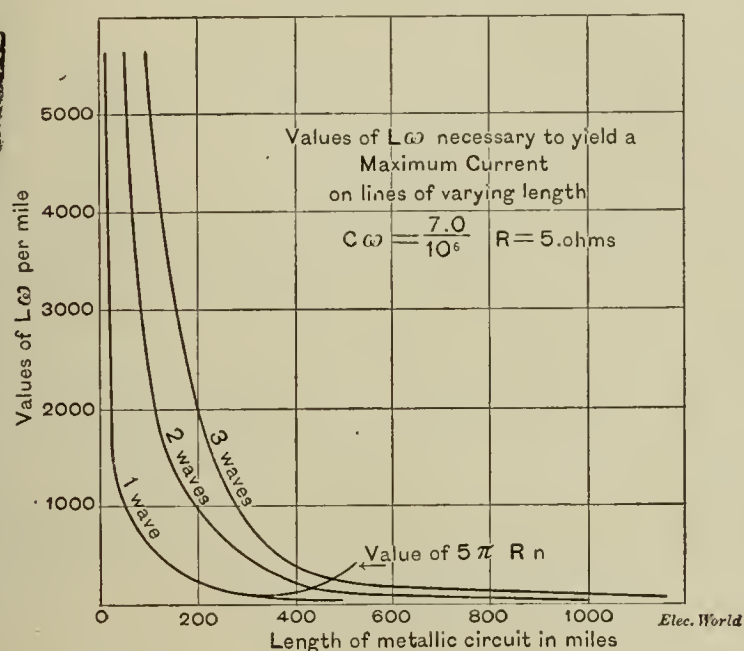


FIG. 9.

small wire is to be used (No. 12 N. B. S. G.), and without attempting to alter the natural value of the capacity which would occur upon a pole line containing such a circuit and with even as low a rate as 80 ~ per second, it is still possible to "tune" perfectly such a circuit by increasing the inductance. Thus, referring to the plot, it is possible to perfectly tune all length lines less than 330 miles to one wave length before a value of $L\omega$ is reached, which no longer exceeds $5\pi Rn$. It then becomes possible to tune perfectly by using two wave lengths up to 425 miles, and by using three wave lengths up to 470 miles, and so on. Of course an increase in the rate of alternation facilitates the tuning of the circuit by allowing a lower permissible value of the inductance, L .

Fig. 10 illustrates an example of resonance on short lines. The resistance per mile is 2 ohms, the capacity is .5 microfarad (.25 microfarad mutual) per mile, a value corresponding to a cable of rubber insulation, and the inductance is .020 henry per mile, a value readily obtainable in several ways. It will be noticed that the current rapidly decreases as the circuit increases in length and at a length of 15 miles or a distance of 7 1-2 miles is a minimum. At this point the power factor (not shown) is also a minimum, and the circuit is practically incapable of transmitting power at this rate of alternation, i. e., 320 ~ per second. But on increasing the circuit to a length of 30 miles, or a distance of 15 miles, the resonance is perfect and the circuit will transmit several hundred times as much power as it was capable

of transmitting a distance of 7 1-2 miles, and the true resistance of the circuit is but one-half the resistance which it would offer to a steady E. M. F. A second and third

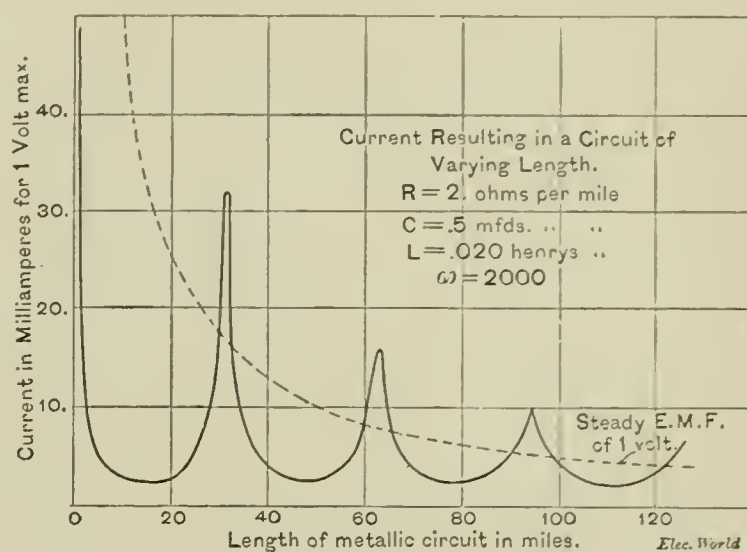


FIG. 10.

maxima occur at two and three times this distance and yield approximately one-half and one-third as great a current.

But while the value of $L\omega$ (40) is capable of yielding perfect resonance for the first maximum corresponding to one wave length, yet the second and succeeding maxima are not perfectly resonant, and as the number of wave lengths increase the departure from true resonance increases, for $L\omega$ only exceeds $5\pi Rn$ at the first maximum in this case.

The effect of this decreasing ratio between $L\omega$ and $5\pi Rn$ is clearly shown in the plot by the gradual flattening of the curve as the distance increases, the decreasing ratio between the maximum and minimum values and the failure to reach a maximum of twice the value secured by a direct current. Thus, at 126 miles the maximum is but 160 per cent. instead of 200 per cent. of the value of the steady current, and the power factor would show a much greater decrease.

Up to this point the circuit has been assumed to contain no receiving instruments at the distant end. It can, however, be readily shown that while the introduction of the receiving instruments at the distant end necessarily alters the value of the current and consequently modifies the problem, yet resonance can still be secured and obeys the same laws which I have pointed out, modified by the impedance of the receiving instruments. Thus, when the receiving instruments are themselves "tuned" by the now well-known laws governing localized capacity and inductance, to the same pitch to which the line has been tuned, then not only will the copper resistance of the line be decreased one-half, but the receiving instruments will receive their energy with no difference in phase between the current and E. M. F. and a truly resonant circuit will result.

The object, however, of these articles was to show that the line loss upon a circuit conveying an alternating current, instead of being a loss necessarily large, and increasing rapidly with the distance, can be made 50 per cent. smaller than the loss due to a direct current of the same voltage by adjusting the inductance and capacity of the circuit so that the natural period of vibration of the circuit will coincide with the rate of alternation which is desired to be transmitted.

Frozen Soap Bubbles.

Prof. Dewar, in one of his recent lectures, in which he performed quite a number of interesting experiments, showed that very fragile bodies, such as a soap bubble, may be frozen solid.

On the Design of Electromagnets for Specific Duty.*

BY P. MATTHEWS.

After carefully reading Mr. Cary T. Hutchinson's reply to my criticism of Mr. E. R. Carichoff's article "On the Design of Electromagnets for Specific Duty," and again referring to the original article, I am still firmly of the opinion that my criticism is well founded. Mr. Hutchinson does not interpret Mr. Carichoff's article; he states something different. He tells us that we are not to regard the line OF , Fig. 1, of Mr. Carichoff's article, called the air gap characteristic, as representing the relation between the induction in the air gap and the magnetomotive force, but the relation between the induction in the iron and the magnetomotive force in the air gap, divided by the length of the iron circuit. This word "characteristic" must have a peculiar meaning if an iron characteristic is simply a $\mathfrak{B} \mathfrak{H}$ curve and an air gap characteristic is a line expressing the relation I have mentioned. The words used by the editor in passing judgment on my article show that he has taken the plain, straightforward meaning of the air gap characteristic which I did, for he says that when $\frac{d\mathfrak{B}}{d\mathfrak{H}}$ are the same for both iron and air

gap, we have the conditions intended by Mr. Carichoff to represent the conditions for maximum work. The further statement of the editor puzzles me. Does he really think that in order to increase the area of the pole piece of an electromagnet I supposed that it was necessary to increase the section of the core? Returning to Mr. Hutchinson's article, the theorem which he establishes by simple mathematics is decidedly interesting, but I cannot agree with his statement at the end that "the results are similar to the conditions for maximum work of a battery, and, like them, are independent of the magnetomotive force." Does not the direction of the tangent to the iron $\mathfrak{B} \mathfrak{H}$ curve depend as essentially upon the magnetomotive force for a given length of iron as upon anything else? Obviously, it does, and this is where all the difficulty lies. Consider the sketch, Fig. 1. Suppose the conditions for maximum work are satisfied for a given current circulating round the core, the polar area being the only variable. If we increase the current the induc-

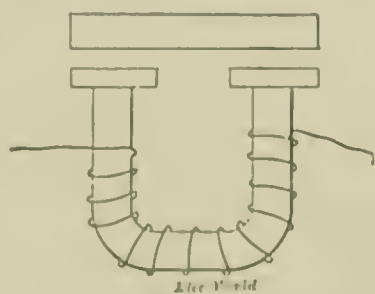


FIG. 1.

tion in the iron will increase, and the tangent to the iron $\mathfrak{B} \mathfrak{H}$ curve will alter in direction, hence the conditions will no longer be satisfied, since the line OF will not alter in direction. We have, therefore, to change the polar area and see if the conditions are again satisfied, but we might as well calculate the force for a different polar area at once, see if the change makes the force increase or diminish, and arrive at its condition for maximum in that way.

When we consider that the method, in addition to the difficulties I have pointed out, does not take into account the magnetic leakage, we are driven to the conclusion that, as it stands, the method is of very little practical use, as I inferred in my previous article.

We must remember that the leakage factor is so important in an electromagnet that if we neglected it we should get a polar area, by this method, so far from the best polar area that the method would be worse than useless. The leakage, however, may be taken into account if we regard it as independent of the polar area—a condition which it will not in

general accurately fulfill, but may approximately in some cases.

Let R = the equivalent reluctance of the paths of the leakage lines shunting the air gap. Then, if we work out the condition for maximum force we get

$$\frac{d\mathfrak{B}}{d\mathfrak{H}} = \frac{R A - L}{R L},$$

where $\mathfrak{B}$ = lines through core,

$\mathfrak{H}$ = magnetomotive force expended on iron,

A = area of air gap,

L = length of air gap.

Determining $\frac{d\mathfrak{B}}{d\mathfrak{H}}$ from the direction of the tangent, at different points on the iron curve expressing the relation



FIG. 2.

between M and N we could calculate the areas A for these points by the above equation. We could then construct the accompanying curve, Fig. 2, which might in some special cases be of value.

The ordinates give the best polar section for a given core and length of air gap, when the core is to be used for several magnets and outside conditions demand certain definite total magnetomotive forces. As, however, the limiting condition for ampere turns is generally the watt loss and consequent heating, for different magnetomotive forces we would use different cores.

The best method of procedure, I am convinced, is by direct experiment.

BY E. R. CARICHOFF.

Mr. Matthews' second attack on the statements put forward in my article "On the Design of Electromagnets for Specific Duty" warrants, I think, a few further remarks. He questions the right to call the line OF in Fig. 1 of my first article the air gap characteristic. The iron characteristic is there given as a $\mathfrak{B} \mathfrak{H}$ curve, which everybody knows means the abscissas of the total characteristic per unit area, divided by the total length of magnetic circuit, and, consequently, I did not think it necessary to state that the line OF represented the total air gap characteristic per unit area, divided by total length of magnetic circuit, as it seemed to me obvious that this was to be inferred from the $\mathfrak{B} \mathfrak{H}$ curve being given instead of the $\mathfrak{B} \mathfrak{A}$ curve for the iron and both curves being plotted on the same scale. By taking values per unit length of magnetic circuit, we get the total values for any length of magnetic by simple multiplication.

The statement that "when the function $\frac{d\mathfrak{B}}{d\mathfrak{H}}$ is the same for both iron and air gaps, etc.," is taken from a paragraph near the end of my first article.

In ancient days we were taught that when the external resistance equals the internal resistance of a battery the current in the circuit is a maximum. When μ is constant the maximum work, as previously defined, is when air gap reluctance equals iron reluctance. When μ is variable the first differential coefficients are equal.

In answer to the first "conclusion to which" Mr. Mat-

* See The Electrical World, Jan. 27, Feb. 17 and 24, 1894.

thews so frankly avows he "is driven," namely, that the method is of little practical use, I maintain on the contrary as a result of actual experience, that one can in the least time, with the least chance of error, design a magnet for a specified purpose, with the expenditure of the least material, or the least electrical energy as required, or with just the proper proportion of the two.

Mr. Matthews' long essay on leakage does not apply to the case in point, because, if he will refer to the second section of my article, he will see a form of magnet in which leakage is almost negligible. His final conviction that the best method of procedure is by direct experiment is also inapplicable, as my first paragraph stated that the method was evolved to suit the exigencies of a case where there was no opportunity for experiment, and none permitted.

In conclusion, I may state that on actual trial, magnets so designed do exactly what they are calculated to do, and thus the cost and time of any "direct experiment" are saved, as well as the time spent in trial calculations; and that, therefore, the method is of great practical use.

Electrical Shop Equipment.

BY HOWARD L. INGERSOLL.

Shops, factories and mills at the present time are, for the most part, well equipped with modern appliances in steam driven machinery. In a few printing and lithographing establishments, where the necessity of cleanliness is combatted by the tendency of belting to fling dust about the room, line shafting has been replaced by a motor in each room. This reduces belting and shafting by a half, and the improvement is quite marked.

The complicated fixtures—shafts, countershafts, pulleys, hangers and belts—entailed by the common means of transmitting power, present at the same time favorable, and seriously objectionable features. In their favor, it may be said that they are well known; improved by all good appliances obtainable; and, in cases where very small work is done, are the best known ways of transmission.

Offsetting this, we have the first cost of material and placing, which is considerable; they always require a great amount of attention and repair, occupy much valuable space, furnish easy and multiple chances for accident and loss of life, and, furthermore, tend to stir the latent particles of dust and dirt, cause them to become an ingredient in the air breathed by workmen and a deposit on all articles within reach. These are objections—serious ones, too—which, in cases of shops supplied with medium and heavy machinery, outweigh the favorable qualities which have made our present equipment the rule.

Considering, first, the betterment of a shop already constructed and running, let us see how changes may be applied. This establishment has its own power plant—boilers, engine, etc. Let the same power plant remain to serve in the new order. With the addition of a generating plant of one or more dynamos, there will be the basis for an electrically driven manufactory. From the generating plant the current is taken to the separate departments by ordinary means. It is distributed through the department by means of a conductor, which may be placed in a similar position relative to the machinery that the line shaft occupied. The hinging point of the change comes here. Each large and independent machine contains a motor in some out of the way part of its frame, which, through gearing, furnishes the driving power.

As to the application of the motor to the various tools, these plans are the result of dynamometer tests with different ones, relative to determining the power required for each under the different conditions appearing in every-day practice. The designs are the outcome of attempting to locate the motor in a protected, yet convenient spot, in the frame

of the machine. A complete illustration of this is not necessary, and we will only specify in one or two cases.

First, let us take a lathe. The one experimented with was a 16-inch lathe, and various tests were made with different materials and cut up to the maximum. It was found that under full load (with belt just holding) the power necessary averaged 0.2489 h. p. This includes friction of adjunctory parts used on lathes. Therefore, with a 1-h. p. motor, wound with resistance in series with field, and the range of speed adjusted at 800—1,600 revolutions per minute, the requisite change of speed and a considerable excess of power would be realized. The operator has a switch in circuit with the above mentioned resistance, which enables the regulation (now made by cones) and the reversing to be done. Thus, the overhanging shipper is done away with.

The motor, *M* (Fig. 1), is located under the headstock, which hinges on lugs *H*, at the back of the bed, which allows of lifting the headstock to examine the motor. It is the only means of access to the motor, as the cabinet at the head end is a closed casting. The motor rests on a shelf cast on the cabinet, and ribbed for rigidity. The headstock drops on V-ways and the wrist bolts, *W*, at the front clamp it solidly in place.

The motor shaft and armature are represented by *b* in

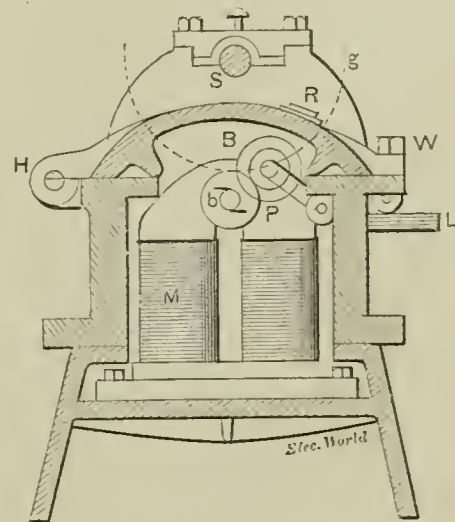


FIG. 1.—LATHE MOTOR.

Fig. 1, and the pinion *P* is of such a ratio to *g* (gear between bearings on spindle) as will give proper velocity ratio for highest speed. *R* is the operator's regulating switch on top of headstock. *B* is the back gear, operated by a stop lever at *L*. The back gear is thrown in by offsetting *g*. This gear *g* has an extended hub on one side, through which is a stop or pin fitting into a hole in the lathe spindle. To set *g* for back gear, it is moved from the face plate into the position above the pinion on the back gear arm, then the gear *d* on *B*, which is above *P* and gears with it, and the pinion *a* on *B* are thrown into gear by *L* (see Fig. 2).

This makes a compact arrangement, the motor being en-

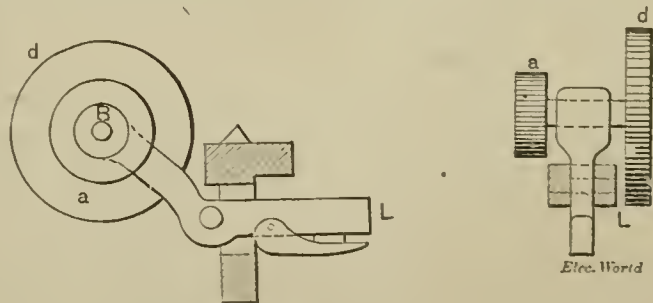
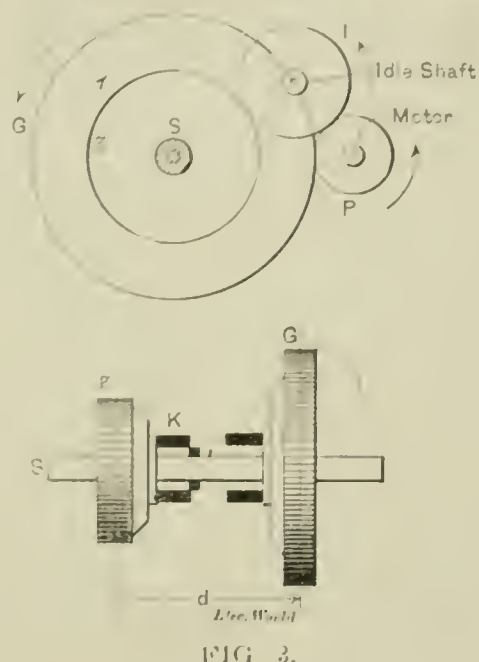


FIG. 2.—DETAILS OF ELECTRICALLY DRIVEN LATHE.

tirely hidden and at the same time readily accessible. The screw cut, feed and other details are applied in a similar manner to ordinary lathes.

The planer offers a ready location for the motor underneath the bed, on a cast shelf, enclosed, and free from dirt.

The difficulty to be overcome is the reverse and quick return. The solution to this is quite simple. It necessitates a friction clutch between two gears on the planer spindle. These gears, Fig. 3, are of different size (g and G). P is the pinion on the motor, Fig. 3, and is so arranged as to drive



an idler I , gearing with the quick return gear g on the spindle of the planer. Another pinion at a distance $= d$ from P drives the feed or forward gear, G direct. Thus we obtain a slow cut, and by having g the requisite ratio to P , we can have any quick turn desirable. The clutch K is operated by a shifter on the planer table, such as is ordinarily used for shifting belts. The motor is always rotating in the same direction, and, furthermore, the friction clutch between g and G throws the load on gradually. If desired, a switchboard can be used to give changes of speed. The coupling to a shaper may be made in a similar manner, with the exception that the clutch is unnecessary, the Whitworth quick return being entirely sufficient. The motor would be placed in the bottom of the casting and geared to the quick return of the common shaper.

For a drill press, the connections would be similar to a lathe, the motor either boxed at the base, and the stepped cones and belt used to connect power with spindle, or placed on a shelf beside the spindle and geared to it.

For driving power for small machines—grinding machines and the like, a few of which are necessary in any shop—belting would probably be indispensable. The cost of these machines, supplied with an independent motor, would be so much compared with their earning capacity that it would be useless to put independent driving mechanism in each. Therefore, it would seem that the surplus power of some large machine might serve the few small tools. The lathe, or other large tool, would be connected to the others by belting, placed along walls of the room so as to be out of the way. The motor in this lathe could be run, whether it were used to propel the gear on the lathe or not. Thus it would furnish an ever ready power for the small sub-tools. The small amount of belting and necessary adjuncts to consummate this would not be a factor.

The arguments for and against present methods in equipment have been given above, together with the advantages to be derived by a change. The only valid argument against this projected method is the cost of these specially built machines. However, when once the manufacture is undertaken, and the machinery given a fair trial, its advantage will be proven clearly. It may be said here that the writer knows of two large firms, builders of machine tools and their accessories, who are experimenting along these same lines. One of them has a line of tools on the market.

To return to the question of economy. The extra cost of the motor would be small compared with the cost of additional labor required to attend shafting and repair belts.

Further, the work of one man will be more productive when the system is tried. Besides this, nothing has been said of the cost of keeping a shop in a cleanly condition, which would be much decreased by avoiding belting. In the case of an old shop, while the utility would be unquestionable, yet the advantage of a change might be uncertain, owing to the expense. But where a new equipment and new establishment are planned, economy and all other considerations point to the fact that the first additional outlay would be well placed.

The noisy and dirty workroom will be changed to a place of quiet and orderliness, and be a matter of pride to the proprietor who has had the wisdom and foresight to keep pace with the tireless march of progress, and the workers in these places will have better nerves, senses and lungs.

Baseball by Electricity.

When the New York Baseball Club started out to win the series of games they have been playing at the Polo Grounds, New York City, it is not probable that they were aware their actions were being actively watched by a large audience several miles removed from the scene of action. Such, however, was the fact, and a double set of cheers was sent up for every good play that was made. The second audience was located in the Standard Theatre, but by an ingenious contrivance it was enabled to view the slightest move of the players, and the anxiety of those present was just as great as though they had been occupying the real grand stand.

A large flat or curtain was painted to resemble a baseball field. At the back was a grand stand and a "diamond" was laid out in regulation order. Every base, however, was represented by a square hole. Under every painted player was a round hole backed by a color which corresponded to the team in the field. Small bells were arranged on various parts of the curtain and near them a sign indicated what various signals would mean. There were also holes to represent the "strikes" and "balls" and to chronicle the fact of a player getting out. Back of every hole was a miniature panorama arrangement on which the various signals were indicated.

The news from the Polo Grounds was received by a telegraph operator, who sat in the place usually occupied by the orchestra leader. As the news came in it was recorded and was reproduced in fac-simile on the curtain, which was accomplished by a series of keys, setting in motion small motors behind each opening. "One ball" was indicated at the opening marked "Ball" by the appearance of a figure 1. "One strike" was recorded in a similar manner. When a player made a base hit he would be seen to disappear from the "home plate" and reappear in the opening at first base. Sometimes when a ball was being pitched a player would disappear from the base opening, and if he reappeared at the next base the audience knew he had stolen a base. More often, however, his disappearance would be followed by the appearance of 1 in the "out" hole, and then the audience knew he had been caught in the act.

The batting order was represented by two signs, with the players and the numbers marked on it, the number corresponding to the batsman appearing on the home plate. All fouls were noticed by a bell, while the double ringing of another bell recorded a "bunt." On the other side of the diamond a bell ringing once, twice, or thrice told of one, two or three base hits, or four times for a home run. When a fly was struck, a large pictured "animal" of the same name appeared just to the left of the pitcher's box.

The whole arrangement was quite unique and brought down the house with its instant record of a game played so far away. It was quite amusing to watch the excitement of the audience when a hit was made. The contrivance is the invention of M. D. Compton, who intends to introduce it in the larger cities throughout the country.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

COMPILED FROM
PRINCIPAL FOREIGN
ELEC WORLD, N.Y.

ELECTRICAL JOURNALS
BY CARL HEDING

ELECTRO-PHYSICS.

Dielectrics.—A Physical Society paper by Mr. Appleyard is abstracted briefly in the London journals of May 18; on testing the insulation resistance of celluloid placed between metal sheets he noticed that the resistance, which was very high, decreased as the time of the application of the battery was increased; it diminished greatly with the increase of battery power and a considerable amount of hysteresis was observed; using mercury in place of the metal sheets the abnormal results disappeared. Some experiments with mixtures of gutta-percha and coarse brass filings, for use as high resistances, are described.

In "La Lum. Elec.," May 12, Mr. Lefevre discusses mathematically at some length certain theoretical considerations and the application of the theory of Lord Kelvin, and gives some experimental verifications.

Condenser Discharges.—In an Academy paper by Mr. Swyngedauw, abstracted in "L'Ind. Elec.," May 10, he discusses the proportion of the discharge of a condenser between two conductors in shunt circuits, one of which contains an air gap; among other things he shows that the quantity of electricity passing through one of the shunt coils may be more than ten times as great as the total charge.

Electromagnetic Induction.—A Physical Society paper by Mr. Bryan on "Electromagnetic Induction in Plain, Cylindrical and Spherical Current Sheets and its Representation by Moving Fields of Images" is abstracted in the London journals of May 18.

Oscillations.—A Physical Society paper by Prof. Minchin on the "Behavior of Certain Bodies in Presence of Electromagnetic Oscillations" is abstracted briefly in the London journals of May 18.

MAGNETISM.

Magnetic Properties of Iron at High Temperatures.—Mr. Curies' Physical Society paper is abstracted in "L'Elec.," May 12; he states, among other things, that the intensity of magnetization is constant as the temperature increases, then decreases at an increasing rate, the maximum rate being at about 745 degrees C.; from 950 to 1,280 degrees the intensity of magnetization diminishes only very slowly, while at the latter temperature it increases suddenly to half of its value and from there to 1,365 degrees it again diminishes.

Manganese Steel.—The Lond. "Elec.," May 18, abstracts briefly some experiments with the magnetic qualities, in a paper by Mr. Hadfield, read before the Iron and Steel Institute.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Standard of Light.—"L'Ind. Elec.," May 10, contains a paper by Mr. Guillaume, in which he describes the Lummel and Kurlbaum method for determining a fixed temperature for the platinum standard; the method was briefly described in the Digest last week; the temperature is defined by the

condition that the total radiation after passing through a layer of water two centimetres thick between two plates of quartz, 1 millimetre thick, is reduced to one-tenth of its intensity. He gives in a diagram the curves showing the relation of the lengths of the waves and the corresponding energies, for sun light, arc light and gas; also for the arc light after traversing five centimetres of water; the ratio of the energy in the visible spectrum to the total energy increases, as does also the ratio of the energy absorbed by the water to the total energy of radiation; the sensitiveness of the proposed method depends on the way in which this ratio varies with the temperature; he shows that under the most favorable conditions the pressure does not permit the temperature to be defined with a sufficient precision for a standard; he discusses the matter theoretically and shows that if the radiation measured by the bolometer increases one per cent., corresponding to an increase of temperature of a little over one degree C., the luminous intensity due to this increase will increase three per cent.; this is the weak point in the method, as a limit of error of one per cent. in the photometric standard requires a precision of one-quarter of one per cent. in the bolometric measurements. He describes in detail the way the method is carried out, showing that great precautions must be taken to insure sufficient accuracy; the impurities in the platinum modify the emissive power, but the nature of the surface is of less importance, as the evaporation of the metal keeps the surface the same; the calorific capacity of the bolometer varies with the thickness of the black layer; he describes an electrolytic method by which the platinum is blackened to a definite amount. He quotes from the authors, in which they say the reproduction of the unit is sufficiently easy if one has the proper apparatus; that the errors are less than one per cent. and that hereafter the photometric measurements at the Imperial Reichsanstalt, of Germany, where these experiments were made, will be based on this unit; they state that this new unit is well adapted to the photometry of lights of different tints, as it requires only a modification of the above defined ratio. In conclusion, Mr. Guillaume states that according to Mr. Abney all tints can be replaced in practice by white, to which has been added a certain proportion of a simple color; all illuminations can therefore be represented by an intensity factor and a formula for the color factor; this he considers a new idea which it would be well to develop.

International Ohm.—The Siemens & Halske Co. of Berlin, will hereafter use the international ohm as a standard of resistance in place of the legal ohm.

Kruppin.—According to a statement in "La Lum. Elec.," May 12, the new resistance material, Kruppin, the properties of which were given in the Digest Jan. 6 and Feb. 3, is an alloy of copper, nickel and manganese, the proportions of which, however, are not given.

Hummel Meter.—"L'Ind. Elec.," May 10, gives an illustrated description of the Hummel meter, which is used largely in Germany and which resembles in principle that of Prof. Elihu Thomson; a short description of the theory is included.

DYNAMOS AND MOTORS

Theory of Alternating Current Motors.—In the "Elek. Zeit.," May 17, Mr. Cahen calls attention to an error in the mathematics of the article of Dr. Behn-Eschenberg (see Digest, April 28), and gives the correct mathematical deductions; the error does not appear to affect the practical results materially.

Alternate Current Induction Motors.—A paper by Mr. Potier, read before the Soc. Int. des Elec., is abstracted at some length in "La Lum. Elec.," May 12, and more briefly in "L'Ind. Elec.," May 10; it is of a mathematical character and has reference to the field.

Variable Speed Motors.—Mr. Leonard, in the Lond. "Elec. Rev.," May 18, replies to the recent inquiry of Mr. Seaman, whether the dynamo will not spark badly when working with its full current at one-tenth its normal voltage; Mr. Leonard replies that in no less than ten different generators with which his system is used, he has never met with the slightest tendency to sparking with any one of them, nor is any adjustment of the brushes required even when the field is reversed.

Domestic Motors.—In a well-illustrated article in "La Lum. Elec.," May 5, good illustrations are given of some small motors, most of them of American origin.

TRANSFORMERS.

Continuous-Alternating Current Transformer.—A translation of the paper abstracted in the Digest May 19, describing the Hutin & Leblanc transformer, is published with the illustrations in the Lond. "Elec. Eng.," May 4.

Closed Circuit Transformer.—A discussion of the general problem of the calculation of such transformers is given in a paper by Mr. Korda in "Comptes Rendus," volume CXVIII., No. 16.

ARC AND INCANDESCENT LIGHTS.

Life and Efficiency Test of Incandescent Lamps.—"L'Ind. Elec.," May 10, publishes in a large full-page table by Mr. Gasnier the results of a long series of measurements with a large number of different lamps, with the object of finding the variations of the luminous intensity and the consumption of energy at different periods of the life; the lamps were all of 110 volts and of 10 and 16 candles, and the test was continued, as a rule, up to 600 hours; the method of making the photometric measurements is briefly described. The results given in the table include the candle power, the consumption in watts and the watts per candle, as also the life of the few lamps which were consumed before the end of the test; the data in the table are of considerable interest, but do not admit of being abstracted.

Small Arc Lamps.—"L'Elec.," May 12, contains an illustrated description of the Buchet lamp, for currents of two to four amperes.

TRANSMISSION OF POWER.

High Tension Continuous Current Transmission.—In an article by Mr. Schultz in the "Elek. Zeit.," May 17, he discusses high tension continuous current transmission. Shunt dynamos, he claims, cannot be made for over 1,000 volts and series dynamos for not over 3,000 volts; for simple transmission with 6,000 volts, for instance, as distinguished from distribution together with transmission, he suggests using two series wound dynamos connected in series, each of 3,000 volts, to connect these over the line wires with two series wound motors similarly connected; it is essential that the motors be coupled mechanically, otherwise they will not be equally loaded and would require regulators. For transmission and distribution to two different motors, say at

4,000 volts, he proposed a similar arrangement, with the introduction of a third line wire connecting the junction of the dynamos with the junction of the motors; when both are running the middle wire conveys no current and when either one is used alone the percentage loss will be doubled and the speed will be slightly reduced, both of which would doubtless be of not much importance in practice.

Transmission of Power.—A descriptive article by Mr. Boucherot, containing a number of illustrations, is begun in "La Lum. Elec.," May 19, describing the installation at the Menier works; in the present part the installation and apparatus are described, as also some efficiency tests of a diphasé Brown alternator of 75 h. p. and 40 periods, and a 15-kw. transformer.

ELECTRIC RAILWAYS.

Worm-Wheel Gearing.—The Lond. "Elec. Rev.," May 18, contains an article by Mr. Dawson, describing some tests with the Reckenzaun motor and gearing, made on an experimental track. There are two independent series motors of 10 h. p. to the truck, the weights and proportions being given; the worm is turned out of a solid piece of steel 6 inches in diameter and well polished, it has a triple thread of 6 inches pitch; the worm wheel is of phosphor bronze 15 1/4 inches in diameter and has 24 teeth; the whole is encased in a dust and waterproof casing containing oil; the inclination of the worm thread on the spindle is 45 degrees, this being the angle which gives the highest efficiency, the theory of which is given. Some practical tests made by the late Mr. Reckenzaun are given, showing a maximum efficiency of gearing as high as 95.4 per cent. when 1.64 h. p. was transmitted; the efficiency grows less for greater horse power and is highest for the least thrust on the tooth, which in this case was 132 pounds; these high efficiencies are said to have been due to careful design, to careful cutting and polishing of the teeth and to abundant lubrication; some efficient tests showing very good results are quoted from the experiments of Mr. William Sellers; a high peripheral speed, a limited pressure, an inclination of 45 degrees and a multiple thread are said to be necessary for the best efficiency, as also great care in workmanship and polishing. Some tests are reported in which the two driving wheels of a raised truck were belted together, one motor thus driving the other as a dynamo, showing an efficiency of the worm gearing of 84 to 88 per cent., allowing 7 per cent. for the loss in the belt and in the friction of the car axles; the worm wheel will drive the worm without any appreciable loss when the current is cut off, and it is stated that one man can push a loaded car on a level, running against the worm; the speed reducing power is 1 to 8, thus enabling cheaper and lighter motors to be used. The coupling of the various parts of the motors for different speeds is given and the results of some tests showing that between 3 and 8 h. p., which is the normal output, the efficiency is quite high; a table is given, but the curves referred to are omitted.

Electric Locomotive.—A brief description, with some data and illustrations, of a 1,200-h. p. locomotive to be completed for a French railroad, is given in the Lond. "Elec. Eng.," May 18, taken from the "Railroad Gazette," of New York; it is intended for trial in fast passenger service, and it is proposed to try the experiment first with storage batteries; the first locomotive is to have a power of only about 300 h. p.; the design is criticised, and it is questioned whether that output can be obtained; under the most favorable circumstances a weight of at least 1 cwt. per effective horse power is required for large electric motors; it is claimed that probably some mistake has been made in the design or data; the advisability of using accumulators is questioned, and it is claimed that the overhead trolley wire construction is the cheapest system, both as regards outlay and working expenses.

Heilmann Locomotive.—According to 'La Lum. Elec.,' May 19, this locomotive, which is now making regular trips, runs at a mean speed of 37.2 miles per hour; the maximum attained was 63; in returning the speed was 46 miles per hour.

Electricity for Heavy Railroad Service.—An article by Mr. Barnes, taken from the "Railroad Gazette," is abstracted briefly in the Lond. "Elec. Eng.," May 18.

Surface Contact Railway.—A brief description from "Genie Civil," of the Claret & Wuillieumier system, which is to be in operation at the Lyons Exhibition, is abstracted in "La Lum. Elec.," May 12; so-called automatic distributors every 300 feet send the current to the sections under the car, from which the current is then taken by the car. The same number contains a description by Mr. Richards of this system, in which a number of illustrations are given.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Cost of Electrical Energy.—An abstract of the discussion of Mr. Crompton's recent paper is given in the Lond. "Elec." and "Elec. Rev.," May 18, in both of which it is also discussed editorially; in the latter, the item of accumulators is referred to, among other things, it being thought that not enough attention was given to it in that paper; the same journal contains a communication. The discussion is limited almost entirely to the mechanical engineering features.

Train Lighting.—The Lond. "Elec.," May 18, states that the London, Brighton and South Coast Railway has decided that its electrically lighted trains are more serviceable than those lighted with either gas or oil; all three systems have been tried by this road, and the electrical system is estimated to render about 15 per cent. more service than the others; the first cost of gas for a train of 10 coaches, including buildings and producer plant, is stated to be \$3,500, that of oil \$600 and that of electricity \$2,000; the yearly cost of maintenance with gas is \$600 per train, with oil from \$350 to \$650, and with electric light only \$250 per train.

Lightning in a Central Station.—In "La Lum. Elec.," May 12, Mr. Robert describes the recent destruction of a machine in a central station by a bolt of lightning, the machine being insulated; the lightning, after destroying the machine, passed to ground through the switchboard.

Berlin Station.—A translation of the article by Dr. Pas-savant, mentioned in the Digest May 19 and June 2, is abstracted briefly in the Lond. "Elec.," May 18; the systems of automatically announcing and localizing faults, mentioned in the former paper, were described in the Lond. "Elec.," May 18, 1893.

Theatre Plant.—"La Lum. Elec.," May 12, gives a brief description of the installation at the Olympia, in which electricity is used more than in any other theatre in Paris.

Electricity in Mines.—A few installations are described very briefly in the Lond. "Elec. Eng.," May 18.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Disturbances in Telephones due to Railway Circuits.—In an article by Messrs. Meyer & Muetzel, in the "Elek. Zeit.," May 17, they describe experiments to determine whether the disturbances are due to induction or to the earth currents; the experiments are described in detail and were made with telephones over the line of a railway. No noises were heard when both the outgoing and the return were overhead lines running along the railway, provided they were near to each other; if, however, they were as much as 2.5 metres apart the noises became as loud as usual; this shows that the disturbance was due to induction; they found that the earth currents, which caused quite a considerable disturbance in galvanometric researches, had very little effect in producing the disturbances in telephones; that they had some effect was shown by the fact that the noises were

loudest when the telephone current went out over the line wire and returned through the earth, but the effect of the earth current was found to be due to the incomplete insulation of the line from the earth, notwithstanding that the insulation was so high that a galvanometer test could not locate any faults; they conclude that it is very important to insulate such telephone lines very carefully from the earth.

Train Signals.—"La Lum. Elec.," May 12, abstracts from the German an illustrated description of the Bormann system, in which telephonic communication is established between the locomotive of a moving train and the station, as also with other locomotives on the same track; a trial of this system has recently been made in Germany; contacts are made through three insulated rails placed between the two tracks and variously connected with the stations and with each other.

Pacific Cable.—A letter of Sir John Pender is reprinted in the Lond. "Elec. Rev." and "Elec. Eng.," May 18, and is discussed editorially in the latter.

Telegraphs in Persia.—A Society of Arts paper by Mr. Wells is abstracted briefly in the Lond. "Elec. Eng.," May 18.

Microphone.—The Anizan-Mercadier microphone is described and illustrated in "La Lum. Elec.," May 19.

ELECTRO-CHEMISTRY.

Purification of Sewage.—In "La Lum. Elec.," May 19, Mr. Rigaut gives the results of the three official reports made on the Hermite process, one of which was unfavorable and the two others favorable, in order that they may be compared with each other; he speaks of another test which is being made, but not finished, by Dr. Chantemesse. In conclusion, he gives a detailed estimate for a city of 100,000 inhabitants near the ocean, on the basis of 0.3 gramme of chlorine per litre and 30 litres per inhabitant per day, the result being 2.19 francs (about 44 cents) per inhabitant per year; for an inland city, 98.6 cents per year per inhabitant, using salt in its solid form.

Tinning Cast Iron.—According to the Lond. "Elec.," May 18, a French company has adopted the process of first coating the iron electrically with nickel and iron or cobalt and iron; 1 kilogramme of sulphate, nitrate or chlorate of nickel is mixed with 3 kilogrammes of sulphate of iron and 1 kilogramme of citric or tartaric acid; or 1-2 kilogramme of the similar compounds of cobalt with 3 kilogrammes of sulphate of iron; this is dissolved in 100 litres of water and completely neutralized with caustic alkali; a current of 50 amperes per square metre is used.

MISCELLANEOUS.

Electrotropism.—The Lond. "Elec. Rev.," May 18, reports some tests of Messrs. Blasius & Sweizer concerning this phenomenon; a current of 108 volts was passed through water containing fishes, and they showed that when the head of a fish is directed toward the anode, calmness or even stupefaction ensued, but if the head is in the opposite direction, excitement is occasioned, accompanied by an effort on the part of the fish to escape the effect; it would appear, therefore, that the phenomenon of electrotropism would proceed from the effect of the current upon the nerves of sensation and there would ensue, according to Pflueger's well-known law of electrotonus, a decrease of excitability at the positive and an increase at the negative pole. If fishes are traversed transversely by the current they display a behavior analogous to dizziness, like in man when the current passes through his head, and they always sink on the side turned toward the anode. The results were the same with an accumulator current.

Relation of Mathematics to Engineering.—The paper of Prof. Hopkinson is concluded in the Lond. "Elec.," May

18, and is editorially discussed in the same issue, which contains also a communication from the author.

Electricity Users' Association.—The object and rules of this new association are given in the Lond. "Elec. Eng.," May 18, in which journal they are also discussed editorially; in general, the object of the association is to test apparatus and advise upon technical questions.

Electrical Advertising.

The accompanying illustration shows the electrically lighted advertising wagon of Keith's Union Square Theatre, New York. Its equipment consists of 32 chloride accumulators of type E, 9 plates, 200 ampere hours' capacity, furnished by the Electric Storage Battery Company, Drexel Building, Philadelphia. The cells are in four boxes, eight to the box, each box weighing, complete, about 400 pounds. Sixteen cells compose a set, one of which is in use on the wagon while the remaining set is being charged.

The wagon is wired with extra heavy rubber covered No. 12 wire and No. 14 specially made black silk cord runs from the wagon to the horses. The wagon carries 15 28-volt, 16-c. p. Dekhotinsky lamps in Edison sockets, and each of the four horses carries 2 30-volt, 16-c. p. lamps of the same make in Swan sockets, fastened between the ears and on the saddle. Bryant switches control the four circuits, two on the wagon and one each on the leaders and wheelers. The batteries are charged from the theatre plant in a small house built for the purpose in the rear of the main building.

This outfit has been in charge of Mr. R. Burbank, electrician of the theatre, and has been running very satisfactorily since it was brought out, in September, 1893. The wagon has been used in Boston, Providence, Philadelphia,

much less, both to install and maintain, the Card Electric Company, of Mansfield, O., has designed for such a service a motor which we illustrate herewith.

Fig. 1 shows the motor with the lower half of the case lowered, exposing the armature and field coils, for inspection or removal. A small chain block, fastened to a beam of the car body by means of an eye-bolt, and to the lower half of the motor case at the extension, shown in the centre, will enable one man to raise or lower it with ease. If the armature is to be removed, the journal caps are taken off, the case supported from below with a timber, a plank laid one end on the motor case and the other on a cross support in the pit; on this the armature is rolled out of its bearings away from under the car and on to the floor. An armature can be taken thus from such a motor easier and quicker, it is claimed, than any other motor on the market, and with less danger of injury.

A novel feature, shown in Fig. 2, is the steel bar for strengthening the cast extensions that form the spring supports. The bar rests in grooves, cast for the purpose, and is clamped down by two eye-bolts fastened by pins between the hinge ribs at the bottom, and clips over the top, dividing the strain equally between four points, overcoming all danger of breaking after long service through a gradual crystallization of the cast metal. There is no reason why such a frame of a motor should not last forever. It will be noticed that all the working parts are encased within the cast frame of the motor, and are absolutely protected from dirt or moisture at all times. Other features are the rigidity of the frame, and the impossibility of parts getting out of alignment. The gear case is made of malleable iron. In the top half is an opening with a hinged lid for inspecting the gears and inserting grease. The rear fastening to the bottom half is made in the form of a detachable hinge, for convenience in lowering and removal.

The core of the armature is built up of the best magnetic



ELECTRICAL ADVERTISING WAGON AND TEAM.

Brooklyn and New York, and has made extended trips through the suburbs of these cities. As an advertising novelty it has been a great success and never fails to attract admiring attention.

The Card Electric Railway Equipment.

Believing that on roads using 18-foot cars and under, over grades not exceeding 8 per cent., a single motor equipment may be made just as reliable as a double one, and will cost

iron procurable, and is slotted to receive the conductors; these slots are insulated with mica, as are also the ends of the core. The shaft is of hammered steel, is four inches in diameter through the core portion, with a one inch square key to prevent turning; the ends are reduced to receive the commutator and oil disc, without impairing the strength or rigidity of the shaft, and terminate in bearings of generous size and length for the journals. The pinion is securely keyed on, and is further held by a nut.

The field coils are wound on forms, each one in two parts and separately covered, first with muslin saturated with

shellac, then with two windings of waterproof tape, and painted with two coats of insulating compound, after which they are bound together with tape and placed in an oven heated by steam to 150 degrees, and kept there until every

mediate removal. To do this is not a serious task with this commutator, requires little skill and may be done any number of times without injury to the commutator, and will, in many cases, prove a great advantage, not only in times of

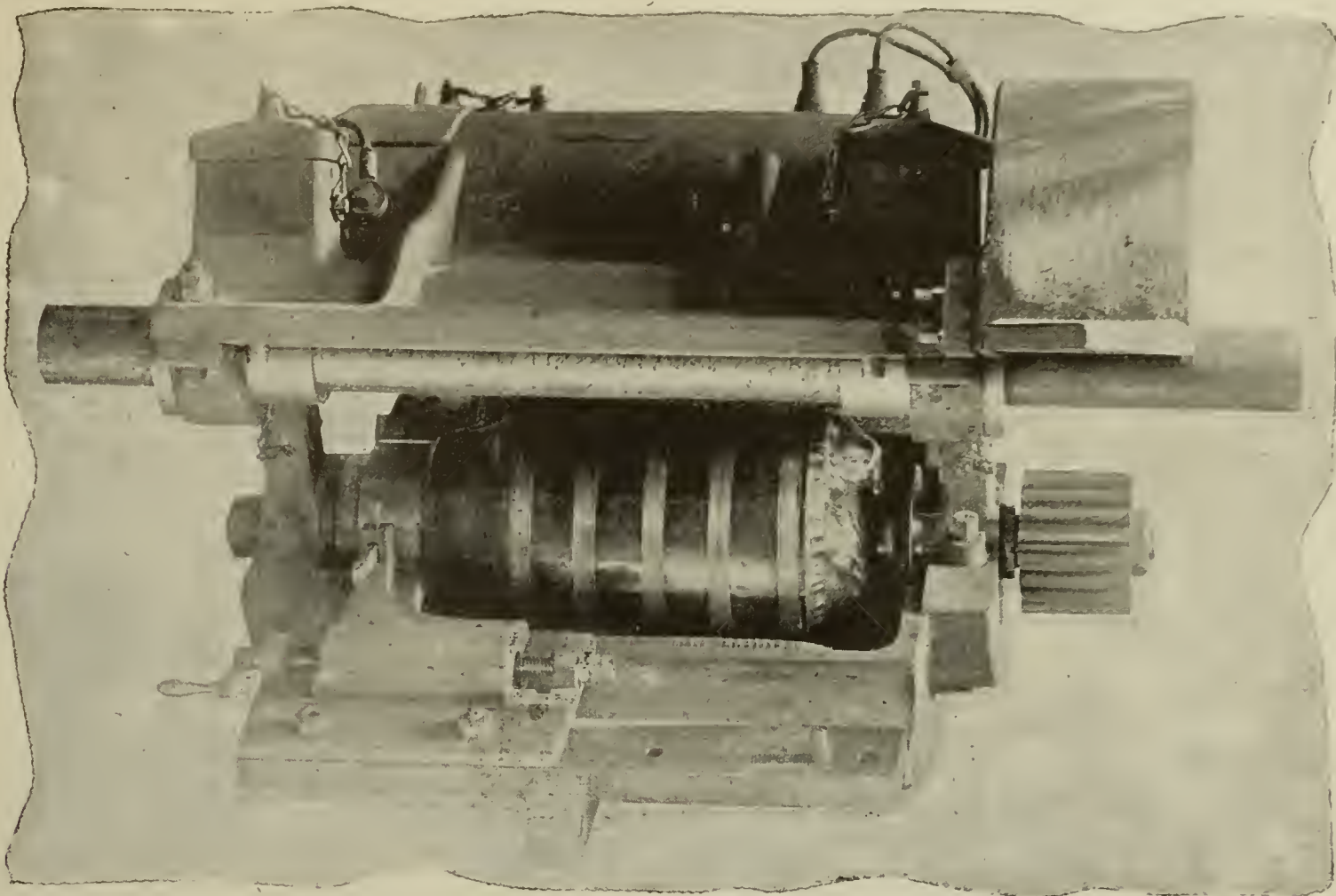


FIG. 1.—CARD ELECTRIC RAILWAY MOTOR.

particle of moisture is driven out. In winding the wire on the forms, each layer is coated with shellac until saturated. Made in this way, of wire having ample carrying capacity, and placed on the pole pieces so that no part of the coil is in contact with iron, and there kept dry and clean, they should last indefinitely.

The commutator is as simple, strong and durable as possible to be made, and by the use of first-class material and good construction, many, if not all, the bad features have been eliminated that have heretofore hung around that end

urgent necessity, but as a ready means of saving from rapid destruction an otherwise good commutator. In construction the segments are set up in a form and over them are driven with a heavy hammer rings of steel until further compression in that manner is impossible, but when the end plates are put on and screwed down, the degree of

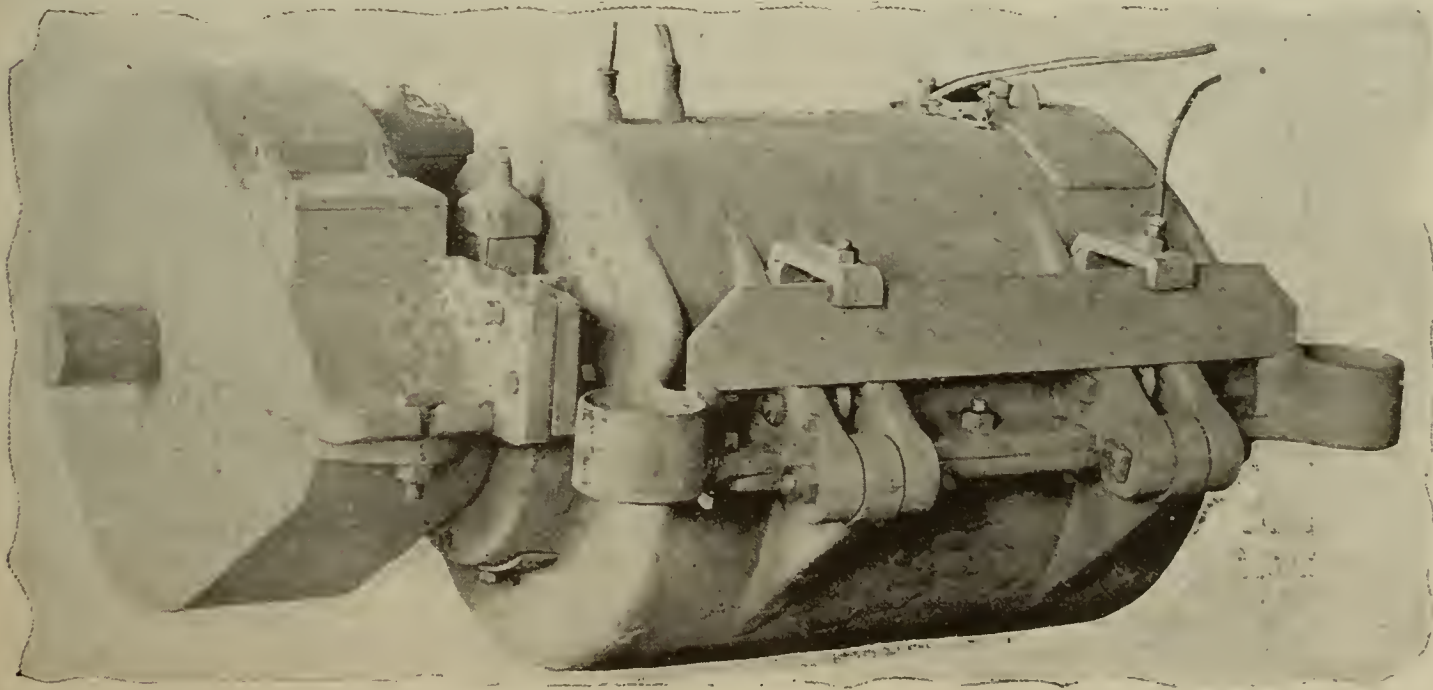


FIG. 2.—CARD ELECTRIC RAILWAY MOTOR.

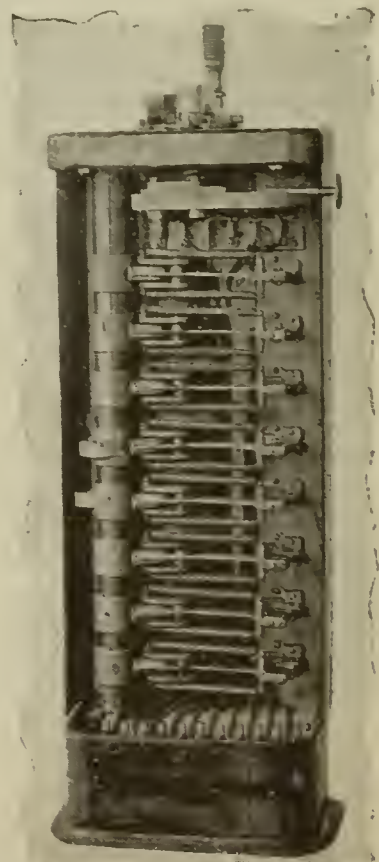


FIG. 3.—MOTOR CONTROLLER

of the armature shaft, and seemed to many to be inherent and an inseparable part of it. The parts of the commutator, other than the segments, are few, and are put together in an exceedingly simple manner. As sometimes happens, a segment, after a little wear, develops a soft spot, or for other cause becomes injured to an extent that demands its im-

strain has been limited to a point when further compression will permit the rings being removed without the aid of a hammer. Another frequent source of trouble is from oil working its way along the shaft into the armature and destroying the insulation, and only a perfect metallic joint, which is seldom obtained, unless aided by other means, will

prevent it. In this commutator, between the hubs of the end plates, is a rubber ring, which is of such size that when the commutator is on the shaft it will fit the shaft snugly and make a perfect union between all parts, and effectually prevent any oil passing through to the armature or working its way outward into the commutator.

The controlling stand, Fig. 3, is ironclad, being covered with iron at the back as well as the front, and is so well protected that moisture or dirt cannot possibly get inside. The design is neat, the height just right for convenience, and the movement of the handle easy and noiseless. The front cover is removed by raising a little and drawing it out. It cannot be put back wrong and cannot become displaced. The operating handle is placed centrally on the top of the cover and turns a short shaft, from which motion is transmitted to another shaft, shown at the left, by means of two small sprocket wheels and a chain. Immediately under the cover is the reversing switch, the handle extending through the case at the right. On the longer shaft are placed eight cams, insulated from it by heavy, hard rubber tubing and secured by hard rubber pins. Opposite each cam is a switch fastened by a suitable bracket or base to the back near the shaft. Each switch is provided with contact pieces to engage with clips on binding blocks fastened to the back. At the bottom of the stand is a series of binding blocks for making connection between controller motor, resistance and the line.

The brush holder proper is bolted fast and never intended to be moved or changed. The carbon socket has a radial movement in the brush holder, which provides for wear at the commutator and for turning off. The flexible wire terminals are fastened on the outside to the binding screws and are securely insulated from the frame, and protected from injury or moisture. There are no screw contacts on the motor except for connecting the two halves together.

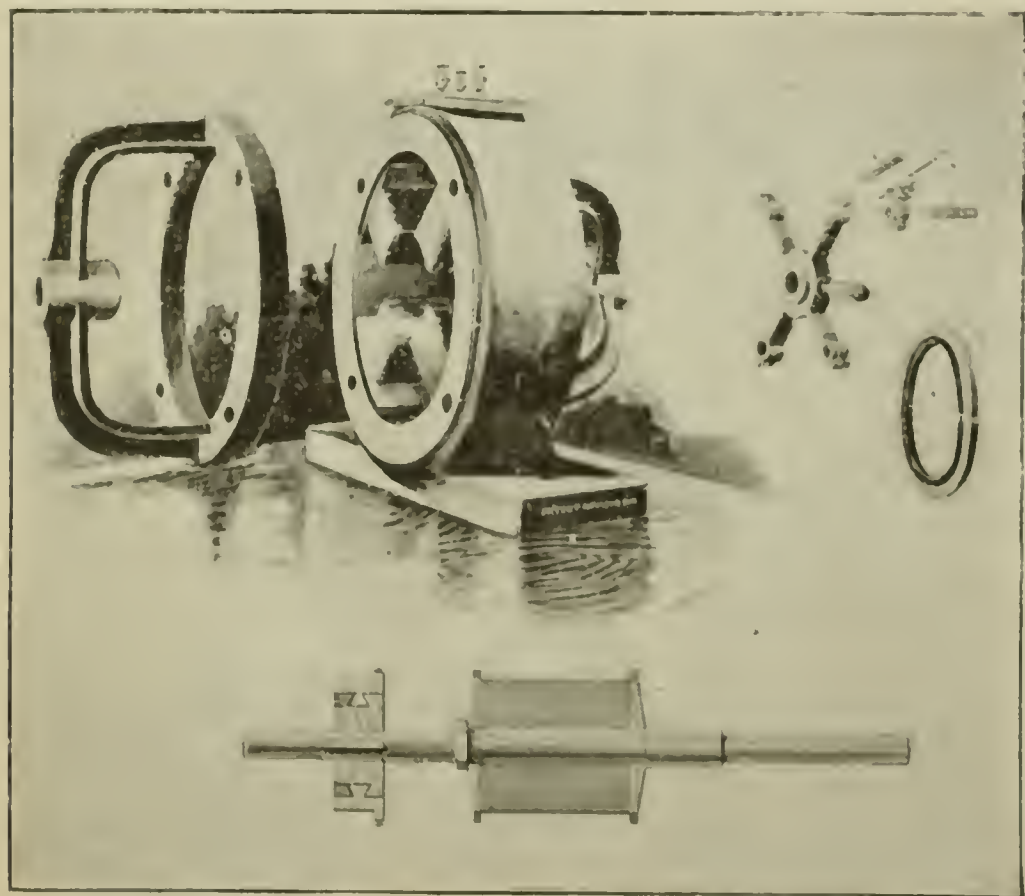


FIG. 1.—EXPERIMENTAL DYNAMO AND MOTOR.

The carbon springs are made of flat steel rolled on themselves a number of times to insure flexibility and give constant pressure on the carbons until worn out. A convenient arrangement for adjusting the tension is provided on the side of the holder. The carbons are replaced through the top opening in the case, and are not disturbed when the armature is lowered or removed.

All the parts of a complete car equipment have been carefully designed to accompany the system, including a controller rheostat, controlling switch and a simple yet efficient

and easily applied attachment for turning off commutators in place on a mounted motor.

Experimental Electrical Apparatus.

The Institute for Home Study of Electricity of Cleveland, O., has designed and is now having manufactured two useful pieces of experimental electrical apparatus, consisting of a dynamo and motor and a combination measuring instrument.

The dynamo and motor, illustrated in Fig. 1, is fitted with self-oiling bearings, two sets of copper brushes and in design and operation is a practical machine. There are also furnished four insulated rings which, when connected to the commutator as directed, enable the machine to be used as an alternator.

By various changes in the connections, the machine may be made a shunt, compound or series dynamo or motor, either two or four pole; with separate excitation and the addition of the rings, which serve as collectors, it may also be made a single, two or three-phased alternator or motor. The armature and field coils winding may be made with larger or smaller wire than is sent with the machines, so as to employ higher or lower voltages and more or less current. The machine is very well adapted for a two or four-pole electroplater. In connection with the machine, instruction diagrams of field and armature windings and connections are given which make possible the above mentioned variations. The E. M. F. and current produced by windings of various sizes of wire are also given, and the machine will be sent unwound with full directions how to complete it, thus furnish-



FIG. 2.—EXPERIMENTAL MEASURING INSTRUMENT.

ing students and amateurs an opportunity to gain valuable experience.

In the combination measuring instrument shown in Fig. 2, a soft iron core is drawn into a magnetic field obliquely, the pull being opposed by gravity. The spool on which the coils are wound is made with an oblong opening, the height of which is four or five times its breadth, thus allowing the necessary freedom of motion to the core. By proper adjustments the direct reading scales can be made quite uniform from one end to the other. It will be seen that there

are no multiplying devices to get out of order, the only motion being the movement of the core and pointer on their support. The instrument is wound with two coils, one of fine wire and the other of coarse. There are four scales, two for amperes, one for voltage, and the fourth for watts.

Mammoth Generators.

The accompanying illustration shows the Walker Manufacturing Company's large direct coupled generator. The machine illustrated has a capacity of 2,000 h. p., has ten poles, and runs at a speed of 80 revolutions per minute. The company makes three sizes of generators on this plan, namely, 1,500 h. p., 2,000 h. p. and 3,000 h. p. capacity.

The bed plate of the machine is cast in one piece and rests on a solid stone or brick foundation, which is made a part of the foundation of the engine. From this foundation is built the enormous masses of iron which go to make up the completed machine. The engine shaft carries the armature and commutator directly attached to it.

The company also manufactures the large shafts and flywheel for many of the engine builders, and it is very convenient to have the entire engine, shaft, flywheel, armature and steel magnets made at the same place, as they are all fitted together in the shop, and everything is made fast and put in good order before shipment.

These are probably the largest power transmitting dynamos made in the world, and no pains are spared in making them perfect in every particular. They run from no load to full load, and even 50 per cent. overload, without the slightest sparking at the commutators or heating in any of the parts, and run quietly, without the noise common to large generators.

The brushes are all moved at one time by the hand wheel

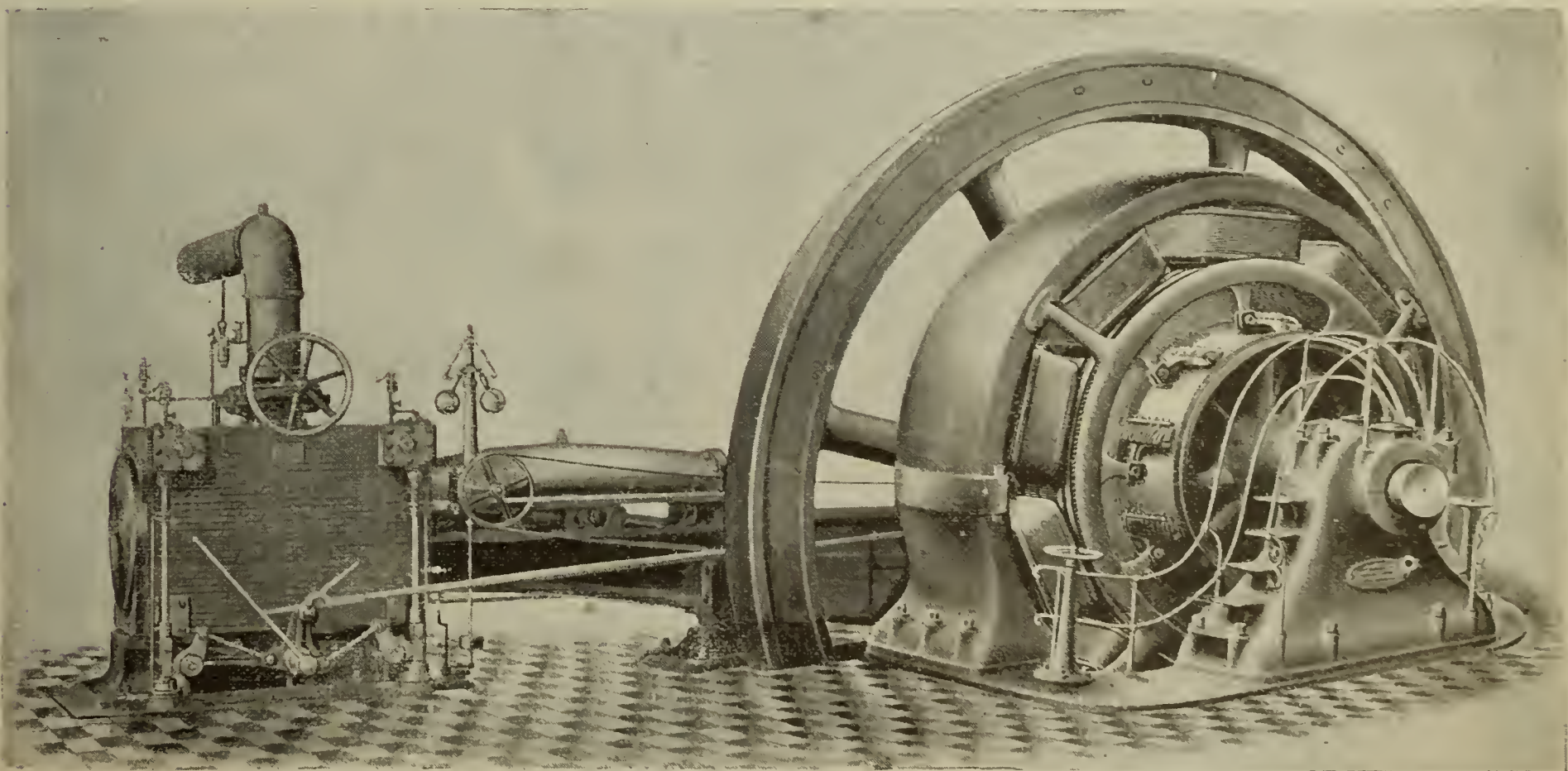
to either vertical or horizontal engines, and also arranged to be attached to both tandem and cross compound and triple expansion engines. This company is also going largely into electrical apparatus for elevated railways and inter-urban and cross country railroad apparatus.

Resistance Standards.

A new standard coil, intended to be free from the objections incident to previous forms, has been evolved from the laboratory of Queen & Co., Philadelphia. It is of the oil immersion pattern, embodying features adopted by the German Reichsanstalt, but with important modifications of their own, rendering it more constant, accurate and convenient.

Fig. 1 shows a section through the centre. S , the standard coil made of platinoid, is wound on a metal cylinder the surface of which is covered with a thin coating of insulating material. On a similar cylinder inside of and concentric with the standard coil is wound the temperature coil T , similarly insulated. These two coils are immersed in a bath of specially treated resin oil contained in the chamber M . It will be noticed that the coils S and T are wound between the same limits of height and depth, and that the casing V , is perforated with many holes so as to allow the utmost freedom of circulation to the oil. M , in turn, rests in an oil bath and is surrounded by the concentric thin cylinder on which is wound non-inductively a coil of copper wire, H . This wire is placed in series with a generator of some sort and an adjustable resistance serves to maintain the temperature at any desired point.

Those who have made use of the oil bath and gas flame for this purpose can appreciate how great an improvement is the electrical method of heating for both constancy and



2,000-H. P. GENERATOR.

fastened to the base of the machine. The lower brushes and also part of the machine are reached by steps leading down into the pit below, so that every convenience for operation is provided for.

The facilities of the Walker Manufacturing Company for making large castings enable them to make every part of these machines. Each individual casting is made as large as is practicable to carry on freight cars and to erect in plants. These machines are arranged to be direct coupled

convenience. The heat produced by H is equalized over the surface of M , and thence conducted to the interior parts. A double walled containing vessel with a space between the walls stuffed with asbestos, as shown at V , serves to render the apparatus independent of external heating or cooling effects. This point is of great importance where work of great accuracy is to be done. The ends of the standard coil are soldered to the inner ends of the terminals, which are made of massive copper similar in design to the standard

British Association ohm. The object in making the terminals so massive is to have their resistance negligible in comparison to the standard coil proper, so that any rise of resistance caused by the temperature of the terminals being higher than that of the coil may be so small a fraction of the resistance of the coil and terminals as to be safely neglected.

The design of the temperature coil is very ingenious. It

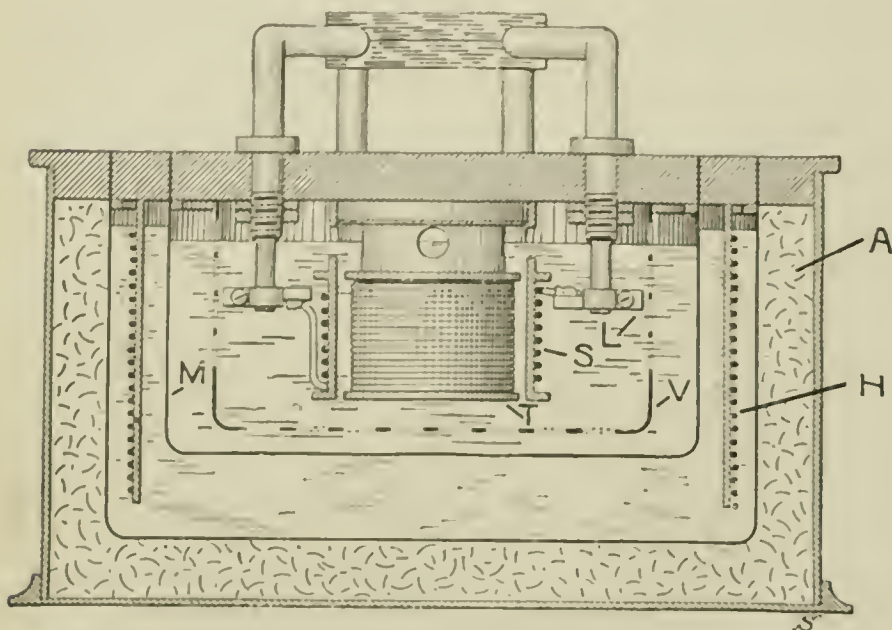


FIG. 1.—SECTION OF STANDARD RESISTANCE COIL.

is composed of copper and platinoid, the proportion of the total resistance supplied by each metal being so adjusted that for each degree centigrade rise in temperature the temperature coil increases its resistance 1-20 of one ohm measured in terms of the standard (i. e., measured by the standard without correcting for its temperature).

Fig. 2 shows the exterior view of the standard. *D* is a flexible wire serving to connect one of the terminals, *B*, of the temperature coil to whatever apparatus is used for the measurement of the resistance of that coil. The other terminal is exactly similar. *K K* are two terminals of the heating coil. The whole apparatus is readily dissectible. By unscrewing two nuts and lifting on the handle in the centre, the plate which holds the standard and temperature coils can be lifted out and both exposed to view. By unscrewing two other nuts the heating coil can be lifted out.

The method of comparing coils with the standard is this: Having a slide wire bridge and Carey-Foster commutator, connect the standard to one side and the unknown to the

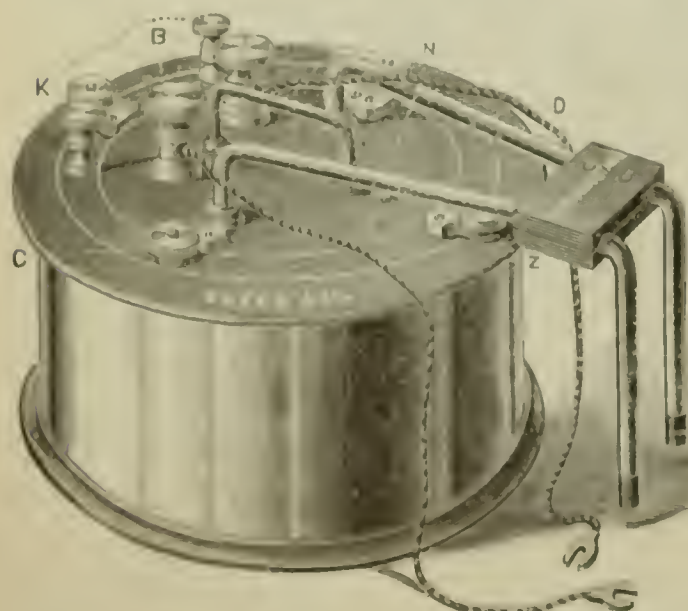


FIG. 2.—STANDARD RESISTANCE COIL.

other side to the Carey-Foster. Adjust the slider until on depressing the key the galvanometer gives no deflection. Read the position of the slider and reverse the commutator. Adjust and read again. The difference in reading in millimetres multiplied by the resistance of a millimetre of the bridge wire in ohms gives the difference in resistance between the standard coil and the unknown (not corrected for the tem-

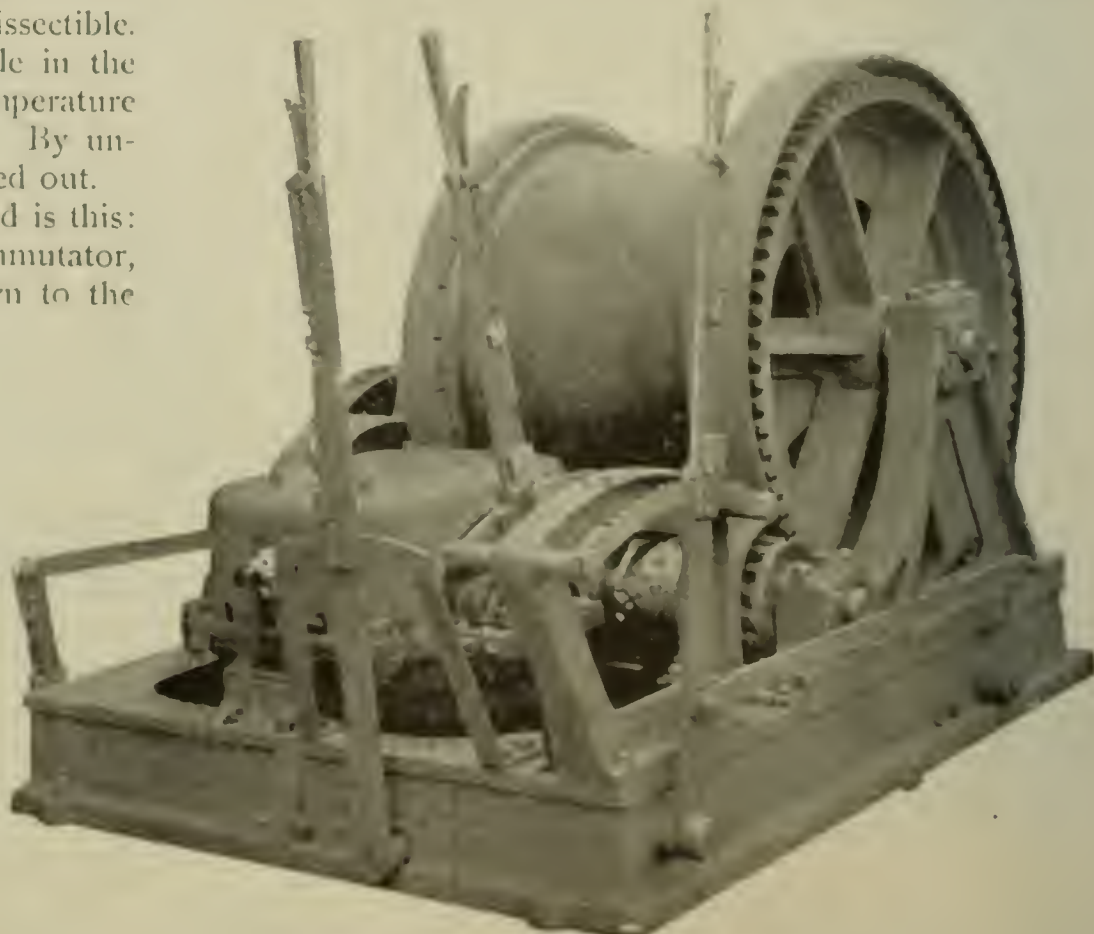
perature of the standard). To make this correction, replace the unknown by the temperature coil and go through the same operation. From the difference of the two settings the resistance of the temperature coil is computed, and then simple arithmetic gives the temperature of the standard.

A very slight alteration of the design for the standard ohm makes a most desirable arrangement for the very important measurement of the temperature co-efficient of metals. If in place of soldering the standard coil to the heavy terminals, we arrange nuts so as to clamp specimens whose coefficient we desire, it is evident that we have with the Carey-Foster bridge all the apparatus necessary, for the specimen is in an oil bath, the heating coil serves for raising to any desired temperature and keeping it there and the temperature coil measures the temperature with great accuracy.

The use of a standard coil in connection with standard cells (or a voltmeter standardized by them) for calibrating a current meter, is very important where great accuracy is required. The only other apparatus necessary is a steady generator, rough adjustable resistance and a sensitive galvanometer. This method is used entirely in the Municipal Standardizing Laboratory of Vienna, where the potential measurements are mostly made by a Thomson balance.

Ironclad Motor Hoist.

The electric hoist continues to be improved. The General Electric Company has perfected its electric hoists, making them stronger, simpler and more compact. They are operated by motors of railway type, in which all moving parts are thoroughly protected. The motor and the hoist are mounted on the same bed-plate to which all bearings, levers, quadrants and other connections are attached, making the machine complete in itself. The drum is provided with a powerful hand brake, lined with wood and operated by a lever, and is thrown in or out of gear by a friction clutch of positive and reliable type, operated also by a lever.



IRONCLAD ELECTRIC HOIST.

The motor is controlled by a rheostat of standard type, which is thrown in or out by a lever. The pinion on the armature shaft and the intermediate gear with which it engages have machine cut teeth and are enclosed in an oil casing. The electric parts of the hoist are thoroughly insulated. These hoists are made in 4, 10, 15, 30, 50 and 90 h. p., as usually rated.

The Electrical Stock Market.

*Ex. Dividend.

MR. A. W. TOPPAN, formerly with the General Electric Company as meter expert and salesman, is now connected with W. L. Walker & Co., of Boston. Mr. Toppan is quite well known among the New England station men, and we congratulate the firm on having secured his valuable services.

THE AMERICAN ELECTRICAL COMPANY, of Providence, R. I., has purchased from the Morgan Construction Company, of Worcester, Mass., a complete rolling mill and electric wire-drawing apparatus.

MR. J. J. GATES, of Hartford, Conn., well known and highly esteemed in electrical circles everywhere, and prominently identified with the Royal Arc Electric Company, has been kept busy recently responding to congratulations. We are pleased to state that Mrs. Gates and the little daughter are doing nicely, while the face of our friend Gates never beamed with greater happiness.

MR. HENRY F. KELLOGG, general selling agent of the Whitney Electrical Instrument Company, recently started on a five months' trip to the Pacific coast, taking in, of course, on the way, all the principal cities, and presenting the well known merits of the instruments manufactured by this company, and which he has done so much to popularize. Mr. Kellogg's many friends wish him a thoroughly pleasant and unusually successful trip businesswise.

THE W. S. HILL ELECTRIC COMPANY, of Boston, has shipped during the present month two orders for switches that weighed over 11 tons, to one company, and reports that notwithstanding the unprecedentedly hard times, their gross sales for the past nine months average nearly 75 per cent. more than for the corresponding months of a year ago, which is certainly a magnificent record, and of which Messrs. Hill, Poor and Everett should feel deservedly proud.

WILLIAM L. WALKER & CO. is the title of a new electrical firm in Boston, with offices at 178 Summer street. It will deal in electrical apparatus and supplies, and will give especial attention to the purchasing and selling of second-hand apparatus, a branch of business in which Mr. Walker has had large experience and attained exceptional success, because of his excellent judgment and shrewd business ability. He possesses a wide acquaintance in the electrical field, who not only wish him every success, but will do all in their power to help him obtain it.

WEBSTER & BEACH, 620 Atlantic avenue, Boston, is a new firm, the members of which are so widely known as to hardly need an introduction—Mr. F. W. Webster having been the first and continuous purchasing agent of the Thomson-Houston company, and until recently holding the same position with the General Electric Company, while Mr. R. H. Beach has also been prominently identified with the same interests as purchasing agent for the St. Paul office, and more recently as manager of the railway supply department of the company in New York. The firm will give special attention to electrical appliances, carrying a full line of all kinds, and will act also as manufacturers' agents. Popular, reliable and energetic, both of them, it is hardly necessary to bespeak for them unusual success.

THE HIGHAM ELECTRIC COMPANY, 164 High street, Boston, is now ready for the conduct of business, and is actively engaged in the manufacture of its incandescent arc lamps. Mr. Daniel Higham is the president of the company, and Mr. J. G. Robinson its treasurer. The claims for this lamp are briefly: 92 per cent. of the total electrical energy is obtained at the arc, and solid carbons can be successfully used instead of cored ones. The total advantage of light for current compared to other lamps is claimed to be as much as 30 per cent. in favor of the Higham lamp. Professor Hooper, of Tufts College, in a recent report upon the lamp, says: "I regard the remarkable features of this invention to be, first, the employment of a simple and durable clutch lamp on a constant potential circuit; second, the use of the inductive coil in place of the usual 'dead' resistance, whereby two-thirds of the power usually wasted is saved; third, the extreme precision of the regulation, and the consequent steadiness of the light."

THE AMERICAN TOOL AND MACHINE COMPANY, 84 Kingston street, Boston, with factories at Hyde Park, Mass., a corporation which has been conspicuously and favorably before the public for over 30 years, has recently taken on new life in the form of a reorganization of its official staff. Mr. E. C. Huxley, one of Boston's most prominent and active business men, and who has earned for himself especial distinction in the line of mill construction work, becomes its president and general manager, and Mr. W. H. Hoffman, who has for a number of years been more or less associated with Mr. Huxley in his labors, and who was for a long period general superintendent of the Eastern works, at Hartford, Conn., of the Buckeye Engine Company, becomes the general superintendent of the company. Messrs. M. H. Barker, chief engineer; W. O. Lincoln, treasurer, and M. M. Whipple, superintendent of sales department, complete the official staff of the company, and are all of them, owing to their long connection with it, almost as well known as the company itself. Under the new deal it is almost needless to predict that the fortunes of the company will be greatly increased.

THE BROWN ELECTRIC COMPANY, Boston, has rearranged its present offices so that they not only present a more attractive appearance, but, owing to the locality of its store room in the upper part of the building, increased facilities have been obtained for the transaction of its business. The company is doing an excellent business, having closed during the past two weeks contracts for the equipment of 10 miles for the Norwalk (Conn.) Street Railway Company, six miles for the Gardner (Mass.) Street Railway Company, six miles for the North Weymouth branch of the Quincy and Boston Street Railway Company, and seven miles for the Calais (Me.) Street Railway Company. Several of the Harthan collapsible trolley wagons, of which the company is the sole New England

agent, are being put together, and one will be delivered to the Plymouth and Kingston Street Railway Company early next week. This company has recently been appointed sole New England agent for the standard line of railway equipment manufactured by the Ohio Brass Company, of Mansfield, Ohio. Mr. H. P. Brown, travelling salesman for the company, has just returned from a trip through eastern New York with a good batch of electric light orders.

Canadian Notes.

OTTAWA, Ont., June 2 1894.

MONTREAL.—Last week the boiler of the East End power house of the Royal Electric Company, on Water street, exploded. The force of the explosion blew out the wall of the station, and one of the foremen was injured, but not fatally. Fortunately there were no serious results owing to the explosion. The whole of the east end of the city was plunged in darkness.

OTTAWA.—A bill has been introduced in Parliament by the Dominion Parliament respecting the unit of electrical measurement, and a bill "Respecting the inspection of electric light." The first bill simply establishes the standard of measurement now in use by electric companies as the legal standard. The other bill provides for inspection similar to that of gas companies. The work will be done by the gas inspectors.

HAMILTON.—It is likely that before the end of next summer Toronto and Hamilton will be connected by an electric railway. The Hamilton Radial Electric Railway will lay a branch to Burlington, where it will connect with the Toronto and Mimico line, which is now being extended westward. The cars in a few weeks will be running to Long Branch, and the latest idea is to extend the railway to Lorne Park this summer.

SIR ADOLPH CARON, postmaster-general, replying to a question asked him in Parliament, said that a contract had been made with the Ottawa Electric Railway Company for the carriage of the mails between the railway stations and the Ottawa post-office. This contract was for four years, dated Nov. 1, 1893, and was at the rate of \$4,000 per annum, which included all additional trips required during contract period. The service by street cars was much superior to the wagons. The mails were delivered at the post-office with greater certainty and with greater safety. The large amount of space in the cars enabled the company to carry all the mails in one trip. The mail clerks were not exposed to the inclement weather under the new system. The amount paid on account of this particular service last year was \$3,822.

THREE BILLS affecting the electric street car service and electric lighting of Ottawa have passed the House of Commons, viz.: An act to confirm an agreement between the Ottawa City Passenger Railway Company and the Ottawa Electric Street Railway Company, and an agreement between the said companies and the corporation of the city of Ottawa, and to unite the said companies under the name of "The Ottawa Electric Railway Company." 2d. An act respecting the Chaudiere Electric Light and Power Company (Limited), and to change the name thereof to "The Ottawa Electric Company." 3d. An act to incorporate the Ottawa Electric Light Company.

English Notes.

LONDON, England, May 24, 1894.

THOMAS PARKER, LIMITED.—Mr. Thomas Parker, the designer of the electrical equipment of the Liverpool Overhead Railway, whose services the Electrical Construction Company recently thought fit to dispense with, has now blossomed out into a limited liability concern, with a capital of £75,000. A great point is made in the prospectus of the fact that Mr. Parker owns the Elckemeyer armature patents for England. Mr. Parker's old company, however, has issued a notice announcing that they also have a license to use these patents, and containing threats of legal proceedings.

PERIPHERAL STATIONS.—The "Engineer" recently gave vent to the suggestion that it would be well for one single colossus to undertake to generate electricity for the whole of the metropolis, the existing concerns converting their present generating stations into distributing centres, and themselves into mere retail dealers in electricity. No doubt from the point of view of freedom from actions for damages and injunctions this idea has much to commend it, and in a letter in the same journal Mr. Kapp, whilst pointing out several inaccuracies in the figures given by the "Engineer," gives general adhesion to the principle of what he is pleased to call "peripheral stations."

THE CARDEW VIBRATOR.—Some years ago Mr. Melhuish, of the Indian telegraph service, read an interesting paper before the Institution of Electrical Engineers on "Signalling Across Rivers in India," a question of considerable importance in that country, by reason of the many big rivers and their eccentric behavior. Mr. Melhuish detailed a large number of experiments, all tending to establish the fact that a circuit containing a Cardew vibrating sounder as a transmitter, and a telephone as a receiver, may be relied upon to work under almost any conditions of line insulation. During some recent severe weather in Persia, an involuntary large scale experiment of the same kind was carried on by the Indo-European Telegraph Department with the same satisfactory result. On one occasion a long length of line lay buried under

mud and water, yet for four and twenty hours the international traffic was carried on uninterruptedly, messages being regularly transmitted between Ispahan and Shiraz, a distance of 332 miles, by means of Cardew sounders.

ELECTRIC LIGHTING AT ST. PAUL'S CATHEDRAL.—For some time past experiments in the electric lighting of St. Paul's Cathedral have been going on under the aegis of Major-General Webber. On Monday the "Daily Telegraph" came out with the following portentous announcement: "Some astonishment, as well as regret, will be felt when it is known that the experiment of lighting St. Paul's Cathedral by electricity has—at any rate for the present—proved a dismal failure. Every preparation had been made; the most skillful electricians had been consulted, and the latest appliances had been brought into requisition, but the result was very disappointing to all concerned. The distribution of light was irregular and inadequate, and the intensity of the shadows is said to have been positively gruesome." In a letter which appeared in the very next issue, all the allegations contained in the above paragraph were denied in toto by Major-General Webber, and before long it may be anticipated that the beautiful decorations which now adorn our metropolitan cathedral will cease to be cooked and smoked by gas.

ELECTRIC LIGHTING IN LONDON.—All the metropolitan electric lighting concerns having now sent in their regulation returns to the Board of Trade for the year 1893, I am enabled to give a few figures showing the present position of electric lighting in London. The total capital outlay of the 10 companies and one vestry engaged in the business of electricity supply amounted at the end of last year to nearly $3\frac{1}{2}$ millions sterling, and as some 700,000 lamps were at the same date connected to the mains, the average expenditure per lamp connected comes out at £5, the lowest outlay being that of the Chelsea company, whose figure is £2 10s., and the highest outlay being that of the London Electric Supply Corporation (Deptford), which has spent no less than £13 for every lamp secured. As to the revenue and expenses, the former was nearly £300,000, and the latter nearly £200,000. Close upon 10 million kilowatt hours were sold to consumers at an average price of 6.38d., each 8-c. p. lamp connected yielding 7s. 6d. per annum. The coal of the London companies for 1893 aggregated £55,000, coal costing 1.328d. per unit metered. In this item the range between the best record, that of the Kensington company (three-wire), and the worst, that of the Metropolitan company (alternate current transformers), is very great; the figures being .74d. and 1.97d., respectively. The output for 1893, I may say, shows a 25-per cent. increase over that for 1892. The price of the kilowatt-hour continues to fall. Last week the Kensington company reduced its charge from 8d. to 6d., and the Westminster company from now offers its customers a day supply at 4d.

News of the Week.

Telegraph and Telephone.

SALISBURY, MD.—A telephone company has been organized at Salisbury.

COLUMBIA, S. C.—Niernsee & La Mott propose to establish a telephone system.

KNOXVILLE, TENN.—The East Tennessee Telephone Company will construct a line to Chattanooga.

APPLETON, WIS.—The Appleton Central Telephone Company office will be equipped with a new switchboard July 1.

PALESTINE, TEX.—L. C. Ketcham has petitioned the City Council for a franchise to construct a telephone system.

SUFFOLK, VA.—The Nansemond Telephone Company has contracted with W. N. McAnge & Co. for the building and equipping of its telephone lines.

THE PALATKA TELEPHONE COMPANY, Palatka, Fla., capital stock \$10,000, has been incorporated. Marcus Loab is president and George Mundee secretary.

THE NATIONAL TELEPHONE COMPANY, Portland, Ore., capital stock \$100,000, has been incorporated to do a general electrical business. E. P. Curtis is interested.

THE NORWALK TELEPHONE COMPANY, Norwalk, Ohio, capital stock \$20,000, has been formed. H. B. Hanford, W. W. Graham and A. C. Greene are interested.

MOUNT PLEASANT, N. Y.—The town authorities have granted authority to a telephone company to string wires in Pleasantville and Unionville. The plant will be located in Chappaqua.

CHAPPAQUA, N. Y.—A franchise has been granted by the authorities of Mount Pleasant to a telephone company to string wires in Pleasantville and Unionville. The plant will be located in Chappaqua.

GLENS FALLS, N. Y., has adopted the Gamewell electric fire alarm system. The equipment will cost the town \$2,800, and it is expected that it will be in working order in six weeks. The new alarm bell will weigh 2,500 pounds.

THE GROFF TELEPHONE COMPANY, Chicago, Ill., capital stock \$1,000,000, has been formed to manufacture and sell magnetic and electric telephones, and devices pertaining to telephones, etc. E. M. Hoy, Joseph Klingensmith, L. E. Pottelger, W. Ream and W. R. Tucker are interested.

Electric Light and Power.

WILMINGTON, VT., is to have electric lights.

CUBA, N. Y.—The citizens have voted to have the electric light.

LONDONDERRY, VT.—Taxpayers are discussing the matter of electric lights.

ELLSWORTH, ME.—Estimates of cost for an electric light plant are desired by the mayor.

IRVINGTON, N. Y.—Taxpayers of Irvington are discussing the matter of a local electric light plant.

WATERBURY, CONN.—The new German Catholic church of St. Cecilia is to be equipped with electric lights.

MORRISTOWN, TENN.—A receiver has been appointed for the Morristown Electric Light and Power Company.

WEST CHESTER, PA.—Address A. P. Hall regarding the proposed electric lighting plant for the State Normal School.

PHILADELPHIA, PA.—W. Smedley, 435 Chestnut street, may be addressed concerning the electric light plant for the Woman's Hospital.

THE VICKSBURG ELECTRIC, TRANSIT AND LIGHTING COMPANY, Vicksburg, Miss., is preparing to erect an electric power plant.

PEKIN, ILL.—Directors of the electric light company have decided to erect a brick building, 36 by 56, and to put in another large engine and two more dynamos.

FOUNTAIN HILL, PA.—The borough proposes to light the village by electricity, and bids should be addressed to A. R. Ritter, secretary, South Bethlehem, Pa.

ST. LOUIS, MO.—The Missouri Electric Repair Company has received the contract from the Alton (Ill.) Roller Mill Company for an electric light equipment for its plant.

BALTIMORE, MD.—The present contract for electric lighting of the streets expires July 1, and bids will then be received from all companies which may choose to do the work.

PITTSBURGH, PA.—Address Longfellow, Alden & Harlow, Vandergrift Building, regarding the incandescent electric light plant for the Mt. Aloysius Convent, Cresson, Pa.

ST. LOUIS, MO.—The city subway commission has decided not to purchase the conduit and franchise of the St. Louis Underground Service Company, but to build a municipal system.

CLARKSVILLE, TENN.—It is reported that the Clarksville Electric Light Company is to sell its plant to St. Louis parties, who will continue its operation and add \$10,000 worth of new machinery.

ESTHERVILLE, IOWA.—An election will soon be held here to vote on the matter of issuing \$12,000 in bonds to put in an electric light and water plant, which a Chicago firm has agreed to put in operation.

ASBURY PARK, N. J.—On June 5 residents of Neptune township will vote in the matter of appropriating money for an electric light plant or for gas lighting. Neptune township adjoins Asbury Park.

FREDONIA, N. Y.—The board of trustees of Fredonia have granted permission to the Dunkirk and Fredonia Street Railway Company to erect poles and string wires on them, to furnish incandescent electric lighting for Fredonia.

BRADFORD, PA.—After a protracted meeting, a resolution was adopted instructing the joint finance committee to inquire into the advisability of the city owning an electric light plant, and to ascertain the cost of same and to confer with the present electric light company with a view to purchasing its plant.

WATERPORT, N. Y.—Articles of incorporation have been filed for the proposed Waterport Electric Light and Power Company, \$40,000 capital, under which Capt. Lina Beecher proposes to build his single rail electric road at Batavia, N. Y. The trial line will be built between Waterport and Lakeside, about $3\frac{1}{2}$ miles.

HILLSBORO, TEX.—The Hillsboro Electric Light Company is to establish an electric light plant with 750 incandescent and 30 2,000 normal c. p. arc lights. A contract has been made with the city government for street lighting. Address E. G. Shields for further information.

ALLEGHENY, PA.—The sub-committee on public lighting has contracted with R. C. Tannahill for the erection of an additional electric light plant on Braddock street for \$25,893. The contract includes the erection of the buildings and equipment ready for the dynamos, and also the erection of two large iron carrying cranes.

PITTSBURGH, PA.—A continuance has been granted to the next term of court in the case of the Denver Consolidated Electric Company, of Denver, Col., against the Standard Underground Cable Company, of Pittsburgh. The plaintiff alleges damages by the defendant company laying cables of an inferior character for electric lighting purposes.

HAWARDEN, IOWA.—On May 26 the city authorities awarded the contract for its incandescent electric lighting plant to J. H. Winchel, Le Mars, Iowa, under plans and specifications prepared by Wm. H. Bryan, consulting engineer, St. Louis. Mr. Winchel will furnish a 36-kw. slow speed T.-H. alternator; 12 by 30 Corliss engine; two 80-h. p. steel boilers; primary and secondary construction for 1,000 16-c. p. indoor lights, and 50 32-c. p. street lights. The contract provides for the completion of this work within 90 days,

but in all probability the plant will be running much before that date, owing to the very favorable cash terms offered. This contract is said to have been placed "at the lowest figures ever known in the electrical industry."

The Electric Railway.

BRAZIL, IND.—An electric street car line is proposed between Brazil and Terre Haute.

BERLIN, CONN.—F. G. Platt says the electric road from New Britain will be in running order by Sept. 1.

SPRINGFIELD, MASS.—The directors of the street railway have voted to erect a new car house on Bond street. New cars have been ordered.

CLEVELAND, OHIO.—A company is organizing with \$300,000 capital to establish an inter-urban electric street railway between Cleveland and Akron.

LEAVENWORTH, KAN.—The Leavenworth Electric Railway Company has been granted a franchise to build the Soldiers' Home and Mount Muncie extension.

LANCASTER, KY.—Fred Balcom may be addressed concerning the new electrical railway proposed between Lancaster and Nicholasville, a distance of 22 miles.

THE WEST END.—The bill to compel the West End Street Railroad Company to issue transfers on all its lines was defeated in the State Legislature this week.

RICHFIELD SPRINGS, N. Y.—There is a project on foot to build an electric road between Richfield Springs and Oneonta, a distance of 34 miles, at a cost of \$7,000 a mile.

GARDNER, MASS.—The directors of the Gardner Street Railway Company have organized as follows: President, F. S. Coolidge; vice president, E. F. Blodgett; secretary-treasurer, J. A. Stiles.

NEW YORK, N. Y.—The Metropolitan Crosstown Railway and the Lexington Avenue and Payonia Ferry Railway have consolidated with the Metropolitan Street Railway Company. Capital \$13,500,000.

STOUGHTON, MASS.—The selectmen have granted permission to the Brockton Street Railway Company to occupy the streets of Stoughton with its road, provided it is completed on or before April 19, 1895.

GETTYSBURG, PA.—In the United States Court the motion of the United States Government to enjoin the Gettysburg Electric Railway from building a branch trolley road on the Gettysburg battlefield was denied.

LOS ANGELES, CAL.—The Los Angeles, Pasadena and Altadena Electric Railway Company will equip the Main street system with electricity. Chas. L. Strange and Hervey Lindley, of Los Angeles, are interested.

PITTSBURGH, PA.—The Beltzhoover and Amanda Avenue Street Railway Company, of which W. H. Wenrick, of Pittsburgh, is president, has been granted a charter, and will be 1½ miles long. It will be completed by winter.

DANVILLE, ILL.—The Danville Gas, Electric Light and Street Railway Company will expend \$10,000 this season for new machinery in its power house. New boilers of 150 h. p. will be put in, and an engine of about the same capacity.

GOSHEN, IND.—A company has been organized at Goshen by J. J. Burns, J. H. Melhany and others to operate the plant of the Goshen Street Railway Company. The company will be known as the Northern Indiana Electric Company.

Miscellaneous Notes.

THE BROOKLYN ELECTRICAL SOCIETY will hold its fourth regular meeting on Thursday evening, June 7, at the residence of R. I. Times, Jr., 26 Prospect place, Brooklyn. Thomas A. Bamford will give an illustrated talk on the construction of telephones.

WHERE RUBBER COMES FROM.—Mr. W. R. Brixey, in a letter to the New York "Tribune," states that in no case, to his knowledge, is a manufacturer of rubber insulated wire using cheap rubbers from the east coast of Mexico or Nicaragua, as claimed by a writer quoted in the "Tribune." The rubbers employed in compounds of high-grade insulated wires, Mr. Brixey states, are invariably rubbers purchased on the Amazon, either Madelra or fine Para, costing at present market rates from 65 to 73 cents per pound, according to age, though for mechanical purposes there are undoubtedly cheaper grades of rubber consumed.

THE EMERSON CUT-OUT SUIT.—A cut-out patent suit of interest to electric light companies was decided on May 29, at Philadelphia, in the United States Circuit Court by Judge Dallas. The suit was brought by Marshall Shapleigh, of Pittsburgh, against the Chester Electric Light and Power Company, to enjoin it from using a spring clip cut-out to prevent the burning out of incandescent lights when an excessive current is turned on. The cut-out in use by the Chester company is manufactured by the Emerson Electric Light and Power Company, of St. Louis, and Shapleigh claims that it is an infringement on his patent. Judge Dallas refused the injunction and dismissed the suit at the plaintiff's cost, on the ground that no infringement was shown. In his opinion Judge Dallas

stated that he was "convinced by the pertinacity and soundness of the point made by the learned counsel for the defendants that their specific combination did not infringe the complainant's patent."

THE DOUBLE ARC LAMP PATENT.—The Cleveland "Plain-dealer" publishes the following interview with Mr. S. H. Hamill, of the Brush Electric Company: "The suit of John E. Ridall, an agent of the Brush company, vs. the Brush company, is for royalties he claims on Mr. Brush's double arc lamp patents, which have been broadly sustained by repeated decisions of the United States courts. Notwithstanding the fact that the Brush company has expended from \$100,000 to \$200,000 to sustain these patents and secure large yearly royalties from them, yet owing to delays in the United States courts and the reluctance of the courts to award damages for sales made prior to decisions, the Brush company has not as yet been able to collect very much from the infringement of these patents during the past. Our accounting against the Western Electric Company, of Chicago, for instance, has covered a period of two years, and is not yet finished. They owe us something like \$50,000. Our cases against the Westinghouse Electric Company, of Pittsburgh, for what are known as the United States company's lamps, have been won, and we should at least receive \$60,000 from them when the accounting is finished. Mr. Ridall has no claim under his contract against the Brush company. If he has any claim at all it would be against customers in his territory who have purchased infringing lamps, and even then he probably could not collect more than from \$10,000 to \$15,000, because his territory simply covers Pittsburgh and a small surrounding country. Under any circumstances Mr. Ridall could hardly get anything from us until we secure damages from others."

Personal Notes.

MR. PAUL C. JUST has been appointed electrical engineer of Lincoln Park, Chicago.

MR. F. UPPENBORN, the editor of the "Elektrotechnische Zeitschrift," of Berlin, has, we have just learned from Germany, accepted the position of electrical engineer of the city of Munich. The well conducted journal of which he has been the editor since January, 1890, has, since his connection with it, been the leading electrical journal of Germany, and has been without a rival. It is the official organ of the leading national society of electricians of Germany, which corresponds to our Institute of Electrical Engineers, and contains the papers read at their meetings. In 1881 he became the editor of the first journal for applied electricity in Germany, the "Centralblatt fuer Elektrotechnik," a high-class technical paper, which was combined with the other at the time he became the editor of the "E. T. Z.," as the "Elektrotechnische Zeitschrift" is frequently called for brevity sake. Mr. Uppenborn is a well posted electrical engineer, and has conducted his paper from the standpoint of an engineer as distinguished from a mere journalist, and his paper therefore contains a wealth of well selected technical information; the only faults that might have been found with it—if they can be called faults—were that it frequently contained long articles which might better have been published in a purely mathematical journal, and that comparatively little attention was given to electrical matters outside of Germany. Mr. Uppenborn is also the author of an electrical engineer's pocket book, for some unknown reason called a "Kalender," which is published yearly, and is perhaps one of the best of its kind, and which is found in the pocket or on the desk of almost every German electrician. Mr. Uppenborn was born in 1859, and is therefore only 35 years old. Who his successor will be as editor of the "Elektrotechnische Zeitschrift" has not yet been announced, but from some recently published information we would not be surprised to find that it is to be Mr. Gisbert Kapp.

Trade and Industrial Notes.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, 50 Broadway, New York, is having a great demand for its Fleming woven wire dynamo brushes. The company is turning out about 150 of these brushes per week, and is 600 behind in orders.

THE NEW ERA IRON WORKS have been incorporated at Dayton, Ohio, with a capital of \$50,000, to manufacture gas engines and iron specialties. Their engine, the "New Era," has been in successful operation for nearly two years. It will be built principally in the larger sizes, and special attention will be given its construction for private electric light plants.

THE ALLEN-HUSSEY COMPANY, general electricians, formerly of 225 Dearborn street, have removed their offices and store rooms to more commodious quarters in the Medinah Building, corner Jackson street and Fifth avenue, Chicago, where they will be pleased to explain the merits of their "loop system" of wiring to any one contemplating electric wiring for lighting purposes.

THE WHITE-CROSBY COMPANY is the style of the new firm which has succeeded J. G. White & Co. The main office is in the Equitable Building, Baltimore, and there are branch offices at 29 Broadway, New York, and in the "The Rookery," Chicago. The officers of the company are J. G. White, president; G. H. Walbridge, secretary and treasurer, and O. T. Crosby, chief engineer.

THE GENERAL ELECTRIC LAUNCH COMPANY is building at Morris Heights, on the Harlem River, New York, an electric

launch for Congressman Sorg, of Ohio. The launch is to be 46 feet over all, carrying two motors, twin screw, and 144 cells of the Consolidated Electric Storage Company's batteries, and will have a speed of 12 miles an hour.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., is bringing out a new type of railway generator of large capacity, with complete station equipment of entirely new and original design, and embodying a number of very important improvements in this class of apparatus. The Mather Electric Company has secured a number of contracts for future delivery of these new large generators on some of the most important electric railways in this country.

CHARLES A. SCHIEREN & CO., 51 Ferry street, New York, have received from the Savannah (Ga.) Electric Railway Company an order for a double perforated 16-inch belt for high speed generator work. The distance from the centre of driver to centre of driven will be 19 feet 6 inches, and the belt is to be made endless, all ready to be put on. The railway company states that they have had two of the Schieren belts in use in their power house for three or four years, and that they have given the most excellent satisfaction.

THE ALSITE ALUMINIUM COMPANY, of 106 Liberty street, New York, has discovered a new process of soldering aluminium by hard and soft solder, by which process the joints thus soldered, it is claimed, are rendered stronger than the metal itself. Among the many testimonials of the merits of this process recently received is one from the Franklin Institute, Philadelphia, which strongly attests the value of the process. The Alsite Aluminium Company also plates aluminium with gold, silver or nickel for the trade.

THE HARRISON NATIONAL TELEPHONE COMPANY, New York, has issued a pamphlet of testimonials to the merits of the Harrison telephone, of which the following, from Denver, is a specimen: "Replying to your favor, would state that I have run a complete circuit through the entire city of Denver, on the poles of the Denver Tramway Company, in close proximity to large electric wires and trolley wires. We attached Harrison telephones to the circuit. There was no induction, and the test proved perfectly satisfactory to myself and many prominent citizens of Denver.—R. L. Crescy."

THE THOMSON ELECTRIC WELDING COMPANY, Lynn, Mass., has acquired the patent rights for the United States for the Sauer petroleum engine, and is now preparing to furnish them in sizes of 2, 4, 8 and 12 h. p. Special attention will be given to the demand for isolated electric lighting plants for private residences, hotels, halls, churches, theatres, etc., and complete plants will be furnished, consisting of engine, generator and necessary appliances, together with wiring and fixtures, as desired. The cost of lighting from a dynamo run by one of these engines of 8 h. p. is shown to be less than one-seventh of the cost of gas jets, with gas at \$1.50 per thousand.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, reports that it is doing a rushing business with the Meston alternating fan motor, notwithstanding the fact that the temperature has been rather against that electrical appliance. Hot weather is sure to come, however, and at least some of the trade believe in being prepared for it when it does come, instead of having to take their chances with the rest in the rush. The same company is exhibiting a line of the Carpenter electric heating and cooking appliances in its Madison street show windows, which are attracting considerable attention.

THE COLUMBIA CARRIAGE AND CYCLE COMPANY, of Milwaukee, has made arrangement to build an immense quantity of

its celebrated road wheels this year, and wishing to get them more thoroughly introduced, they have made a net price to consumers, which they claim is lower than the same grade of wheel can be sold for on a wholesale basis, and therefore offers a splendid opportunity to obtain a high grade American wheel at a great reduction. The purchaser is not only secured by the reputation for reliability of this house, but also by a written guarantee, which it furnishes with all its wheels.

QUEEN & CO., Philadelphia, have placed upon the market a new tachometer for measuring the instantaneous velocity of shafts. The portable tachometer, reading from 40 to 3,000 revolutions per minute, is a particularly valuable instrument. Three spindles are geared to the rotating parts, each having a separate scale on the dial, so that the instrument is direct reading throughout its range. A detachable joint is supplied with an end slightly flexible transversely fitting any of the spindles. The flexibility acts as a safeguard against breakage, in places where the tachometer shaft is not applied exactly parallel to the shaft whose speed is to be measured. The scales are graduated from 40 to 200, 120 to 600 and 600 to 3,000.

ALMON & SARGENT, electrical engineers and contractors, at 620 Atlantic avenue, Boston, and 136 Liberty street, New York, have recently filled orders from the North River Electric Light and Power Company for six, class B, L. P. and D power transmitters, to be used in their New York City station. Also two class B transmitters for the Pelton Water Wheel Company, to be used at Jackson, N. H.; they have also received orders from Marr & Gordon, Barre, Vt., for one 30-h. p. generator and one 25-h. p. motor, to be used in transmitting surplus water power at their polishing works to stone sheds, a distance of 2½ miles, and also have the contract for the construction. They are also nearing the completion of wiring the fountain in St. Albans, Vt., for electric lights. This firm is doing an excellent business and deserves it.

THE CARPENTER ENAMEL RHEOSTAT COMPANY is moving its factory from Bridgeport, Conn., to Hoboken, N. J., in the new Factory Building erected by John C. Crevier, at the Fourteenth street ferry terminal. The company's factory will be very accessible in its new location, being less than 15 minutes distant from Union square, which will be a great convenience to its various customers having offices in New York City. The following is a list of the principal agencies of the Carpenter company: Chas. D. Shain, general selling agent, 136 Liberty street, New York City; the Central Electric Company, 173 Adams street, Chicago, Ill.; Walker & Kepler, 531 Chestnut street, Philadelphia, Pa.; William Oswald, 42 Union street, New Orleans, La.; R. C. Wiggins, 31 Milk street, Boston, Mass.; The Robins Electric Company, 830 Liberty avenue, Pittsburgh, Pa., and Owen Ford, Rialto Building, St. Louis, Mo. The officers of the company are: H. Ward Leonard, president; L. B. Gawtry, vice president, and Charles E. Carpenter, secretary and treasurer.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-ROOKER MANUFACTURING COMPANY, 2140 DeKalb St., St. Louis, Mo.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED MAY 22, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

520,033. ELECTRIC BATTERY; W. W. Burnham, Newton, Mass. Application filed Sept. 7, 1891. A battery having a perforated cover, a rod of circular zinc supported by the outer jar, a carbon electrode having a diminished head and a flexible band adapted to clasp the bevelled head and rest upon the cover.

520,050. SYSTEM OF ELECTRICAL CONVERSION AND DISTRIBUTION; T. H. Hicks, Detroit, Mich. Application filed Dec. 15, 1892. This comprises a motor and converter, converter conductors terminating in separate commutators, and the motor field being wound with supplemental coils in circuit with one of the converter commutators.

520,061. RAILWAY SIGNAL DEVICE; F. E. Kinsman, Plainfield, N. J. Application filed Feb. 1, 1893. This comprises an electric signal, and a controlling magnet for stopping apparatus inefficient or unresponsive under the action of the current used in operating the signal.

520,062. APPARATUS FOR CONTROLLING THE MOVEMENT OF RAILWAY TRAINS OR VEHICLES; F. E. Kinsman, Plainfield, N. J. Application filed June 23, 1893. This comprises a controlling arm on the vehicle and a trip on the line of way, a fluid pressure device operating the trip, and a spring or other retractor tending to move the trip into position for engagement with the arm on the vehicle.

520,072. PEDAL GOVERNOR FOR ELECTRIC MOTORS; A. G. McKee, State College, Pa. Application filed July 13, 1893. The combination of a contact stud, a reversing stud, stop stud provided with an arresting rib, and a pivoted bar carrying a spring contact for engaging the studs.

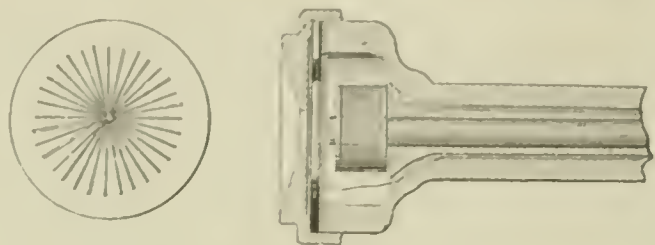
520,083. TELEPHONE TRUNK LINE SYSTEM; J. I. Sabin and W. Hampton, San Francisco, Cal. Application filed Feb. 12, 1894. The combination with a trunk line terminating in a switch at the operator's board, of single cord telephone lines terminating in connecting plugs thereat, and an operator's telephone set terminating in a switch socket.

520,086. TELEPHONE; H. F. Slocum, New York, N. Y. Application filed May 20, 1893. A diaphragm having a voltaic battery connected with the telephone circuit, arranged within the diaphragm so that the internal resistance of the battery will be varied by the changes of form assumed by the diaphragm. (See illustration.)

520,088. INCANDESCENT LAMP; F. S. Smith, Pittsburgh, Pa. Application filed June 28, 1893. The process of forming a tight seal at the leading-in wires, which consists in heating the wires, removing the scale in a pickle, dipping the wires into a bath of tin and moulding the wires into that portion of the chamber destined to surround them.

520,106. TRANSMITTING SOUND; H. B. Cox, Hartford, Conn. Application filed Aug. 6, 1890. This consists in recording sound vibrations and telephonically transmitting such recorded vibrations in condensed form.

520,108. ELECTRICAL TRAIN BRAKE; W. C. Fletcher, St. Louis, Mo. Application filed July 28, 1892. This comprises a generator, a circuit controlling the brakes, a switch on each car adapted to short circuit the brake on the car and a circuit which operates electromagnets connected to the switches to cut out the brakes successively.



NO. 520,086.—TELEPHONE

520,111. ELECTRIC LOCOMOTIVE; R. M. Hunter, Philadelphia, Pa. Application filed April 25, 1893. This comprises a driving axle, an electric motor journaled thereon and having its weight supported thereby, a pivoted truck in advance of the driving axle, and a central pivot support between the truck and the motor. (See illustration.)

520,120. GALVANIC BATTERY; E. F. Northrup, Ardmore, Pa. Application filed Feb. 18, 1893. A battery having an electrolyte consisting of a mixture of zinc oxide and aluminium chloride in contact with the positive element, and a depolarizer consisting of iodine in contact with the negative electrode.

520,127. ELECTRIC ANNUNCIATING APPARATUS; H. E. Walter, Richfield Springs, N. Y. Application filed July 23, 1891. This comprises a series of contact buttons, forming terminals of sub-stations, gang switch having a rigid frame, means for mounting the switch to move in a curved path, tripping mechanism for holding the switch, and means for restoring the switch to its normal position after it has been tripped.

520,128. SWITCHBOARD FOR HIGH TENSION CIRCUITS; J. J. Wood, Fort Wayne, Ind. Application filed Feb. 6, 1891. This comprises a slab having a hole through it, a socket piece having a front flange and opposite ears, a fastening plate and screws passing through the plate and screwing into the ears to clamp the socket piece to the slab.

520,129. ELECTRIC CURRENT INDICATOR; J. J. Wood, Fort Wayne, Ind. Application filed Feb. 6, 1891. The combination of a coil, an armature pivoted to move therein, a spindle for the armature made of non-magnetic material, and having steel pivot pins inserted in its opposite ends, and pivotal bearings in which the pivots turn.

520,143. FORMER FOR WINDING ARMATURE COILS; H. L. Kirker and W. Chambers, Pittsburgh, Pa. Application filed Nov. 26, 1892. A coil former having broad and shallow wire ways at its sides, and deep and narrow ways communicating therewith at its ends.

520,152. DYNAMO ELECTRIC MACHINE OR ELECTRIC MOTOR; R. K. Welch, Philadelphia, Pa. Application filed June 24, 1891. A commutator consisting of a disc-like carrier and a series of segments secured to and projecting radially beyond the carrier so as to provide a narrow bearing for the current collector.

520,156. ELECTRIC RAILWAY TROLLEY; T. M. Brown, Cleveland, Ohio. Application filed Sept. 28, 1893. The combination of a base plate, a second plate, a contact device carried by the second plate, two parallel trolley poles, and universal joint connections between the poles and the two plates.



NO. 520,223.—ELECTRIC ADVERTISING OR SIGNALING APPARATUS.

520,169. BRUSH HOLDER FOR DYNAMO ELECTRIC MACHINES OR MOTORS; A. L. Riker, Brooklyn, N. Y. Application filed March 31, 1894. This comprises two contact plates hinged one to the other so that their contact faces are parallel in all positions of the plates with reference to each other.

520,181. ELECTRIC CLOCK STRIKING MECHANISM; F. L. Gregory, Chicago, Ill. Application filed April 27, 1893. The combination of a gong, a reciprocatory striker and switch actuator, an electrical striker-actuator, and a locking switch in circuit with the striker-actuator.

520,206. UTERUS BATTERY; C. S. W. Hinkley, San Antonio, Tex. Application filed April 10, 1894. This comprises a rigid stem formed of substances which are conductors of electricity, and a button or body connected to the stem.

520,213. TROLLEY WIRE HANGER; T. J. McTighe and S. W. Childs, New York, N. Y. Application filed Jan. 23, 1893. The combination of a U-shaped metal clip, an ear having an inclined bottom edge, a wedge and two or more rivets uniting the clip to the ear.

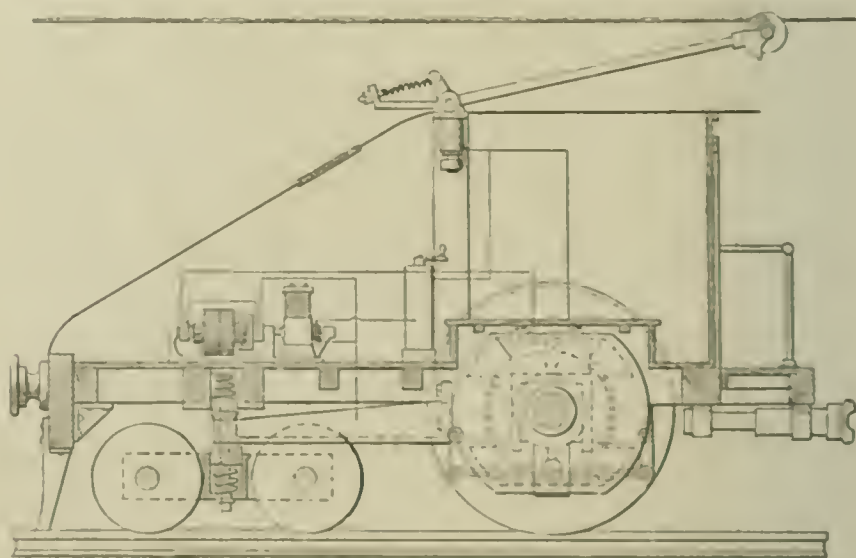
520,223. ELECTRIC ADVERTISING OR SIGNALING APPARATUS; G. L. Schneider, San Francisco, Cal. Application filed Jan. 20, 1894. This consists of a mat of lights, contacts in electrical connection therewith, a corresponding series of push buttons adapted to make and break connection with the contacts, and suitable electric circuits. (See illustration.)

520,228. ELECTRIC LOCOMOTIVE; R. Eickemeyer, Yonkers, N. Y. Application filed June 18, 1891. A motor casing having its sides, bottom and armature frame seamless and integral, and also having integral rectangular extensions or arms, containing jaws for the reception of the car axle boxes.

520,222. ELECTRIC ARC LIGHTING SYSTEM; D. Higham, Boston, Mass. Application filed Jan. 2, 1894. This comprises an induction coil in the main circuit in series with the arc and series windings with the lamps, and an elastic and slow yielding connection arranged serially together between the mechanism and frame of the lamps.

520,234. INDICATOR FOR FIRE ALARM OR OTHER PURPOSES; W. H. Kirnan, Bayonne, N. J. Application filed Jan. 18, 1892. This comprises a number of drums controlled by impulses employed in giving the alarm, and a tripping device to govern the movement of the drums.

520,246. AUTOMATIC TELEPHONE SYSTEM; L. E. Simoneau, Montreal, Canada. Application filed July 11, 1893. This comprises a box containing a telephone, a door, and spring actuating parts for automatically throwing the same open.



NO. 520,111.—ELECTRIC LOCOMOTIVE.

520,263. CARBON SWITCH; F. Von Hefner-Altenieck, Berlin, Germany. Application filed Nov. 15, 1893. This comprises a carbon switch, a worm wheel and worm shaft, an inner journal for the shaft, a switch lever carrying contacts connected with the line wire, and a link between the parts.

520,261. COMMUTATOR; C. Hoffman, Berlin, Germany. Application filed Sept. 28, 1893. The combination with a commutator bar comprising a base bar and a removable contact bar, of a common retaining key therefor.

520,267. ELECTRICAL GOVERNOR; W. H. Miller, New York, N. Y. Application filed June 18, 1884. The combination with a dynamo of a regulator comprising a magnet, an armature, means for connecting the armature with adjustable brushes, and mechanism for maintaining the pull of the armature constant.

520,274. ELECTRIC RAILWAY; E. W. v. Siemens, Berlin, Germany. Application filed Sep. 30, 1892. This comprises an insulated overhead slotted tubular conductor extending along a line of railway, and an electrically propelled car having a travelling contact within the tubular conductor.

520,279. ELECTRIC SWITCH; H. E. Werline, Lancaster, Pa. Application filed Feb. 15, 1893. This comprises contact plates, a switch spindle, a conducting brush bar secured thereto, spring actuated brushes attached to the brush bar and adapted to engage the contact plates.

520,304. CONDUIT ELECTRIC RAILWAY; W. R. DeVoe, Shreveport, La. Application filed Jan. 20, 1894. A lining section for underground electric railways comprising a metallic plate, having integral lateral upward flanges, and an intermediate upward, hollow integral flange.

520,356. CONDUIT ELECTRIC RAILWAY; C. W. Siemens, deceased. Application filed Oct. 19, 1893. In an electric railway system, a continuous underground chamber having hinged or removable covers giving access thereto, channel irons located at intervals within the chamber, and a conductor supported by the channel irons.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., 253 Broadway, New York.

The Electrical World.

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NEW YORK, JUNE 16, 1894.

No. 24.

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1883 " 63 " "	1890 " 289 " "
1884 " 82 " "	1891 " 325 " "
1885 " 100 " "	1892 " 316 " "
1886 " 138 " "	1893 " 317 " "

The first issue of 1894 contained 320 different Advertisements.

No announcements of the publisher are included in this list.

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NEW YORK, JUNE 16, 1894.

NO. 24

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THAT \$50,000 PRIZE AGAIN.

That wily corporation, the Metropolitan Traction Company, has made another announcement in regard to its recent sham electric street railway competition, this time implying that the failure rests with the State Railroad Commissioners. President Vreeland on Saturday stated that "the company had waited until tired for some action on the part of the State Railroad Commissioners, who were to have been the judges in the matter, and had employed engineers to make examinations on its own account." It may be remarked that had these engineers examined the several thousand plans said to have been submitted, they could have made no award, as the time limit was such as to preclude compliance with the terms of the competition. The Railroad Commissioners are doubtless little satisfied with the part they have been made to play in the matter. The use of their names gave a stamp of good faith to the competition, and they would be fully justified in thinking that insult has been added to injury, as to their recent part of decoy they are made to assume the present one of scapegoat. It is rumored that the commissioners are preparing a public statement in which will be given in very plain terms their opinion of the equivocal use that has been made of the names of a State Department and State officials.

LEGALIZING ELECTRICAL UNITS.

The passage by the House of Representatives at Washington of the bill for the legalization of electrical units can be regarded as a recognition of the influence of the American Institute of Electrical Engineers and of the National Electric Light Association. Although the question of legalizing some of these units was before Congress after their adoption subsequent to the Paris Electrical Exhibition of 1881, the matter has received no encouragement until now, and the present comparatively speedy action may be largely ascribed to the action of the above two bodies at their recent annual meetings, united with the persistent efforts of Prof. Mendenhall at Washington. The units thus legalized are those adopted at the Chicago International Electrical Congress—the ohm, volt, ampere, coulomb, farad, joule, watt and the new unit of inductance, the henry. While these are now legal units it will be best to adhere to the characterization, "international," adopted by the Chicago Congress, in order not to confound them with the so-called "legal" units adopted at Paris in 1889, and the earlier ones known as the "B. A." or British Association units. The electrical units were originally in a bill before Congress which also included a number of other units relating to measures of length, weight and volume, but it seems that the new science has outdistanced its brethren in this as it has in so many other ways.

ISOLATED PLANTS FOR COUNTRY RESIDENCES.

While a considerable number of storage battery plants has been installed for the lighting of country residences, yet these are but a small fraction of what might be in use in view of the advantages of the electric light, where usually kerosene is employed as the illuminant. One of the reasons which has led such plants to be regarded with suspicion is the supposed necessity of a skilled or special attendant. Were it

made plain that the coachman and a stable boy, or the gardener and a laborer could in most cases successfully run such a plant without too seriously interfering with their other duties, the subject would be looked at in a more favorable light. In starting up a storage battery plant or shutting it down, the services of an intelligent man are necessary, but at other times it may be left in charge of any one who merely knows enough to keep up steam in the boiler and to keep the charging current constant by manipulating a rheostat. In several cases of which the writer has knowledge men of this character have had charge of plants, and in no case has there been any trouble. The more intelligent man does not need to be regularly present more than an hour or so in starting up in the morning, and a short while at the time of shutting down, a glance from him between times being otherwise sufficient, while the regular attendant may employ a good part of his time working on odds and ends, as the care of the plant will not entirely engross his attention. As such a plant would only be run two or three days a week the coachman or gardener would not find the extra duty too irksome, while the other man could probably in most cases be taken from his regular work without crippling it seriously.

THE INCANDESCENT LAMP PATENT AND BATE REFRIGERATOR CASE.

We have had inquiries in regard to the probable effect of a reversal by the United States Supreme Court of the point of law involved in the Bate refrigerator case, in respect to a patent which, under the application of the present interpretation of the law, expires before the decision is handed down. That is, what would be the status of a manufacturer of incandescent lamps subsequent to November of this year if the Supreme Court should reverse the law of the lower courts, and thus prolong the life of the Edison patent to January, 1897? Strictly speaking, all such manufacturers would be infringers subject to an accounting for past profits and subject to an injunction restraining them from continuing the manufacture of lamps. For the decision of the Supreme Court would be in effect that the Edison patent had continued to live, the lower courts having been in error in limiting its life to that of a foreign patent granted prior to the grant (not application) of the domestic one. It does not follow, however, that the courts would treat cases under these circumstances as it would infringers at the present time. Notwithstanding that the owners of the Edison patent might claim that their patent was still in force after November, 1894, and give notice to that effect to those starting after that date to manufacture incandescent lamps, the latter would have a strong plea of good faith through the unanimous decision of the lower courts in favor of the view which implied the expiration of the domestic Edison patent with the Canadian one. As a consequence of the equities in their favor, and particularly in respect to companies started after November, 1894, it is probable that the courts would not in any case sustain claims against them that were not entirely reasonable under the extenuating circumstances, so there is no reason to fear a repetition of the harsh measures heretofore enforced against infringers. It may be said that such a course would be a hardship against the owners of the Edison patent, as it is through no fault of theirs that the ambiguity in regard to its expiration exists and that when the Supreme Court sustains their claim the courts should enforce it rigorously. Such a view would, if established, however, place in the hands of powerful corporations a dangerous weapon, of which they could take advantage to frighten away competition even after having been defeated on the main points at issue by continuing litigation and claiming to expect a reversal, accompanied by the threat that they would then crush those who had taken advantage of the

original decision. As there is said to be an exceedingly small chance of a reversal in the Bate refrigerator case, and as a decision is expected before November, there is really little occasion for speculation as to what might happen in the contrary case.

ELECTRIC CONDUIT ROADS.

As is well known to our readers, the city of Budapest is provided with a conduit road which has now been in successful operation for a number of years. As this road is by far the largest and most successful of its kind and as it may now be considered to be running normally, we give in another column an abstract of the report for the year 1893, which will doubtless interest those who are giving attention to conduit roads. From this report it will be seen that the road is paying a dividend and is being extended, overhead lines being added for suburban traffic, in which they are replacing steam lines. Like in all new undertakings, the cost is undoubtedly greater than it would be in a similar line constructed at the present time, with the knowledge gained from the experience with this road. In this connection we might call attention to the fact that in view of the frequent inquiries about the effects of snow, rain and ice on this line, we made personal inquiry a few years ago, the results of which were very favorable. Our special correspondent at Budapest recently informed us that in the past winter there was one very severe snowstorm, during which the road was stopped until nearly noon; the storm was an unusually severe one, and also stopped the traffic on all the horse car lines, as well as on steam railroads. If this is the worst that can be said against the conduit road, it certainly is not very bad. From this article and others that have heretofore appeared in our columns, it appears that the success, both technical and financial, of this system has been thoroughly established, and there need, therefore, be no apprehension of failure in New York, where it is proposed to soon commence the construction of three miles of road practically the same as that at Budapest. In our issue of May 12 we referred to the official announcement of the Metropolitan Traction Company, of New York City, that it had decided to give the Budapest system a trial and that the Siemens-Halske company, which had built the European road, would also build the proposed one in New York. From an official statement issued on last Saturday, however, it seems that the Tammany-esque Traction Company has changed its mind in regard to giving the contract to this firm, its latest announcement being that the General Electric Company will build the road. President Vreeland states that three miles of road will be built over a route not yet selected, using a voltage of 300. The Metropolitan Traction Company will construct the road-bed and conduit precisely in the same manner as if a cable were to be used, and supply the cars with steam power for the operation of the road, while the General Electric Company will supply and install a complete electrical outfit. When completed the road will be operated for a year by the Traction company, at the end of which time, if the experiment has been successful, the General Electric Company will be paid the sum previously agreed upon, and the system extended to other lines. If unsuccessful the electrical equipment must be removed and the road will then be equipped with a cable. It is intimated that patent litigation will result from this latest move, the Siemens-Halske company claiming that its patents will be infringed by the General Electric Company if it constructs the road provided for in the contract, while the latter reports that its patents would have been infringed by the former if the contract had been awarded to it. While stockholders concerned will not view with equanimity this further prospect of patent litigation, the electrical street railway industry will receive another impetus if the conduit experiment is successful, of which there seems to be little reason to doubt.

The Invention of the Telegraph.

To the Editor of The Electrical World.

Your issue for June 2 contained an article apropos of this being the semi-centennial anniversary year of the opening of the first telegraph line, and you therein erroneously state that the "first public message" was sent upon the 24th of May, 1844, and that it was the message: "What hath God wrought?"

Permit me to correct this mistake, which I am not surprised at your making, for the date mentioned has always been considered that upon which the first message was sent. It was upon that date that the first message of which there is any record was sent over the completed line between Washington and Baltimore, but as a matter of fact it was neither a public nor a news message, for it was absolutely a private one, sent by Morse (at Washington, and received by my father, Alfred Vail, at Baltimore), in fulfilment by him of a promise made by him to Miss Ellsworth, daughter of the then Commissioner of Patents. This lady was much interested in the efforts to obtain the passage of an act by Congress appropriating \$30,000 to build the line from Washington to Baltimore, and was the one to carry to Morse the news of the final passage of the bill, whereupon he promised that she should dictate the first message to be sent over the line when completed.

The really first public and first news message that was ever sent by telegraph was sent on the afternoon of the 1st of May, 1844 (twenty-four days in advance of the so-called first message), and was sent from Annapolis Junction, upon the Baltimore and Ohio Railroad, 22 miles from Washington, which was upon that date the end of the line, then being built.

My father obtained from passengers upon the afternoon train from Baltimore to Washington upon that 1st of May the information that the Whig convention, assembled to nominate candidates for the Presidency and Vice Presidency, had met, nominated Henry Clay and Frelinghuysen and had adjourned, and that many of the delegates were upon that train, bound for Washington.

My father immediately telegraphed the news to Morse at Washington, and when the train arrived there the passengers were astounded to find a great crowd at the station cheering for Clay and Frelinghuysen, and, too, they saw in the "extras," which the newsboys were crying, the information in print.

This information I have had from one of the delegates to that convention, and I also found it stated in a letter, written the next day by my father to my mother, who was in New York.

I have no desire to detract from the credit due Morse, Henry or any other of the many scientists who have contributed more or less to that which now constitutes the electric telegraph, but I do feel that the very important part taken by Alfred Vail has never, either at the hands of Morse or the world, received the consideration due it.

Prof. Franklin L. Pope has justly said: " * * * The telegraph of to-day, and the universal telegraph of the future, comprises solely the work of Joseph Henry and Alfred Vail. * * * " Surely he who contributed to the invention the dot and dash alphabet and the recording receiver and the finger key, only by which that alphabet could be utilized for the transmission of intelligence, should be accorded the credit for what he has done.

New York City.

STEPHEN VAIL.

I do not care to enter into a newspaper controversy with Mr. Vail, which could be productive of no good whatever.

My father's claims were upheld by the Supreme Court of the United States, and during his lifetime he successfully

defended his title as the father of the telegraph against countless claimants, who had contributed something or nothing to its success. That Alfred Vail rendered most valuable technical and financial assistance to Prof. Morse, those who know anything about the birth of the telegraph would never dream of denying. That he and Prof. Henry were the "sole" inventors of the telegraph of to-day is a preposterous statement which it is not worth while to notice. Alfred Vail's letters to my father, which are now in our possession, breathe nothing but a spirit of profound respect and gratitude. If in his letters to his family he wrote differently, I can only say that it does not redound greatly to his credit. Alfred Vail was a man of means, and when the dark days of the telegraph came, he was discouraged, and with the other partners, gave it up as a failure. As a parent he deserted his child. Morse, then alone and unaided, almost on the verge of starvation, carried the enterprise through to success. Then, Alfred Vail and the other partners came back and helped to reap the benefits which Morse had secured for them.

In all great enterprises one name is bound to stand pre-eminent. That Morse frankly availed himself of the services and assistance of others does not in the slightest degree detract from his fame. This was the opinion in the Supreme Court case, and this must be the opinion of posterity. In spite of petty quibbles as to which was the first public message, and who ran to the printer's office to find out which letter of the alphabet occurs most frequently, Morse remains the father of the telegraph. The first simple principles which sprang as if by inspiration into the brain of the poor artist on the packet-ship Sully, in 1832, are the principles of the telegraph of to-day. All the hair-splitting in the world will not alter that fact. It was the verdict of the world during my father's lifetime, it is the verdict among scientists to-day, it will be the verdict of the future to all time.

Bedford, N. Y.

EDWARD L. MORSE.

Alternating Currents and Fuse Wires.

BY DUGALD C. JACKSON.

In the editorial comments made in your issue of May 26 on papers read at the last meeting of the American Institute of Electrical Engineers, the correctness of Mr. Ochsner's experiments on commercial fuses is questioned. A conservative position in such matters is certainly to be appreciated in all cases where the results of experiments do not agree with the results of previous experience. In this case the results seem to agree so closely with general experience that the correctness of Mr. Ochsner's conclusions seems to be fully borne out.

In the discussion of the fuse question at the last convention of the National Electric Light Association the eccentricities of fuses were thoroughly ventilated, but it does not appear that fuses are considered less reliable by station men when used on alternating current circuits than when used on continuous current circuits. Oxidation was brought into that discussion as a fertile cause of unreliability in fuses, and there does not seem to be any reason to expect the character of the current to affect the oxidation. Mr. Ochsner's paper was completed before the report of the Washington discussion was published, but the two seem to be in harmony. The same is true of similar discussions which have occurred elsewhere, and the experience of the majority of people whom I have consulted in regard to the matter and experience of my own tend to the same conclusions.

If the resistance of any commercial fuse alloy when used on alternating current circuits is liable to an increase as great as 15 to 30 per cent. in a few hundred hours, accurately rated fuses are a delusion. If a marked effect of this kind is to be found in fuse alloys, it seems entirely reasonable to

expect a commercial depreciation in brass and german silver, and even in copper, iron, etc., when used to conduct alternating currents. That such is not the case is shown by resistance coils, electric light lines and wires in other uses, which ordinarily seem to last as well when carrying alternating currents as when carrying continuous currents.

My attention was specifically called to this matter about a year ago, after the question had been raised, by a fuse wire manufacturer, who wished me to determine whether his wires were appreciably affected by the alternating current. I found that they were not affected within the comparatively limited test period, and Mr. Ochsner then took up the more extended testing of various other wires with the results given in his report. The way in which the work was carried out gives me confidence in the correctness of Mr. Ochsner's conclusion that as far as the direct action of the current is concerned, fuses are just as reliable on alternating as on continuous current circuits. Unstable alloys may doubtless be made whose resistance will be affected in a marked manner when a current is passed through them, but this does not appear to be the condition of the ordinary fuse alloys.

General Electric and Fort Wayne.

The final struggle between the General Electric and the Fort Wayne Electric began with a number of legal skirmishes last week, the result of which would appear to incline in favor of the latter. The immediate cause was a publication of a notice calling for a meeting of the stockholders of the Fort Wayne Electric Company "to elect directors and transact other business." The local Fort Wayne interest assumed that the object in view was to close the Western works and transfer the business to Schenectady. To avert this supposed action, R. T. McDonald, on June 6, applied to Judge Dawson, of Fort Wayne, Ind., for the appointment of receivers to liquidate the affairs of the Fort Wayne Electric Company, which petition was granted, and H. J. Miller, of Fort Wayne, and E. J. Hathorne, of Boston, were made receivers. Simultaneously with the filing of this application, Mr. McDonald organized and incorporated the Fort Wayne Electric Corporation, with a capital stock of \$1,500,000, which contracted with the receivers to continue the business of the Fort Wayne Company and secured the approval of Judge Dawson to this arrangement. The first holders of stock in the new incorporation are R. T. McDonald, C. C. Miller, S. C. Lombard, Charles S. Knight and M. C. Gross.

In New York on June 8 the General Electric obtained an attachment from Judge Andrews, of the New York Supreme Court, against the Fort Wayne company for \$500,000, money lent to the latter between May 1, 1892, and May 1, 1894, but the property of the Fort Wayne company in New York had already been transferred to the new incorporation. On June 9, Judge Dawson, of Fort Wayne, granted a temporary enjoining and restraining order to prevent the stockholders' meeting above referred to, and to enjoin the attachment of property in other States, which now, it is claimed, legally belongs to the receivers.

An officer of the Fort Wayne company, in answer to a telegram of inquiry from *The Electrical World*, telegraphs that the attachment was obtained by the General Electric Company to annoy the new Fort Wayne Corporation and discourage competition, and that the Fort Wayne company claims it is not indebted to the General Electric in any sum whatsoever.

The General Electric Company states that it owns a half interest in the Fort Wayne company, and that its action was to protect this interest and assert its rights against the present policy of bitter warfare of the latter company against it. The Fort Wayne interests claim, on the other hand, that the scheme of the General Electric Company was to secure

control of the local plant at the annual meeting, close it up, and transfer the manufacturing business to Schenectady, as has been done with other corporations. A local newspaper charges that a gigantic Wall Street combine is at the bottom of the scheme to close up the shops of competing electric companies and concentrate them on their railroad lines under the direct control of the General Electric Company, in order to profit by the shipping business. The assets of the Fort Wayne Electric Company, the paper states, are sufficient to pay all of its debts and leave a considerable surplus for distribution to its stockholders, so that no man will lose a dollar, and the capital of the new company is ample for its purposes, while the arrangements it has made are such that no sacrifice in respect to the assets in the hands of the liquidators will be necessary.

"Thus, Phoenix-like," it concludes, "rises out of the wreck contemplated by the combine a new company, with a business as broad as the land, to compete with the General Electric octopus and defy its power. Mr. McDonald is doing this for Fort Wayne, for the men who subscribed \$25,000 when the integrity of the company was threatened some years ago; he is doing it for the 1,200 employees of the works and their families; he is doing it for his fellow-citizens, for his friends and his home, at a time when he could dispose of his interests at his own price and continue with the General Electric Company at his own salary, with headquarters in New York. A great legal battle is on and in the struggle for the life of the Fort Wayne company Mr. McDonald can rest assured of the sympathy, support and good will of the citizens of Fort Wayne, who are sure to appreciate his loyalty to the metropolis of northern Indiana."

The Field Railway Patent.

To the Editor of The Electrical World.

In Judge Townsend's decision annulling the Field electric railway patent, the main statutory bar to the validity of the patent is held to be an English patent of Clark, granted in 1864. In justice to a meritorious inventor and engineer, still living in Paris, it is proper to remark that the English patent referred to is based upon a French patent of Jean Henri Cazal, dated May 25, 1864, No. 63,155. Clark was merely the agent who obtained the English patent for Cazal, and, in fact, the name of this French inventor appears in the English patent specification as the person who communicated the invention to Clark. An article in "*L'Industrie Electrique*" of March 10, 1892, quotes the subject matter of Cazal's patent so far as it relates to electric railways and the electrical transmission of power, and an abstract of this article was given in *The Electrical World* about that time. In the statement of the Field railway case, as it appears in one of the electrical journals, a French patent of "Bovee" is referred to as another reference for the Field patent. A French patent of F. A. Bovee, dated Sept. 17, 1878, No. 126,446, is undoubtedly the patent referred to. It is reproduced in extenso in "*L'Industrie Electrique*" of March 25, 1894.

Yours very truly,

Paris, France.

A. M. TANNER

Minimum Temperature of Visibility.

According to a Physical Society paper by Mr. Gray, this temperature for the surface of the solid is about 470 degrees C., but this may be reduced considerably if the person remains for a few minutes in a dark room. At night a surface for 410 degrees C. is visible; by resting the eyes in complete darkness this may be reduced to 370 degrees nearly; different people's eyes differ somewhat, but probably not to any great extent if tested under the same conditions; the surfaces at these temperatures do not appear red, but look like a whitish mist.

SWITZERLAND AS THE PRESENT ELECTRICAL CENTRE OF EUROPE

BY FREDERICK BATHURST.

THE POWER TRANSMISSION PLANT FOR THE OERLIKON ELECTRICAL WORKS.

Before referring in detail to the installation of this unique and interesting plant, which may be taken as an index of the developments we shall ultimately see in all important manufacturing centres, it may be possible in a few words to show that it is but the forerunner of an immense development in Switzerland itself.

Something like one-eighteenth part of the area of this wondrous bit of mosaic, of grass, granite and glacier, is covered with perpetual snow; the glaciers, in fact, reach a total of about four hundred. It is small wonder, then, that the melting of this ice has made it possible to utilize from this natural water source the greater part of 500,000 h. p.

The necessity of power to the Swiss manufacturer is impressed upon the traveller when, in climbing amongst the lower ranges of the mountains, he comes upon some of the many still existing wire rope transmissions and finds that their erection dates from perhaps 20 years back. One of the most indicative of these is that near Wald, by which some 60 h. p. is transmitted over the crest of the hill into an adjoining valley, where the industry is located. In all, a dis-

costs the consumer, when delivered, on the average 26 francs, or \$5 per ton.

An interesting problem in this respect is presented to the sociologist and politician. What are the essential causes that govern the suggestion and organization of such huge power transmission schemes as those now contemplated in Switzerland? For instance, the project which originates in Zurich to utilize 12,000 h. p. from the Swiss Niagara, the Falls of Schaffhausen, where the River Rhine with a width of 300 feet takes a plunge of 80 feet, and that originating in Basle to develop 16,000 h. p. from its neighboring water-powers. The former is still further enigmatical when one considers that the town of Zurich does not employ more than 6,000 h. p. in its factories.

There must be some impelling motives behind these schemes, but whether they materialize or not it is evident that the Swiss themselves fully recognize that it is only by the use of electricity that these problems can be solved, and the rest of Europe looks to them as a nation possessing the men best fitted by their dual experience in hydraulics and electrics to carry them out.

The Maschinenfabrik Oerlikon, better known to electricians as the Oerlikon Electrical Works, is no exception to



BASIN AT END OF ONE OF CANAL LEVELS AND TURBINE HOUSE.

tance of 3,000 metres, nearly two miles, is traversed in the effort to supply power from the convenient generating to the suitable distributing point.

Political as well as physical reasons prevent any extension in the use of coal, which, when obtained under the present conditions, comes either from Belgium or from England, and

the conditions generally prevailing, and obtain the power they require for manufacturing from a point situated among the hills and dales, 12 miles away from the factory. The visitor or workman must take train northward from Zurich to Bulach, and then walk for three-quarters of an hour through the woods or along a canal to Hochfelden, near

where the generating station is placed. En route one notices the sight, familiar in Switzerland, of a *dry river*; the course of the bed, where water should be, is marked by large boulders and loose stones, but near it upon the hillside, taking a parallel course down the valley, is a canal, the product of Swiss industry, and which by means of a dam diverts and conveys the river water to a point where it is desirable to pass the water back to its proper course through the turbines of a power generating station. This River Glatt is notably one that with more reason could be called a canal. The dam and embankment work is carried out by a construction company as a private enterprise, for the right and privilege of making a certain charge per horse power for water delivered. The Glatt ultimately flows into the Rhine near Schaffhausen.

The cut shows the basin, at the end of one of the canal levels (then empty), upon which the turbine house is situated. This station is a three-story brick structure built on the valley side of the canal embankment.

The turbines are placed upon the foundations in the

revolve within the armature ring frame, which is raised above the floor level by means of supporting collars. The armature is very simple and substantial in construction, consisting of a laminated iron core ring having 96 holes pierced close to the inner periphery and through which the copper bars are passed. The bars are arranged in three independent circuits. There are three generators and three converters, but only two of each are employed in the regular working, the others being held in reserve. The turbine shafts run at 180 revolutions per minute. Within the armature bars a low-pressure, three-phased, 85 volt current is generated which is passed into the primary coils of the converters, one of which will be noticed standing opposite each machine. A frequency of 48 is employed. The secondary windings of the converters transform up the voltage to 13,000 volts.

The converters are interesting from the fact of their having an oil circulation. Taking the average load on each transformer as 170 kw. and allowing a loss in conversion of 2 per cent., some 3.4 kw. of energy is being lost continuously, which appears as heat. In order to dissipate this heat and



GENERATOR ROOM.

lowest or first floor, having a water entrance from the embankment side.

The entrance to the flumes is regulated by means of the usual form of lift-up gate. A by-pass sluice is provided so that excess water can be conveniently handled. The turbine wheels are arranged horizontally and the shafts pass vertically upward into the second floor.

The Swiss practice is to arrange the wheels of turbines (usually slow speed) driven from low falls horizontally. Those running from high falls are generally quick running and have their driving shafts horizontal.

Above is shown the second floor of the power house, which forms the generator room. The field magnets, 32 poles, separately excited from auxiliary continuous current machines, are placed upon the ends of the vertical turbine shafts and

maintain the converters at a reasonable temperature, the oil is circulated through serpentine tubes that are immersed in a tank through which there is a constant flow of cold water. The circulation is effected by means of a pump, but the fact is sometimes apparent to the attendant that oil, although a good electrical insulator, is also a good heat conserver.

By the use of low tension generators and converters, the attendant can work around the machinery without fear and danger, and when entering this power house, except for a conspicuous wire netting to be seen on the outside of the building, no one would suppose that it contained anything more dangerous than the ordinary lighting plant. The high potential parts, all being stationary and needing no attention, can be adequately protected.

(To be continued.)

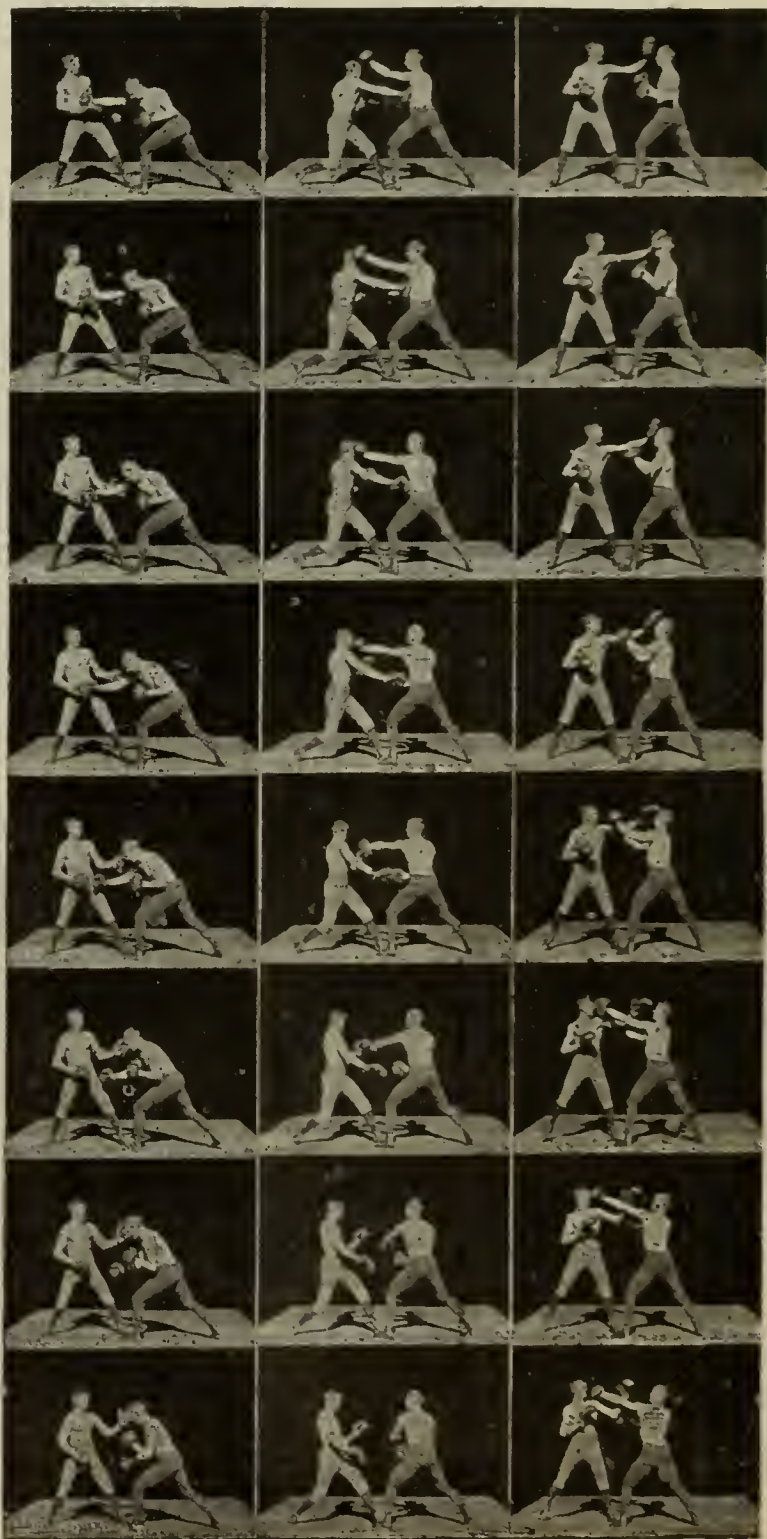
The Kinetophone,



Thomas A. Edison conceived the idea of the simultaneous record and reproduction of sound and motion in 1887, the idea naturally being suggested by that familiar toy, the zoetrope. The work of the inventor and his assistants has borne fruit in the kinetograph and kinetoscope, which are now making claims upon public attention, and which, whatever may prove to be their practical value, will stand as striking illustrations of human ingenuity and patience. That Mr. Edison himself believes in the future possibilities of this device is evidenced by the following recently published statement: "I believe that in coming years, by my own work and that of Dickson, Muybridge, Marie and others who will doubt-

erally understood. A series of photographs of the object or objects which it is desired to reproduce are taken with a rapidity of between forty and fifty views per second. These photographs are then developed and by means of the kinetoscope are either projected upon a screen or exposed directly to the eye at the same rate of motion. As the interval between the exposure of the successive photographs is too short to be appreciated by the human eye, the motions of the subject appear continuous to the observer. It is apparent that this invention lies largely in the realm of photography and, as in the phonograph, electricity plays a subsidiary part.

The kinetograph reaches its highest sphere of usefulness in conjunction with the phonograph, by which it is intended to reproduce every word and movement of the subject in their proper relation. For the combined instrument, the name "kineto-phonograph" has appropriately been suggested. While the kineto-phonograph has not been brought to a sufficiently practical form for public exhibition, as has the kinetoscope, the experiments in the inventor's laboratory have been so successful that it is regarded only as a question



KINETOSCOPIC RECORDS.

less enter the field, that grand opera can be given at the Metropolitan Opera House at New York without any material change from the original, and with artists and musicians long since dead."

The principle of the kinetograph—the recording—and the kinetoscope—the reproducing—instrument is doubtless gen-

of time, by those engaged in the work, when the apparatus will be perfected.

The credit for the development of the kinetograph and kinetoscope belongs, after the inventor himself, to Mr. W. K. L. Dickson, whose wide experience in photography and familiarity with the application of electricity have rendered

him an invaluable assistant to Mr. Edison. In the June number of the "Century," Antonia and W. K. L. Dickson trace the history and development of the invention and point



THE KINETOSCOPE ON EXHIBITION.

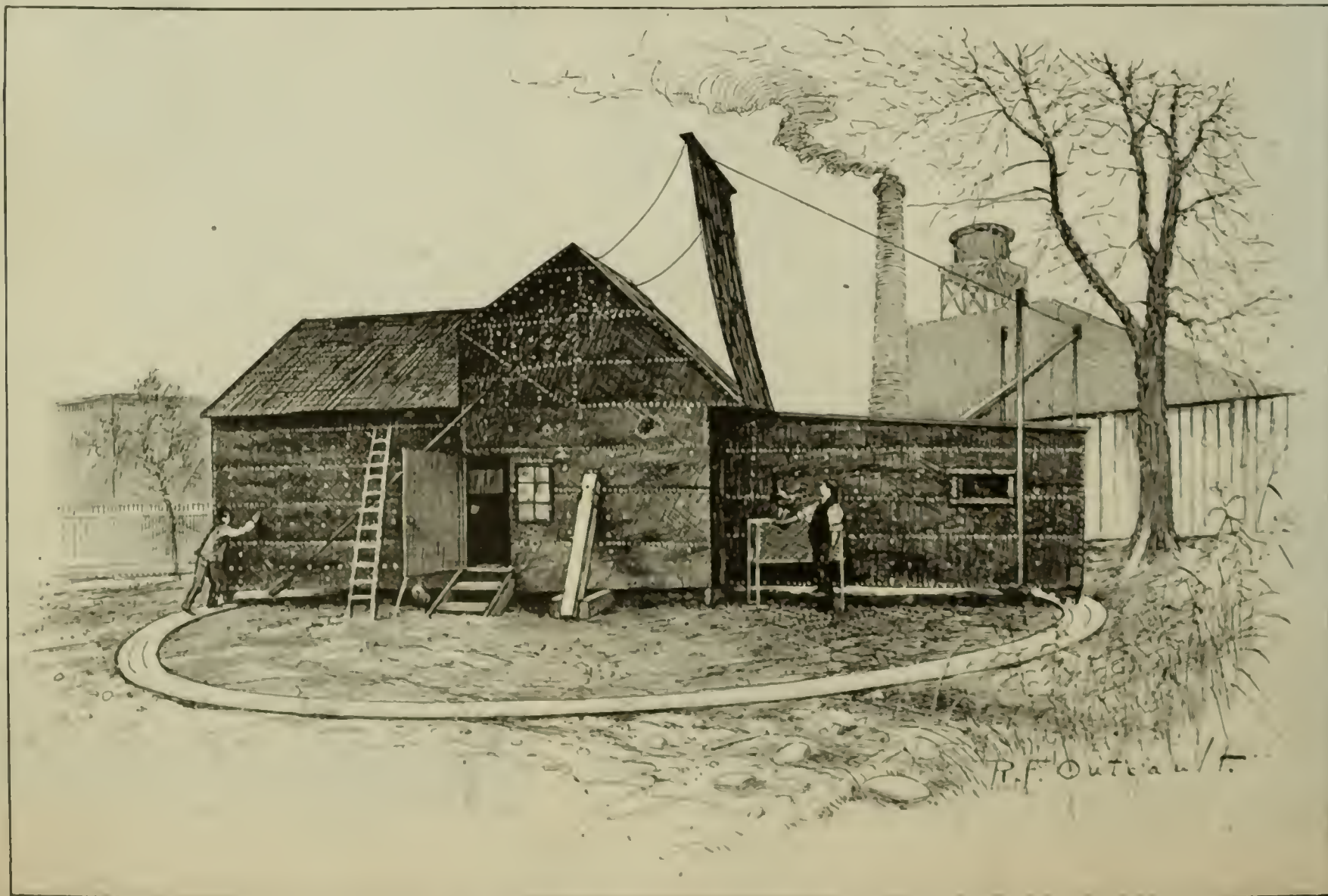
out some of the many difficulties which beset the path of the experimenter along these lines.

The first experiments were made with a cylindrical shell, the same size as the ordinary phonograph cylinder, upon which minute photographs were placed. The two cylinders

The Daguerre, albumen and other similar known processes failed, and an attempt was made to use cylinders coated with the Maddox gelatine bromide of silver emulsion, but the difficulty here was that when the minute photographs were enlarged they were unduly coarse.

The next move was to try larger impressions, which were swiftly rotated upon the edge of a wheel or disc, supplied with a number of pins, which projected under the centre of each picture. These pins successively broke the primary circuit of an induction coil, to the secondary of which was connected a Geissler tube. The tube was lighted at the exact moment the picture passed before it. The results were very encouraging. Experiments were then made with celluloid films placed on drums something like the old tinfoil phonograph. The pictures were taken spirally, the sheet of celluloid removed and developed and then placed on a hollow drum, inside of which was a Geissler tube connected to an induction coil. Brass pins on the exterior of the cylinder broke the circuit at the proper moment and each picture was in turn illuminated. A highly sensitized strip of celluloid half an inch wide was then tried, but the width was soon increased to an inch and a half. The photographs were but an inch in width, but the extra width was perforated and a locking device employed to hold the film steady during the infinitesimal time—about the one-fiftieth part of a second—during which the shutter opened and a photograph was taken. Then in about 1-460th part of a second the film is jerked forward and again held at rest and another photograph taken. This system allows an exposure of one-hundredth part of a second for each picture, which is sufficient for excellent work.

The speed of this photographic work is certainly astonish-



EDISON'S KINETOGRAPHIC THEATRE.

were placed on a shaft side by side, and the photographic and phonographic impressions taken as nearly at the same time as possible. Photography at such a high rate of speed was a new art and the first results were not especially promising.

ing. Forty-six impressions are taken each second, which is 2,760 a minute and 165,600 an hour; or, as Mr. Dickson has graphically put it, "were the spasmodic motions added up by themselves, exclusive of arrest, on the same principle that a

train record is computed independent of stoppages, the incredible speed of twenty-six miles an hour would be shown."

After securing the negative, the next step is to secure a positive strip of film. When this is prepared it is ready to be placed in the kinetoscope or photo-kinetoscope. When a phonographic record has been taken simultaneously with

The only form of this apparatus yet placed on public exhibition is a nickel-in-the-slot form of the kinetoscope. Several of these machines may be seen in one of the accompanying views, which shows the interior of an exhibition room on Broadway, New York City. They consist of a cabinet containing an electric motor and accumulator cells



INTERIOR OF KINETOGRAPHIC THEATRE.

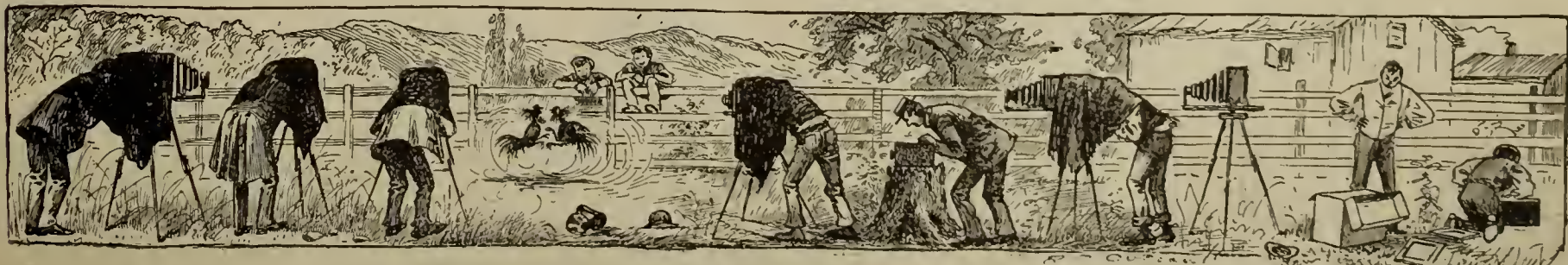
such a strip, the two are started together by a simple device and kept together throughout the reproduction, a single electric motor operating both. One of the greatest difficulties met with by the experimenters was the nicety of adjustment required to simultaneously record and reproduce the sound and motion.

In taking the photographs, either sunlight or artificial light is employed; in the latter case four parabolic magnesium lamps or twenty arc lamps, provided with highly actinic carbons, supplied with powerful reflectors, are used. A special building has been constructed for photographic purposes, interior and exterior views of which are herewith given. It swings on a central pivot, so as to obtain any desired light. A stage is arranged inside and provision made for very sharp contrasts of light and shade.

for operating the mechanism which moves the film. The film is in the form of an endless band, fifty feet in length, which is passed through the field of a perpendicular magnifying glass. The impressions pass before the eye at the rate of forty-six per second by means of a rotating slotted disc, the slot of which exposes a picture at each revolution and separates the fractional gradations of pose.

Portions of two different kinetoscopic bands are here reproduced showing several sections of the films. Close examination will show the almost imperceptible change between one view and the next.

As to the future of this most ingenious and interesting bit of mechanism, time only will demonstrate whether it is to be a mere scientific toy or an invention of real practical value.



OUR ARTIST'S SUGGESTION TO COUNTRY PHOTOGRAPHERS.

Budapest Electric Conduit Railway:

As this road, the largest, oldest and most interesting of the few successful conduit roads, is attracting so much attention, both here and abroad, the following data, taken from the official report of 1893, may be of interest:

The capital stock was increased from \$1,446,000 to \$1,928,000 by the issue of 10,000 new shares of a par value of \$48.20 each.

Certain lines were lengthened, and, furthermore, the "Central-Friedhof" section had its motive power changed from steam to electricity, with overhead conductors.

The generating plant in the central station and the rolling stock were increased to keep pace with the above extensions and the rapidly increasing business.

Corresponding figures for the years 1892 and 1893 are shown in the following table:

	1892.	1893.
Car-miles	1,433,540	1,593,530
Passengers carried	10,989,172	12,499,274
Receipts	\$369,558	\$443,090

The company has a central station building covering an area of 852.56 square metres, standing in grounds having an area of 2,230 square metres, and two car yards. The yard "Arena ut" has an area of 9,094 square metres, of which 3,221.44 square metres are under cover; the area of the other yard, "Koebanya ut," is 10,660 square metres, with 1,668.17 square metres under cover.

The length of line is as follows:

1. Surface road with underground conductors: Length of street, 12,283.87 metres; total length of track, 25,459.64 metres.

2. Surface road with overhead conductors: Length of street, 5,246.12 metres; total length of track, 10,132.49 metres.

3. Road with steam as motive power and Vignol rails: Length of street, 5,549 metres; total length of track, 6,693.05 metres.

4. The Koebanya car yard, with Haarmann track and Vignol rails: Total length of track, 1,229.69 metres.

Altogether, the length of street is 23,072.99 metres (14.31 miles); length of track, 43,514.87 metres (26.98 miles).

The equipment of the central station consists of three compound condensing steam engines of 100 h. p. each; three dynamos (type J-1); three reserve armatures; four compound condensing engines of 200 h. p. each, directly connected with four dynamos (type J-2); two reserve armatures for the above; one motor for driving the ventilating fan of the cooling tower and the centrifugal pumps; one continuous current transformer, consisting of two dynamos (E-1), for lighting purposes; five Steimmüller water tube boilers of 98 square metres heating surface each; one Steimmüller water tube boiler of 212 square metres heating surface; four Worthington steam pumps, used as cold water and feed water pumps; two centrifugal pumps; two injectors; one cooling tower for thoroughly cooling the water from the condenser; one water filtering apparatus; one washing machine, driven by electricity; one accumulator battery, for lighting the central station and the car yards after the machines have shut down; two traveling cranes in the power house; one bridge scale.

The two car yards, where there are also repair shops, are provided with electric motors and the necessary tools, machines, accumulator batteries, etc.

In order to keep the track clean and in repair, there are sweeping machines, snow plows, etc., which can be driven by horses or electric power.

The rolling stock consists of 92 cars, of which 82 are motor cars, 10 being summer cars without motors.

For the steam railway there are five locomotives, nine passenger cars, and three open freight cars.

The working pressure on the line is 300 volts. The cars are lighted by three incandescent lamps in series.

The operating receipts and expenditures were as follows:

OPERATING RECEIPTS.	
Passenger traffic	\$443,090
Various receipts	27,323
Total	\$470,413

OPERATING EXPENSES.	
General management	\$23,280
Inspection and repair of track	27,330
Managing and commercial service	41,024
Operating and shop service	111,911
Sundry expenses	3,374
Total	212,919

EXTRA EXPENSES.	
Taxes, stamps, etc.	\$47,350
Charged off to depreciation	28,920
Stocks redeemed	8,098
Total expenditure	297,287

Balance	\$173,126
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For the benefit of those who are interested in commercial figures, we give herewith the balance sheet for the year 1893:

BALANCE SHEET.	
Assets.	
Track system, central station and rolling stock	\$1,643,622
New buildings and improvements	458,809
Bonds deposited at the capital (city)	24,456
Extraordinary reserve:	
Real estate	96,992
Stocks	186,187
Bills receivable	207,905
Cash on hand	7,860
Material in stock	24,115
Total	\$2,649,946
Liabilities.	
Capital stock	\$1,928,000
Extraordinary reserve	354,033
Traffic reserve fund	3,352
Tax reserve	1,338
Renewal reserve	53,447
Stock sinking fund	8,098
Bonds	7,690
Bills payable	105,842
Coupons not redeemed	442
Balance of 1892	14,578
Surplus for 1893	173,126
Total	\$2,649,946

After making deductions from the surplus in accordance with the statutes, it was proposed to declare a dividend of 8 per cent. and to carry \$12,315 forward to the new account.

A very brief description of the system may prove of interest in this connection. The conduit is placed under one rail and consists of castings having flanges of 18 centimetres (7 inches), placed 1.2 metres (about four feet), the space between being a conduit of concrete. The oval-shaped conduit has a width of 28 centimetres (11 inches), and a height of 33 centimetres (13 inches). The slot consists of two beam rails having no inside lower flange and fastened to the iron frames by wrought iron angle pieces. The width of the slot is 33 millimetres (one and five-sixteenths inches). The total depth of the foundation below the rail top is 70 centimetres (27 1/2 inches). The conductors, both positive and negative, are made of angle irons, secured by means of insulators fastened to the castings. They are sufficiently high above the floor of the conduit to be protected from the water which may collect. They are, furthermore, under the top of the oval, so that they cannot be touched from the outside. No earth return is used as both leads are insulated. The water which runs into the conduits is collected at the lowest points and passes through settling boxes to the sewers.

The system is run with 300 volts, and all the dynamos lead to common bus wires. The leads are made of lead-covered cables armored with iron bands, and laid directly in the earth: these lead to junction boxes from which others run along the road and are connected at intervals by means of short branch conduits to iron leads in the conduits.

The first portion of the road—about one and a half miles—was opened July 30, 1889, and has therefore been in operation nearly five years.

Practical Notes on Dynamo Calculation.—V.

BY ALFRED E. WIENER.

13.—Total Length of Armature Conductor.

The amount of inactive, or "dead," wire required to join the active portions of the armature conductors into continuous turns depends upon the shape of the armature, the height of the winding space, and the manner of winding. In an armature, for instance, having a core section of great length parallel to the pole faces, and but a small thickness perpendicular to the same, this useless addition to the generating wire will be comparatively small, while in short armatures with great core depth the proportion of the dead to the active length will be considerably greater. Furthermore, if two armatures of same length, same core diameter, and same radial depth have equal lengths of active conductor, but are wound with different heights of the winding space—as will be the case if the one has a smooth core with winding covering the entire circumference and the other a toothed body—then the external diameters, and consequently the lengths necessary to join the active conductors, are greater in the latter case, and therefore it is evident that the armature with the higher winding space requires a greater total length of armature conductor. If, finally, two otherwise entirely equivalent armatures are wound by different systems, a considerable difference may be found in the total lengths of wire required to produce equal lengths of active conductor.

a.—Drum Armatures.

The *active* length of the armature conductor being known, the simplest method of expressing its *total* length, for a drum armature, is

$$L_t = k_3 \times L_a, \quad (19)$$

where L_t = total length of armature conductor, in feet (parallel wires considered as one conductor);

L_a = active length of armature conductor, in feet, from formula (3);

k_3 = constant, depending upon shape of armature and system of winding. See Table XIX.

The ratio, k_3 , of the total to the active length of the armature conductor, in a drum armature, depends chiefly upon the ratio of length to diameter of the armature core. In modern machines the lengths of drum armatures usually vary between one and two diameters; in special designs, however, a value as low as 0.75 or as high as 2.5 may be taken for this ratio. The following table gives average values of the constant k_3 for various shape-ratios, for smooth as well as for toothed drum armatures:

TABLE XIX.—RATIO BETWEEN TOTAL AND ACTIVE LENGTH OF WIRE ON DRUM ARMATURES.

Ratio of Length to Diameter of Armature core. $l_a : d_a$	Value of k_3 .	
	Smooth Armature.	Toothed Armature.
0.75	2.50	3.10
0.8	2.45	3.05
0.9	2.40	3.00
1	2.35	2.95
1.1	2.30	2.90
1.2	2.25	2.85
1.3	2.20	2.80
1.4	2.15	2.75
1.5	2.10	2.70
1.6	2.05	2.65
1.7	2	2.60
1.8	1.95	2.55
1.9	1.90	2.50
2	1.85	2.45
2.25	1.75	2.35
2.5	1.70	2.25

Another form often used for expressing the total length of wire on a drum armature is indicated by the formula:

$$L_t = K \times (l_a + k_4 \times d_a) = L_a \times (1 + k_4 \times \frac{d_a}{l_a}); \quad (20)$$

K = total number of conductors all around armature circumference;

k_4 = constant, depending upon system of winding.

This formula (20) has the advantage over (19) that no special table is required for its constant, since for a certain type of armature, and a certain system of winding, k_4 is very nearly constant for all sizes and shapes. The value of k_4 for the smooth drum armatures considered in Table XIX. lies between 1.3 and 1.7, and as an average 1.5 may be taken, thus making the formula for the total length of conductor for smooth drum armatures:

$$L_t = L_a \times (1 + 1.5 \times \frac{d_a}{l_a}). \quad (21)$$

Formula (21), then, means that the additional length of dead wire to every conductor of a smooth drum armature is one and one half times its core diameter, or that the total length of one conductor in a smooth drum is equal to the length of the body plus one and a half times the core diameter. The reason why k_4 , even for the same type and same winding method, has not the same value for all sizes, is that the proportion of the core diameter to the thickness of the armature shaft is very much different for different sizes. In a small drum, for instance, the shaft takes up considerably much more room than in a large one, and therefore the dead lengths are comparatively larger in a small machine. In fact, $k_4 = 1.5$ gives too high values for small ratios of length to diameter, which occur in large drums, while the values found by (21) for large ratios of length to diameter, which are met in small armatures, are below those given in Table XIX.

For $l_a : d_a = 1$, or $d_a : l_a = 1$, for instance, we obtain, by comparison of (19) with (20) and (21):

$$k_3 = \frac{L_t}{L_a} = 1 + k_4 \times \frac{d_a}{l_a} = 1 + 1.5 \times 1 = 2.5,$$

while Table XIX., which is averaged from actual practice, gives $k_3 = 1.35$ for this ratio, to which number would correspond the small value of $k_4 = 1.35$.

On the other hand, if $l_a : d_a = 2$, or $d_a : l_a = 0.5$, we get:

$$k_3 = 1 + 1.5 \times 0.5 = 1.75;$$

the table-value for k_3 is 1.85 for this shape-ratio, and therefore the high value of $k_4 = 1.70$ would answer in this case.

For toothed drum armatures the numerical value of k_4 , in the practical limits of the ratio of shape, lies between 1.9 and 3, the average being about 2.5; hence formula (20) for toothed drum armatures becomes:

$$L_t = L_a \times (1 + 2.5 \times \frac{d_a}{l_a}); \quad (22)$$

that is to say, the average length to be added to each active conductor in a toothed drum armature is two and one-half times the core diameter of the drum, or the average dead length in each turn (consisting of two active conductors) is five times the diameter at the bottom of the slots.

b.—Ring Armatures.

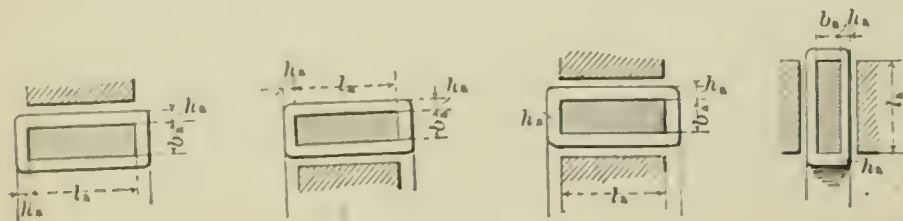
In a Gramme wound ring armature of a core section of given dimensions, the ratio of the total to the active length of the conductor depends upon the arrangement of the field magnet frame. There are, altogether, eight different possibilities of arranging the poles around a ring armature; these eight methods, however, can be classified into but five principally different cases, viz.:

- Case I. Polepieces facing *one* long armature surface, see Figs. 4 and 5;
 " II. " " *two* long armature surfaces, see Figs. 6 and 7;
 " III. " " *one* long and *two* short armature surfaces, see Fig. 8;

Case IV. Polepieces facing *two* long and *one* short armature surface. see Figs. 9 and 10:

" V. " " *one* long, *two* short, and *part* of second long surface, see Fig. 11.

Denoting with l_a the length, and with b_a the breadth of the cross-section, and assuming the winding-height, h_a , to



FIGS. 4, 5, 6 AND 7.

be the same all around the section, we obtain the following formula for calculating the total length of conductor on a ring armature:

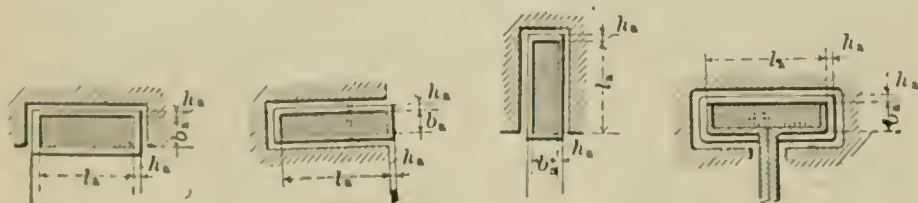
$$\text{Case I.: } L_t = \frac{2 \times (l_a + b_a + h_a)}{l_a} \times L_a \quad (23)$$

$$\text{" II.: } L_t = \frac{l_a + b_a + h_a}{l_a} \times L_a \quad (24)$$

$$\text{" III.: } L_t = \frac{2 \times (l_a + b_a + h_a)}{l_a + 2b_a + h_a} \times L_a \quad (25)$$

$$\text{" IV.: } L_t = \frac{2 \times (l_a + b_a + h_a)}{2l_a + b_a + h_a} \times L_a \quad (26)$$

In these formulæ l , b_a and L_a are known by virtue of equations (12), (18) and (3), respectively, and h_a can be



FIGS. 8, 9, 10 AND 11.

taken from Table XV., if the actual winding depth is not already known by having previously determined the winding and its arrangement.

A formula for Case V. is not given, because, in the first place, the arrangement shown in Fig. 11 is not at all practical, and the makers who first introduced the same have long since discarded it, and, second, because the distance of the internal pole projecting depends upon the construction and manner of supporting of the armature core, and, consequently, cannot be definitely expressed.

c.—Drum Wound Ring Armatures.

In modern ring armatures of the types indicated by Figs. 4 and 5, the conductors facing two adjacent poles of opposite

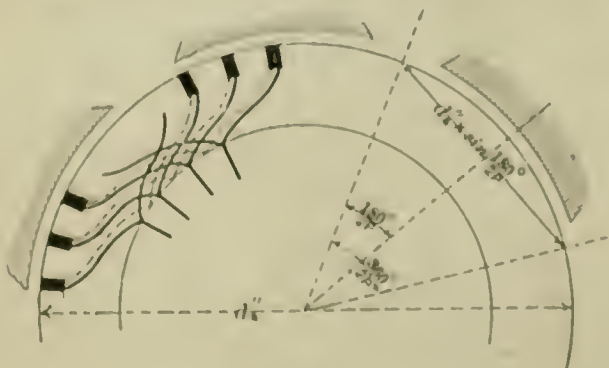


FIG. 12.

polarity are often connected in the fashion of a bipolar drum, by completing their turns across the end surfaces of the armature body, thus converting the multipolar ring armature into the combination of as many bipolar drum armatures as there are pairs of poles in the field frame; see Chapter 25. By this arrangement, which is illustrated in Fig. 12, not only a considerable saving of dead wire is experienced, but also the exchanging of conductors in case of repair is rendered much

more convenient, especially when in bending of the connection strips the Eickemeyer method is applied.

The total length of the armature conductor can, in this case, be calculated by applying, for both smooth and toothed bodies, the above formula (21), replacing in the same the core diameter, d_a , by the chordal distance of two neighboring poles, measured from centre to centre along the circumference of the armature over the winding. The formula for the total length of conductor on a drum wound ring armature, therefore, is (see Fig. 12):

$$L_t = \left(1 + 1.5 \times \frac{d_a'' \sin \frac{180^\circ}{2P}}{l_a} \right) \times L_a \quad (27)$$

Inserting in this formula the numerical value for the size of half the pole angle, we obtain the following set of formulæ for the various pole numbers that may be used in practice.

TABLE XX.—TOTAL LENGTH OF CONDUCTOR ON DRUM WOUND RING ARMATURES.

Number of Poles, $2P$.	Half Pole-angle, $\frac{180^\circ}{2P}$.	Length of Pole-chord (Diameter=1) $\frac{\sin \frac{180^\circ}{2P}}{\sin \frac{180^\circ}{2P}}$.	Total Length of Armature Conductor (Formula 27) $L_t = \left(1 + 1.5 \times \frac{d_a'' \sin \frac{180^\circ}{2P}}{l_a} \right) \times L_a$
4	45°	0.707	$L_t = \left(1 + 1.061 \times \frac{d_a''}{l_a} \right) \times L_a$
6	30°	0.500	$L_t = \left(1 + 0.750 \times \frac{d_a''}{l_a} \right) \times L_a$
8	22½°	0.383	$L_t = \left(1 + 0.574 \times \frac{d_a''}{l_a} \right) \times L_a$
10	18°	0.309	$L_t = \left(1 + 0.464 \times \frac{d_a''}{l_a} \right) \times L_a$
12	15°	0.259	$L_t = \left(1 + 0.388 \times \frac{d_a''}{l_a} \right) \times L_a$
14	12½°	0.222	$L_t = \left(1 + 0.333 \times \frac{d_a''}{l_a} \right) \times L_a$
16	11¼°	0.195	$L_t = \left(1 + 0.293 \times \frac{d_a''}{l_a} \right) \times L_a$
18	10°	0.174	$L_t = \left(1 + 0.261 \times \frac{d_a''}{l_a} \right) \times L_a$
20	9°	0.156	$L_t = \left(1 + 0.235 \times \frac{d_a''}{l_a} \right) \times L_a$
24	7½°	0.131	$L_t = \left(1 + 0.196 \times \frac{d_a''}{l_a} \right) \times L_a$
30	6°	0.105	$L_t = \left(1 + 0.157 \times \frac{d_a''}{l_a} \right) \times L_a$

(To be continued.)

On the Measurement of the Power of Polyphased Currents—II.*

BY ALEXANDER D. LUNT.

Whatever be the number of conducting wires feeding current to the "mesh," whatever the cross connections between the terminals of those conducting wires, and whatever be the directions of the currents therein, it may likewise be shown that for any given distribution the algebraic sum of the line wire currents is always zero, supposing, of course, that the system is insulated. Each separate current in the "mesh" enters into the equations twice and then with opposite signs. The currents in the line wires, however, appear only once, and hence their algebraic sum is at once shown to be zero by the simple addition of the several equations.

As a matter of fact, the same law of continuity, followed by an incompressible fluid in a system of pipes, is followed by electricity in a system of conductors. Thus, an electric current cannot enter a given space without an equal amount flowing out. And the slightest consideration will show that the same is true whether there be capacity or self-induction in the system.

That the impressed E. M. F's. may not be zero at any instant is not at all inconsistent with the fact that the line wire currents are algebraically zero at any instant. It is scarcely necessary to add that inequality of the phase angles between and the presence of higher harmonics in the E. M. F. curves only tend toward a reduction of efficiency, and in no way affect the validity of the principle of continuity.

Consider for the moment the meaning of the term potential. Broadly speaking, potential is the capacity of a body for doing work, and is in general a function of the position of the body. If the so-called body be a charge of electricity,

* In Fig. 2 in the section of this article published last week the letters a and b were inadvertently transposed, thus rendering the equation immediately following meaningless. Also the word "not" was omitted after "has" in the first line of the third paragraph of the article.

then its potential is measured by the work required to be done in moving it from a point where its stored-up energy is zero to any given point where the body may be placed. We might consider this transfer of the charge to take place along a conductor. If we imagine a continual succession of such charges being transferred in this manner, we then have an electric current, and the total work done in one second in supplying current at the given potential is represented by the product of the number of unit charges supplied in one second by the given potential.

Thus if q be the quantity of electricity supplied in the time dt and at a potential v , then the product of these two quantities represents the work done or the energy stored up in the time dt , or in other words, $p = qv =$ the potential energy developed in the time dt .

Since a given quantity of electricity conveyed in one second represents a certain current, then the rate of doing work, or, in other words, the power of a current at a potential v is $\rho = iv$.

Consider any system or network of conductors to which current is supplied from any number of terminals whose potentials are p_1, p_2, p_3 , etc. Owing to the differences of potential between the terminals current enters at some and leaves at others. Thus suppose a current i_1 is supplied at one terminal, i_2 at another, etc., then at any instant $\sum i = 0$ from the principle of continuity. If the current i_1 be supplied at a potential p_1 , the current i_2 at a potential p_2 , etc., then the total rate of supply of energy to the network is $\sum ip$. Since currents enter at some terminals and leave at others, all in general being at different potentials, it would not be accurate to say that of the total expenditure of energy in the network the current i_1 contributes at the rate $i_1 p_1$, the current i_2 at the rate $i_2 p_2$, etc. This would be true only if i_1, i_2 , etc., left the network at zero potentials.

For illustration, take a simple case where the network is supplied with current from two terminals. The network may have any form whatever. The current i_1 is supplied at one of the terminals at a potential p_1 , the current i_2 is supplied at the other terminal at a potential p_2 . The rate of supply of energy to the system is then $\sum ip$, or,

$i_1 p_1 + i_2 p_2 = i_1 (p_1 - p_2)$ [since $i_1 + i_2 = 0$] $= i_1 E$, which is the familiar expression for the energy of a linear current. It is evident that the energy supplied at either terminal is not the product of the potential of the terminal by the current supplied at that terminal. The several products represent the potential energies of the several currents, and it is the algebraic sum of these products which gives the energy expended in the network. The separate products, taken by themselves, are indeterminate. In fact, the expression for the energy expended in the network is in some respects analogous to the definite integral of the calculus.

The same reasoning applies whatever be the number of terminals. If the E. M. F. applied at the terminals be alternating or variable, then at any instant the power expended in the network is

$$\rho = \sum iv,$$

where i and v are the instantaneous values of current and potential.

If the network or system of conductors be supplied with current by means of, say, three terminals, then the conditions of either a two or a three phase alternating system are satisfied. The power being expended at any instant in such a system will then be

$$\rho = A\alpha + B\beta + C\gamma, \quad (1)$$

where A, B and C are the currents supplied at terminals whose respective potentials are α, β and γ , as represented in figures (1) and (2).

As previously shown,

$$A + B + C = 0, \quad (2)$$

whence from (1) and (2),

$$\rho = A\alpha + B\beta - (A + B)\gamma,$$

rearranging,

$$\rho = A(\alpha - \gamma) + B(\beta - \gamma). \quad (3)$$

And in the same manner,

$$\rho = B(\beta - \alpha) + C(\gamma - \alpha), \quad (4)$$

$$\rho = C(\gamma - \beta) + A(\alpha - \beta). \quad (5)$$

These three alternative expressions may be collectively represented by

$$\rho = \sum i(v - v_0);$$

and hence the mean power of a polyphased system may be represented by

$$\sum \frac{1}{T} \int_0^T i(v - v_0) dt,$$

where v_0 is the potential of some one selected terminal with which the potentials of the other terminals are compared, and i and v the respective currents and potentials at each of these other terminals.

(To be continued.)

An Optical Phase Indicator and Synchronizer.*

BY GEORGE S. MOLER AND FREDERICK BEDELL.

In starting a synchronous alternating current motor it is usual to bring the motor up to speed by some external means and to switch it into connection with the generator when the motor and generator are running synchronously, but are in opposite phase. Various devices have been employed to indicate synchronism and to show when the motor is in opposite phase to the generator, one of the simplest of these devices consisting of an incandescent lamp used as a pilot lamp. The lamp is connected directly in the circuit supplying the motor, so that all the current through the motor armature passes through it. Before the motor is started the lamp glows steadily. As the motor attains considerable speed, the lamp suddenly flashes up and dies out alternately, according to whether the electromotive force generated by the motor and the electromotive force from the alternator are in the same or in opposite phases. Beats are thus produced which occur at longer intervals as the motor approaches synchronism with the alternator. When the intervals are long enough to be quite marked, the motor is connected directly to the generator circuit by cutting the lamp out at a moment when it is dark, indicating that the machines are in opposite phase. At the same time the external power, which has driven the motor to synchronism, is removed. Instead of one lamp, several lamps or a lamp together with dead resistance may be used where required.

This device is simple and efficient. It does not, however, indicate the moment when exact synchronism is reached, nor does it show whether the motor is running at a greater or less speed than that corresponding to the generator. It does not show the exact phase difference between the motor and generator, and does not indicate the phase relations after the motor has been connected to the alternator and is being driven by it.

The following instrument has been devised by the writers to give definite information in regard to the relative speeds and phase positions of the motor and generator in laboratory investigation. It shows

(1) When the machines are synchronous;

(2) Which machine is running the faster when they are not synchronous;

* Presented at the Philadelphia meeting of the American Institute of Electrical Engineers, May 17, 1894.

(3) The angle by which the motor lags behind the generator.

We will first describe the simplest form of the phase indicator. The motor and generator are placed together with shafts in line and abutting, but not quite touching. The two machines must have the same number of poles, so that a revolution of the armature of each represents the same number of alternations. The abutting ends of the shafts carry two discs, one connected rigidly with the motor armature, the other similarly connected with the armature of the generator, as shown in Fig. 1. In these discs are curved slits, one slit for each pair of poles of the machines. These slits are shown in Fig. 2 for an eight-pole machine. The two discs are in every way similar, the one being the reverse of the other. The two discs are practically superimposed and together form one disc with four holes, where the slits of one disc cross over the slits of the other. Evidently the distances of these four holes from the centre depend upon the relative positions of the two armatures; they move in and out as the armatures shift their relative positions. From the symmetrical arrangement of the slits, if one armature is stationary and the other is moved past two pole pieces or through 90 degrees of arc (corresponding to a complete period of alternation, or 360 degrees of phase), the intersection of the slits will be the same distance from the centre as before. The curvature of the slits is such that the distance to or from the centre that the intersections of the two sets of slits move is proportional to the change in relative position of the two armatures.

When the two armatures are running at the same speed in the same direction and there is a source of light on one side of the discs, the intersection of the slits, as seen from the other side, appears as a continuous ring of light. A slight difference of speed causes this ring of light to move outward or inward, according to which disc is revolving the faster. The more rapidly the ring moves in or out, the greater the difference in speed of the two discs. If the ring is moving out, a new ring starts at the centre when one ring reaches the edges, and these rings keep following one



FIGS. 1 AND 3.

another outward. If the difference in speed is the other way, the successive rings move inward.

In Fig. 3 the heavy dotted line represents the ring of light for a particular position of the two discs.

The position of the ring of light indicates the relative position of the two armatures. The discs may be secured to the shafts, so that when the armatures are in the same positions with reference to the pole pieces (i. e., the machines are in the same phase), the ring of light will be at the inner or outer ends of the slits. The concentric rings in Fig. 3 represent the phase differences corresponding to positions of the ring of light in this case.

For convenience in operation, the arrangement of the apparatus, which has thus far proved satisfactory, has been as follows: On one side of the pair of discs is placed an incandescent lamp enclosed in a box. One side of the box

is close to the discs and has a slit in it about half an inch wide, extending from the shaft to the circumference of the disc. This slit is covered with a piece of oiled paper, so as to give a diffused light upon the discs. A complete ring of light is no longer seen from the other side, but only a small portion, corresponding to the width of the half inch slit. A stationary scale is fixed so as to extend from the shaft to the edge of the discs on the opposite side from the lamps, so that the distance of the changing line of light from

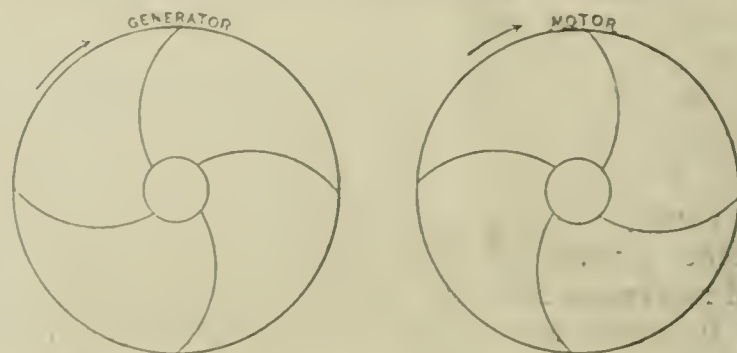


FIG. 2.

the centre may be read so as to give the phase difference of the two machines by direct reading. To enable one to see the scale and line of light most conveniently, a mirror is arranged at 45 degrees with the discs, so that the line of sight is at right angles to the shaft.

The discs may be arranged in the manner just described upon the abutting ends of the motor and generator shafts only in case the two machines have the same number of poles. Where such is not the case, one or both of the discs can be driven by gears, which will give the proper relative speeds of the two discs.

In operation, the instrument has proved quite satisfactory, giving exact and definite information concerning the changes in the armature lag of the motor. The fluctuations in this lag are usually quite marked, and the conditions which cause them can be readily investigated by this apparatus. For instance, this fluctuation is small with proper field excitation; as the field current of the motor is diminished, this fluctuation increases, the line of light moving rapidly back and forth through a greater and greater distance, which finally becomes so great as the excitation is weakened that it goes a distance beyond which it cannot recover; i. e., the motor gets out of step and stops. It would be possible to make a more detailed investigation of these fluctuations by means of a revolving mirror, and they may be photographed and made of permanent record by means of a moving plate.

The apparatus can be applied to other lines of work involving an investigation of phase differences and synchronism, and may be modified to meet the requirements of the problem in hand; but it is peculiarly suited for use in synchronous motor work, for which it was designed. The scope of the present paper admits only of a general description of the apparatus here given.

Standardizing Electrical Measuring Instruments.

BY ELMER G. WILLYOUNG.

In the introduction to his paper the author briefly traced the history and development of electrical measuring instruments, showing that as electrical machinery was improved the necessity of better measuring devices was recognized, and various styles of instruments were originated and brought to varying degrees of perfection. As at present made, however, all of these various instruments have in them dangerous elements of change, and must be frequently examined and restandardized. Consideration of this fact convinces the author that this restandardizing should be done by the stations themselves, and an arrangement of

* Abstract of a paper presented at the Eleventh General Meeting of the American Institute of Electrical Engineers, at Philadelphia.

apparatus should be devised which would make the utilization of some absolute standard method simple and convenient. The potentiometer method seems to be the only one at all satisfying these requirements.

THE POTENTIOMETER METHOD.

Broadly, the potentiometer method consists in opposing some known proportion of the drop of an unknown E. M. F. through a given resistance to a definitely known E. M. F., the proportion being so chosen that no current is produced by the latter known source. This condition being established, an equation involving the unknown E. M. F. as the only unknown quantity immediately obtains. The method in general is fairly well known, being variously called the standard cell method, the Poggendorf, or Rayleigh-Pog-

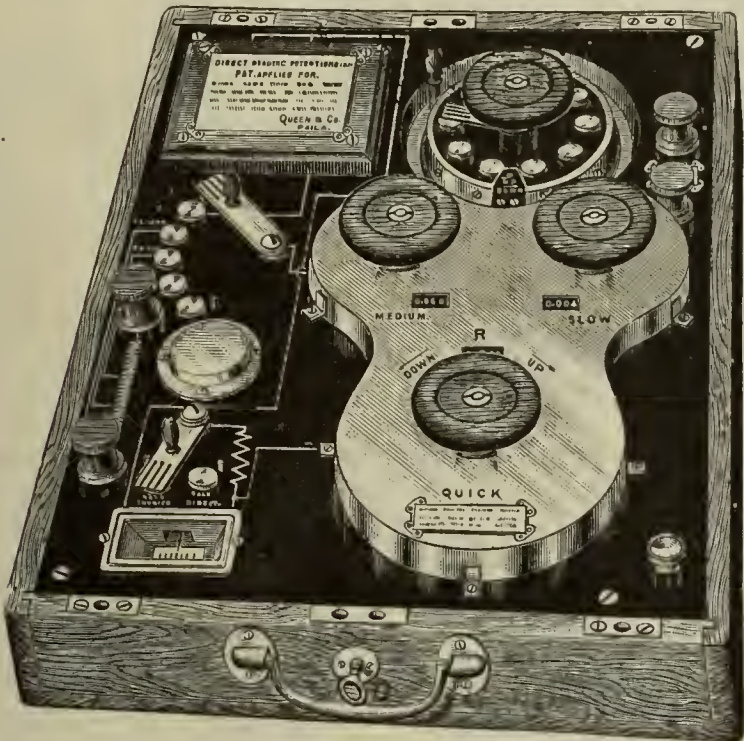


FIG. 1.

gendorf compensation method, the Rayleigh method, etc.; it is not by any means so widely known, however, as it deserves to be.

The advantages of the potentiometer are: (1.) It is a zero method; a calibrated galvanometer, is, therefore, not necessary. (2.) Accuracy depends only upon a standard cell and a standard resistance, and results obtained by the best authorities over a number of years show that both of these may be relied upon within extremely small limits of error, with proper treatment, for a practically indefinite time. (3.) It requires but simple apparatus, always obtainable, and ordinary care. It can be used without inconvenience in re-

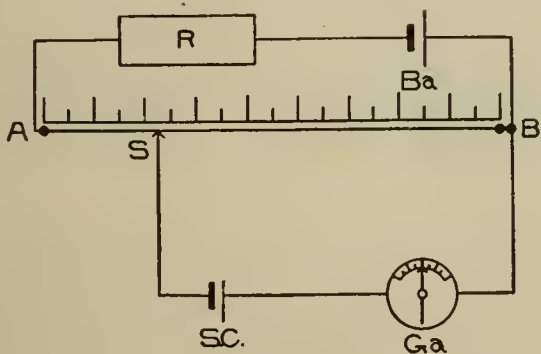


FIG. 2.

gions of great mechanical instability and of intense and variable magnetic fields.

AN IMPROVED DIRECT READING POTENTIOMETER.

This instrument, invented by the writer and illustrated in Fig. 1, is capable of being used for measurements of voltage from 0 up to 1,500 volts and of current from 0 up to any required upper limit with a maximum error of not over 1-10 per cent. It is based upon the form of potentiometer originally suggested by Dr. Fleming, which is shown in

diagram in Fig. 2. Some good suggestions were also obtained from the improved form of Mr. Crompton.*

A diagram of the arrangement of circuits in my improved form of apparatus is shown in Fig. 3. The wire *B* of Fig. 1 is here equivalented by three sets of coils marked respectively *Q*, *M* and *S*. The regulating resistance (*R* of Fig. 2) is made up of two parts, one resistance, *R*₁, consisting of coils, and the other, *R*₂, being made up of a bare wire of resistance equal to one of the coils of *R*₁. This wire is laid back and forth upon about 350 degrees of an ebonite cylinder and has a fixed brush, *P*, so

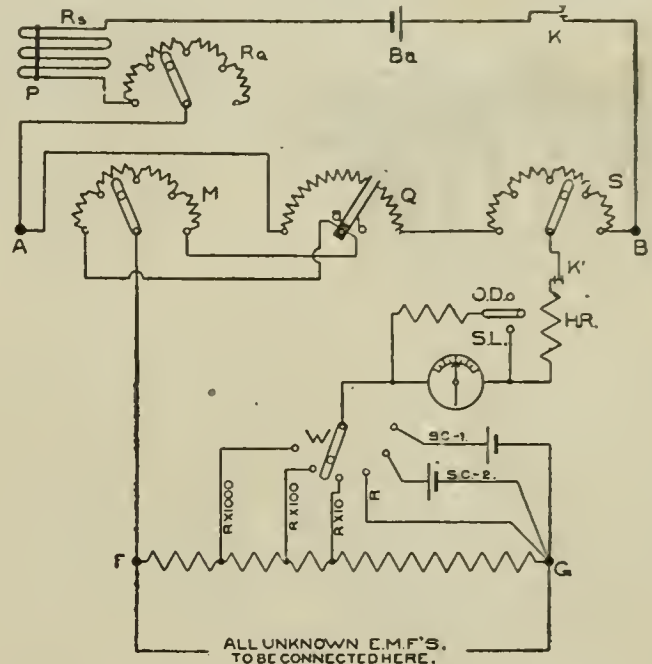


FIG. 3.

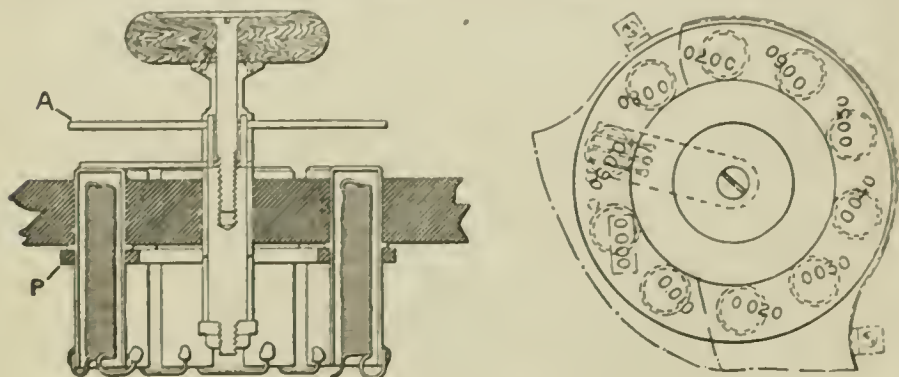
arranged with reference to it that *P* short circuits more or less all of the *v*'s simultaneously, thus giving a large range of variation for a very small angle of rotation. The quick and rough regulation is effected by *R*₁; while the finer adjustment is obtained by *R*₂. The two series of coils, *M* and *S*, have at their centres two switches which are in series with the galvanometer and unknown E. M. F.; moving these switches over the coils is exactly the same as shifting the points *S* and *B* of the derived circuit in Fig. 2. *M* is the medium movement, each coil being 1-140 of the entire resistance between *A* and *B*, while *S* is the very slow movement, each of the nine coils in *S* being equal to 1-10 of the resistance of one of the coils of *M*. In order to get a rate of separation of the two derived circuit terminals by steps of 10 times the value of a coil of *M*, a third series of resistances, *Q*, is provided. This is a rather peculiarly arranged affair, its function being to take out resistance from between the derived circuit terminals and place it outside, or vice versa, the total resistance between *A* and *B* remaining always constant. The construction of this arrangement is shown in Fig. 5; here merely the diagram of circuits can be depicted. It is evident that this change of resistance from one part of the circuit to the other accomplishes exactly the same result as is obtained by *M* and *S*, viz., the separation or bringing together of the two derived circuit terminals. We have, therefore, the entire resistance, *A*, *B*, divided into 1,500 parts, and the derived circuit terminals separable along this resistance by steps of 100 parts, using *Q*; 10 parts, using *M*; and single parts, using *S*. This means an ability to set to 1 part in 1,500, or to 1-15 per cent.

Some of the details of construction employed in this instrument are, it is believed, sufficiently interesting to be worthy of description. Fig. 4 shows a novel way of econo-

* See "Electrician" (Lond.), May 12, 1893, page 32.

** Instead of this form of regulator I have thought of substituting some form of carbon or graphite resistance, since all that is needed is invariability for a certain period.—E. G. W.

mizing space and material in the construction of the coils and contact points suggested by Mr. H. L. Sayen. The contacts instead of being brass rod or portions of rod, as usual, are tubes having a metal end. Into these tubes the coil, wound on a slim spool as usual, is slipped, one end of the wire being soldered to the open end of the tube. Holes just large enough to receive these tubes are then drilled into the rubber top of the instrument and the tubes slipped up from below with closed ends uppermost until stopped by a



FIGS. 4 AND 6.

flange which has previously been soldered around the tube at about three-fourths of an inch from its end. A rubber plate, *P*, about one-eighth of an inch thick, and also drilled through with holes corresponding to the tubes, is slipped over them from below and screwed fast to the under portion of the top plate. All the tubes are thus firmly clamped in place by means of their flanges. The other ends of each coil are then soldered to the next tube, etc.

Fig. 5 shows the construction of the resistance exchanging arrangement, *M*. There are two concentric circles of segments as pictured, these segments being provided with spring pieces. The coils are joined between diagonal segments. Pivoted at their centre is a switch formed of a circular plate of hard rubber, carrying at its periphery a number of angled brass wedges or knives corresponding to the segments of the coils. Instead of one of these wedges is a pair of contact pieces corresponding to *a* and *b*, of Fig. 3, and joined to the rest of the circuit as shown in that figure; each piece of this pair makes contact with but one segment. It is obvious, therefore, that as the switch rotates the series is always broken between *a* and *b*, while the continuity of all the rest of the series is maintained by the wedges which pass between the segments and keep them metallically joined.

In order to get at the standard cells in case either or both of them should show any signs of giving out, all that is necessary is to remove the four screws in the raised block seen in the upper left-hand corner of Fig. 1. This will expose the binding posts to which the cell terminals are joined, the cells themselves being contained in two brass tubes passing down through the top. The binding screws are loosened and the cell or cells drawn out, when they can be shipped back to the maker for exchange.

This form of potentiometer is practically direct reading, the required values of E. M. F. being numerically set down upon the face of the instrument when balance is attained. The manner in which this is effected is very readily seen from inspection of Fig. 6, which shows a composite view of one of the switch devices *M* or *S*. Fixed to the switch handle so as to rotate with it and above the contact and contactor itself is a disc, *A*, of Fig. 4, of hard rubber; this has engraved upon its upper surface a series of numbers corresponding to the coils of the series, and differing in value by an amount equal to the value of the resistance of each coil in terms of the whole resistance between *A* and *B*. Thus, the disc of *Q* having 14 resistances, each 1-14 of the whole resistance is engraved with the series of numbers 0.100, 0.200, 0.300, etc., up through 1.400. *S*, on the other hand, is engraved 0.001, 0.002, 0.003, etc., through 0.009. *M* in the same way, has its

disc, which is engraved 0.010, 0.020, 0.030, etc. In the instrument these three switch devices are grouped together, as shown in the general view, Fig. 1. A raised metal box, in shape something like a three-leaf clover, covers their operative portions. In each box there is cut a rectangular hole just large enough to expose a single one of the numbers engraved upon the rubber disc below. These numbers are so placed upon the disc that the one visible indicates the number of parts of the whole resistance, which, by virtue of the position of its switch, are placed between the points of the derived circuit. The sum of the three numbers displayed is, therefore, the total number of parts of the whole placed between the derived circuit terminals by virtue of the position of all the switches, the number of tenths being taken from one, of hundredths from another, and of thousandths from the third.

The value of this instrument as a convenient and quick way of obtaining absolutely reliable determinations of current and E. M. F. is, we believe, very great. There are scores of engineers, laboratories and stations who constantly find it necessary to secure a standardization of their ammeters or voltmeters. To make a voltmeter determination takes a great deal of time, even if but one value is to be gotten, and an amount of skill and painstaking not always immediately available. The absolutely steady current, suitable solution, chemical balance, etc., are also adjuncts not always at hand. To keep any form of standard instrument about for purposes of comparison is usually not feasible. If the instrument has springs the springs may change. If permanent magnets they are almost bound to change. Other forms of apparatus more free from variable elements, as e. g., tangent galvanometers, are easily affected by strong fields and mechanical disturbances and require either to be always kept set up absolutely undisturbed or else to have considerable time spent upon them each time before using, in order to adjust them into good condition. In the potentiometer there are practi-

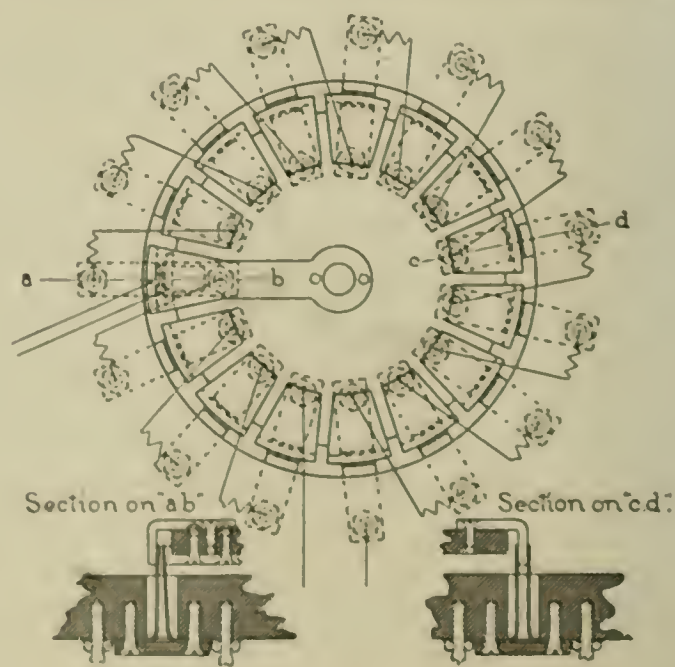


FIG. 5.

cally no variable elements, at least within limits practically infinitesimal in practical measurements. Dependence is placed solely and entirely upon standard resistances and standard cells, both of which have been thoroughly investigated by many workers and the variations of which are well understood. The apparatus is simple and compact and its mode of use can be successfully learned by a schoolboy in a few moments.* Being a zero method it is absolutely unaffected by neighboring currents or magnetic fields and the galvanometer being a dead beat and jewel suspended D'Arsonval, may be used under the most severe conditions of mechanical shock and vibration. On board ship it is believed absolutely the only apparatus which could possibly be used.

* The dimensions over all are 11 inches by 14 inches by 5 inches deep; weight less than 10 pounds.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

COMPILED FROM
PRINCIPAL FOREIGN
ELEC. WORLD, N.Y.

ELECTRICAL JOURNALS
BY CARL HEDING

ELECTRO-PHYSICS.

Velocity of Propagation.—An Academy paper by Mr. Dufour is abstracted at some length in "L'Ind. Elec.," May 25; the object is to find whether the equality in the velocity of propagation of very short electric waves in space and along conductors exists for waves which are shorter than 30 cm., which is the shortest with which Hertz experimented; it is shown that the law is true to lengths as short as 8.5 cm.

Propagation of Electricity Along Lengthy Conductors.—The Lond. "Elec. Rev.," May 25, gives a brief synopsis of a recent paper by Prof. Potier from the "Jour. Phys. Theor. et Appliquee," 3, page 107, in which he discusses the relative truthfulness of the two theories which are held, without, however, deciding in favor of either.

Magnetic Deflection of Cathode Rays.—The translation of an article by Mr. Lenard from the "Wied. Ann.," 52, No. 5, page 23, is given, together with a number of illustrations in the Lond. "Elec.," May 25.

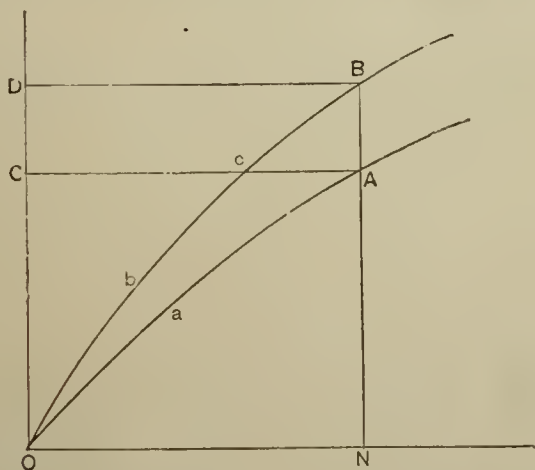
Ether.—In "La Lum. Elec.," May 26, Mr. Blondin gives at some length a resume of the (British) Royal Society paper by Mr. Larmor, published in the "Proceedings" of that Society, volume LIV., page 438.

Optical Wave Surfaces.—A Royal Society paper by Mr. Heaviside "On the Transformation of Optical Wave Surfaces by Homogeneous Strain" is abstracted briefly in the Lond. "Elec.," May 25.

Physical Science.—In the leading editorial in the Lond. "Elec. Rev.," May 25, attention is called to the wise and careful use of the imagination in experimental investigation in physics.

MAGNETISM.

Force Exerted by an Electro-Magnet.—In a brief paper by Mr. John Hopkinson, published in the Lond. "Elec.," May 25, he discusses the subject in the following way: Referring



FORCE EXERTED BY ELECTROMAGNET.

to the adjoining figure, in which OA is the curve in which the ordinates are induction and the abscissae magnetizing forces, the work done in magnetizing the field of the magnet

is the area, $OaAc$, divided by 4π if OA represents this curve when the armature is in one position and OB that after the armature is moved to a closer position, then he shows that the net work done by the current is represented by the area $OaABbO$, divided by 4π , and this is equal to the mechanical work done upon the armature in moving it from one position to the other, the current in the magnet being constant; by noting the distance of the movement of the armature the (average) force can readily be calculated; when the distance between A and B is small the area ABc is small and of the second order, and the work done is then equal to $OaAcB$. He then develops the formula in which the force is equal to the area multiplied by the square of the intensity of induction and divided by 8π , when the lines of force are parallel and the displacement of the armature is small and parallel with the lines of force; the work done is the force multiplied by the displacement. In the case in which the induction is proportional to the magnetizing force, as where there is a coefficient of self-induction, the mechanical work done is equal to one-half the square of the current $\times$ coefficient of self-induction $\times$ displacement; the work done by the current is twice this amount, one-half of it goes to work on the armature and the other to increasing the moment of the magnet; if the inductions and currents are in absolute units the work and the force will be measured in ergs and dynes respectively. (The paper is written in such an abbreviated form that the meanings of the terms are not clearly described; one letter seems to be used for different purposes and there is a misleading typographical error.)

Magnetization at High Frequencies.—A paper by Prof. Klemencic read at the Vienna Academy of Sciences is abstracted briefly in the Lond. "Elec.," May 25; the results show that over the range which he used the permeability had a constant value; that it was not due to the magnetizing forces being small was shown by the fact that at least on the surface of the wire and at the commencement of the oscillations, the magnetizing force exceeded more than one hundredfold the maximum limit within which the permeability is constant; in these experiments there must exist a time lag in the magnetization which should not be confused with the hysteresis.

Hysteresis and Permanent Deformations.—An Academy paper of a mathematical character by Mr. Duhem is briefly abstracted in "L'Ind. Elec.," May 25.

Magnetization by Hertzian Currents.—A paper by Mr. Birkeland is abstracted in "L'Ind. Elec.," May 25.

Resistance of Pure Water.—An article of some length by Profs. Kohlrausch and Heydweiller is published in full in the "Elek. Echo," May 10. They describe in detail the method of producing pure water, the measurements, the properties, a theoretical discussion of the calculation of the conductivity and a comparison of the calculated and the ob-

served results, given in a table for different temperatures and showing close agreement. The conductivity at 0 degree C. of the purest water that it was possible to produce was 0.014×10^{-10} ; one millimetre of this water at this temperature has a resistance equal to a copper wire of the same cross-section extending 1,000 times around the earth. The action of the air on the conductivity of the water is surprisingly great; the conductivity increases to over five times the amount when the water is exposed to the air for five hours; the conductivity increases when the current passes through the water; the increase may be as much at 100 per cent., but it falls again and the increase seems to disappear in several hours. The temperature coefficient is great and becomes greater the purer the water and the conductivity increases rapidly with the temperature, in which case it differs from the other conductors.

Resistance Alloys.—A Physical Society paper by Mr. Van Aubel is abstracted briefly in "L'Ind. Elec.," May 25; he calls attention to some patented alloys (possibly of nickel) made in Germany, which have a very high electrical resistance and a small temperature coefficient; the figures for the best one are a resistivity in microhms centimetre of 50.2 and 47.1 for hard and soft wires and temperature coefficients respectively of -0.000011 and $+0.000005$. Mr. Guillaume called attention to an alloy of 68.6 Cu, 30. Mn and 1.3 Fe, which had the greatest resistivity which he could obtain, it being 108 microhms centimetre; it has the advantage of having a very small temperature coefficient which changes signs.

Testing for Grounds.—In a communication to the Lond. "Elec. Rev.," May 25, Mr. Wilson mentions the method used by the Glasgow Corporation, which requires absolutely no disconnections in a complete network of wires; "the direction of the current due to putting on an earth resistance as described" (no description, however, is given) "is noted by laying a pocket compass on the conductor and bringing the needle parallel with it by means of a strong bar magnet before making the earth seeking current"; two men in 1-2 to 1 1-2 hours can trace a ground without lifting more than six or eight junction box lids; he states that the method has been fully described. A ground in a series arc light circuit may be found by first taking the difference of potential between one end of the circuit and the earth, thus locating the fault between two lamps; it may be then located by means of a sensitive portable galvanometer at that part of the line; "a resistance is put in circuit, such that the difference of potential across it is the same as the drop on 100 feet of line. The ratio of the galvanometer deflection, across the resistance, and from line to earth, gives at once the fraction of 100 feet that the fault is distant."

Frequency and Periodicity.—In an editorial in the Lond. "Elec. Rev.," May 25, these two terms are discussed, and it is claimed that the word frequency is applied to the number of single waves or half cycles, and can therefore be applied to the pulsations of a rectified alternating current, while the word periodicity applies to the number of double waves, and that therefore the periodicity is equal to half the frequency; it is stated that these words were taken from the science of the pendulum, in which they are used with these meanings; as both words are not necessary, it is suggested that frequency could be used, as it applies to both alternating and pulsating currents. (It appears that this definition of frequency is different from the universally accepted one; frequency and periodicity are generally used synonymously, both applying to the number of complete waves per second.)

Substitute for Selenium Cells.—In the Lond. "Elec. Rev.," May 25, Mr. Viles suggests as a substitute, a delicate microphone made of two carbon filaments, one resting lightly on the other; a thin magnetic plate, blackened on one side, like the veins of a Crookes radiometer, is attached to the upper

filament, and the whole is enclosed in a high vacuum; when light falls on the blackened surface a pressure is caused, which alters the resistance of the circuit; he suggests that it might be used for relays or possibly as a photometer or thermostat.

Standard of Light.—"L'Ind. Elec.," May 25, contains a list of errors, some of which are important, in the original article, of which an abstract was given June 9.

Measuring the Resistance of Electrolytes.—A paper by Mr. McKittrick, from the "Transactions of the Nova Scotian Institute of Sciences," is reprinted in the Lond. "Elec. Eng.," May 25.

Modified Lippmann Electrometer.—The modification mentioned in the Digest May 12 is described and illustrated in "L'Ind. Elec.," May 25.

DYNAMOS AND MOTORS.

Alternating Current Motors.—The translation of the first part of a paper by Prof. Ferraris on "A Method for the Treatment of Rotating or Alternating Vectors, with an Application to Alternate Current Motors," is given in the Lond. "Elec.," May 25, and is highly recommended in an editorial; it relates to a method of treating, by graphical calculations, the quantities occurring in the problems of the rotary magnetic fields; the present portion is of a theoretical character. It consists of a simple and obvious method which may assist in the interpretation and in the elementary explanation of many phenomena; its application is shown in the magnetic field, and by means of it he explains, in another article published in the same journal, an elementary theory of the principles of synchronous alternating current electric motors.

TRANSFORMERS.

Polymorphique Generators and Transformers.—In a well written article by Mr. Hospitalier, published in "L'Ind. Elec.," May 25, he gives a very good classification of generators and transformers, including a brief description of each of the numerous different kinds, and a mention of those in use; the descriptions are devoted exclusively to the polymorphique generators and transformers; by polymorphique generators he means those which can generate successively or simultaneously electrical energy in various forms, and by polymorphique transformers those which receive the energy in one form and convert it into one or several different forms; the usual dynamos and transformers he designated as monomorphique. The classification is complete and includes a description of the transformation of continuous, simple alternating, diphasic and triphasic currents, each into each of the others. The only new system mentioned is one which has been proposed by Prof. Potier for transforming simple alternating currents into triphasic currents, which is briefly as follows: Conceive a simple alternating current motor with closed circuited armature revolving at its normal velocity; the armature develops in the inducing part a field which turns with the same frequency; if the inducing part is provided with a second winding, distributed regularly over the whole periphery, and if three connections be made 120 degrees apart, triphasic currents may be led off, thus furnishing a transformation of simple alternating into triphasic currents; the same method may be used for transforming a simple alternating current into a diphasic current by a mere change in the connections of the wires.

ARC AND INCANDESCENT LIGHTS.

Blackening of Lamps.—In referring to Prof. Anthony's recent Institute paper, Prof. Fleming, in the Lond. "Elec. Rev.," May 25, states that in 1885 he published the conditions under which the deposit is apparently due to a general evaporation, and where it is due to a projection causing a shadow; out of 100 lamps which were blackened, not 5 per cent. showed the shadow; he claims to have shown conclusively that the shadows are either produced by a very

high temperature at one spot or by a localized high temperature in the filament.

Price of Incandescent Lamps.—"L'Ind. Elec.," May 26, calls attention to the fact that at a recent meeting of lamp manufacturers (presumably German and Austrian) it was decided to adopt a minimum price of 18.8 cents for lamps up to 120 volts and 32 candles in lots of at least 50; for central stations the minimum price is 16.2 cents; it is stated that another meeting will be held in June in which English and French manufacturers are expected to take part.

Watertight Protecting Globe.—A simple device made in Germany is described and well illustrated in the "Elek. Anz.," May 17.

Lamp Base.—A base for lamps with several filaments is described and well illustrated in the "Elek. Anz.," May 13.

TRANSMISSION OF POWER.

Power Transmission in India.—The report of the committee to consider the question of the available power in the Periyar irrigation works in Southern India is published in the Lond. "Elec.," May 25; the fall of the water is 1,200 feet, which will yield 60,000 effective h. p.; it is recommended to divide it into two parts of 500 feet each on account of the great fall and to transmit the power electrically to a distance of from 80 to 350 miles, the greater part being to the town of Madras at the latter distance. Some figures are given regarding the hydraulic machinery, the cost of power, etc. Prof. Forbes made the report on the electrical part of the problem; he prefers the two-phase system, saying that the three-phase system is unsuitable; he prefers a frequency of 10 for motive power purposes, but as a large amount of current is to be used for lighting he has decided on a frequency of 50 periods, although the efficiency of the motors at that frequency may only amount to 85 per cent.; he recommends 5,000-h. p. dynamos as units, having vertical shafts and generating from 30,000 to 40,000 volts, directly; the cost of the dynamos is given as not over \$30,000; he states that an alternate current dynamo can be obtained about 40 per cent. cheaper than a direct current machine, when dealing with large amounts of power. The cost of transformers of 1,000 h. p. or over may be taken as not over \$5 per horse power, and they would probably not cost more than half this amount; one overhead line (circuit?) is to be used for each unit, and the poles are to be A-shaped; different figures are given for the cost of the line at different current densities; for 400 amperes per square inch, the total cost of the principal parts of the electrical plant are as follows: Copper, for the line, \$125; poles and insulators, \$31.50; dynamos for 1.46-h. p., \$8.75; transformers for 1 h. p., \$5, or a total of about \$170 per horse power delivered; the annual charge may be taken as \$9.50.

High Tension Continuous Current Transmission.—A translation of the article by Mr. Schultz, abstracted in the Digest June 9, is given in abstract in the Lond. "Elec. Eng.," May 25.

ELECTRIC RAILWAYS.

Electricity for Heavy Railroad Service.—In the Lond. "Elec. Eng.," May 25, Mr. Lea criticizes the article by Mr. Barnes in the "Railroad Gazette," mentioned in the Digest June 9. He states that Mr. Barnes' figures are not to be considered as representing the utmost or even the average powers of electric working in railway service; the figures 1.8 and 4.2 pounds of coal per horse power hour for good stationary and steam locomotives, respectively, should be stated as referring to the indicated horse power in the cylinders and not to the brake h. p. or the drawbar pull; some reduction ought to have been made in the steam locomotive's efficiency to reduce it to the drawbar pull; he thinks 20 per cent loss for the engine friction, hauling dead weight of engine, etc., is not too much to assume; the percentages of loss which Mr. Barnes gives for an electric line are

higher than is actually shown by daily working; the steam locomotive burns at least five and one-half pounds per horse power hour, reduced to drawbar pull, while for the electric line it is about three pounds, full load being assumed in both cases.

Paris Underground Railway.—According to the Lond. "Elec. Eng.," May 25, a definite decision may shortly be arrived at concerning this road; the railway will run from the extreme western part of Paris to the extreme eastern part and will be carried in an iron tunnel 20 feet in diameter.

Worm Wheel Gearing.—The paper abstracted in the Digest last week is criticised by Mr. Kennedy in the Lond. "Elec. Rev.," May 25; he calls attention to a possible printer's error and to other points which are not clear; as the tests were only for a small horse power he suggests that tests up to 20 h. p. would be of interest, as this gearing falls in efficiency as the load increases.

Self-Propelled Vehicles.—One hundred and two different vehicles will be entered in the competitive tests to be held in Paris on the 19th of July, among which are only three or four in which electricity will be used; most of them are to be run with petroleum, as that is the source of energy which it is easiest to obtain during a voyage; "L'Ind. Elec.," May 25, promises a description of the electrical vehicles.

Steam Tramway.—The Serpolet system of steam generation and utilization for tramway purposes is described and illustrated in "L'Elec.," May 19; the steam is generated by forcing water between two hot plates in the form of a flattened tube.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

London Central Stations.—The leading editorial in the Lond. "Elec.," May 25, is devoted to its annual analysis of the capital and revenue accounts of the stations in London; the tables are quite complete and contain the accounts under a large number of sub-divided headings. No attempt at a comparison is made and the tables do not admit of being abstracted, but the following figures are given in the text: The average capital expended per lamp connected is \$25, the best individual figure being about \$12.50; the aggregate gross income for 1893 amounted to about \$1,425,000, and the total kilowatt hours in the meters amounted to nearly 10,000,000, the increase in both cases being about 25 per cent. over the figures for the previous year; the average market price of a kilowatt hour in London last year was 12.76 cents; the average return per lamp connected was about \$1.85; the total coal bills amounted to about \$274,000, equivalent to about 2.65 cents per kilowatt hour sold or 10 per cent. less than in the previous year; the lowest coal bill per kilowatt hour was that of the Kensington company, and was 1.48 cents, the next being that of the Westminster company at 1.56 cents.

Central Stations in Germany.—The article of Mr. Uppenborn, mentioned in the Digest June 2, is abstracted briefly in the Lond. "Elec. Eng.," May 25.

Destructors.—The report on dust destructors for the electric lighting of the Shoreditch Vestry is given in full in the Lond. "Elec. Rev.," May 25. It is intended to supply steam, not only for the lighting station, but also for baths and wash houses; they estimate that the average daily winter load on the central station may be taken at 100 kw. at the start and considerably less during the summer months, and that the probable annual expenditure in coal for the baths and wash houses would amount to \$2,500; a tabulated estimate of the capital required shows it to be \$87,500 and the annual saving in adopting the dust destructors instead of using coal is given as \$21,650; the proposed plant includes the Halpin storage system, in which the steam is stored (as described in the Digest Feb. 11 and 18, 1893).

Cost of Electrical Energy.—A continuation of the discussion of Mr. Crompton's paper is given in the Lond. "Elec. Eng.," May 25.

WIRES, WIRING AND CONDUITS.

Couplings for Underground Wires.—"Ind. and Iron," May 25, contains an illustrated description of a new screw coupling for underground cables used in England; the wires are screwed together and the joint is enclosed in a screw cap.

Lead Covered Cables.—A machine for making the lead covering is illustrated and described in "La Lum. Elec.," May 19.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Loud Speaking Telephone.—The Graham telephone is mentioned again in the Lond. "Elec. Rev.," May 25, in which it is spoken of very highly; the editors have personally inspected and used them and state that no description can possibly do them justice; they say that they are no laboratory instruments, but simple, reliable, practical telephones which any one can use at once; they believe that this telephone will create a sensation and ought to revolutionize the present systems; that it is an enormous advance on anything they have seen, that the articulation is perfect and the loudness wonderful; the talking can be plainly heard all over the room, and no call bell is therefore required.

Leakage in Telegraph Wires.—The Lond. "Elec.," May 25, contains an article by Mr. Fitzgerald, "On the Effect of Leakage on Wave Propagation in Telegraph Wires; or, Mr. Oliver Heaviside's Theory Explained by Analogy." Analogies are made with the propagation of air waves and the action of balls hitting against one another; the article does not admit of being abstracted; it is written in an easily understood style and is of considerable interest; some of the analogies appear to be new.

Type Printers.—A somewhat detailed description, including 15 cuts of the instrument used by the Exchange Telegraph Company, by Mr. Digby Latimer, is reprinted in the Lond. "Elec. Rev.," May 25.

Electric Clocks.—The Schmechlik master clock for electric time transmission, and itself operated electrically, is described and illustrated in the "Elek. Anz.," May 13.

The Cauderay system of clocks, operated electrically by primary batteries, is illustrated and described in "L'Elec.," May 19.

Pacific Cable.—Another letter in reply to the former one is published in the Lond. "Elec. Rev." and "Elec. Eng.," May 25.

ELECTRO-CHEMISTRY.

Alternate Current Electrolysis.—The Lond. "Elec. Rev.," May 25, recommends highly a Royal Society paper, volume LIV., page 407, by Hopkinson, Wilson and Lydall, for those interested in commercial electrolysis; a very brief abstract is given, in which it is stated that 0.00000007 gram of hydrogen is sufficient to polarize 1 square centimetre of platinum.

Chloride Accumulator.—The article by Mr. Andreoli is continued in the Lond. "Elec. Rev.," May 25; he states that it is an undeniable fact that the first chloride of lead accumulator was made twelve years ago by Mr. Maxwell Lyte, who, however, made solid plates and that he, Mr. Andreoli, was the first to combine the chloride of lead with the grid in 1886.

Minimum E. M. F. for Alkaline Solutions.—The Lond. "Elec. Rev.," May 25, recommends a paper by Mr. Nourisson, read at the French Academy of Sciences, in which he establishes and confirms the law that the minimum E. M. F. is constant on the one hand for oxy-salts and on the other for haloids derived from the same acid.

Electrical Dyeing.—Attention is called in the Lond. "Elec. Rev.," May 25, to a paper in the "Chemiker Zeitung," volume XVII., page 1,633, in which a satisfactory method for indigo dyeing is given.

MISCELLANEOUS.

Pumps for Great Pressure.—In "L'Elec.," May 19, a system of centrifugal pumps for great pressures is described

and illustrated; an electric motor is coupled directly to two or more centrifugal pumps, which are connected in series, the water, after having passed through one pump, entering the other and receiving additional pressure; the system is in use in France. An abstract of the article is given briefly in the Lond. "Elec. Eng.," May 25.

World's Fair.—The Lond. "Elec. Rev.," and "Elec. Eng.," May 25, give the portion on electricity from the report of the Royal Commission for the Chicago Exhibition.

Electricity and Some of Its Uses.—A lecture by Sir Frederick Bramwell, of an elementary character, is reprinted, with the illustrations, in the Lond. "Elec. Eng.," May 25.

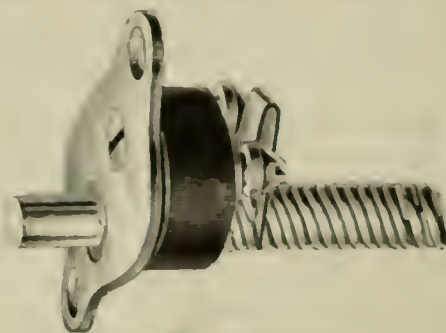
Consumers of Electricity.—An article in the Lond. "Elec. Rev.," May 25, discusses the new Users' Association, mentioned in the Digest last week.

Automatic Electrolyzing Machine.—A "nickel-in-the-slot" machine for generating a pulsating current to be taken by the hands is illustrated and described in "L'Elec.," May 19.

The Geary & Mossop Door Spring.

The door spring, shown in the illustration, is one of the latest products of Messrs. Geary & Mossop, Chester, Pa., of which Craig R. Arnold is the selling agent.

This spring is constructed on new principles, avoiding the use of iron or such metals as will rust and corrode, thus affecting the efficiency of the device. The principal deviation is the use of a long phosphor bronze spring, one end of which is fastened in the brass head plate which secures it to the door; the other end of the spring has a small brass washer fastened into it, and located between these ends is a German silver contact strip which is bent in the form of a loop, thus giving great flexibility to the contacts. The binding screws have conical heads and the German silver tongue makes or breaks the circuit as desired between these screws. The wires are fastened under the heads of the latter.



DOOR SPRING.

Should these heads become worn in time by use, they are readily changed to a new position, thereby presenting a fresh surface for contact. The use of the phosphor bronze spring in this shape secures a number of advantages. Instead of the pin being rigid, it is flexible to a degree never before reached, and the German silver tongue is readily changed from one turn to another, and tightens or loosens the contacts as desired.

Quite another advantage that will be appreciated by artisans is the fact that a single bit bored into the frame will admit all of the apparatus; no chisels or other tools are required. The hole which admits the insulating head leaves ample room for the wires to be connected.

A New Transformer Cut-Out.

The Packard Electric Company, Warren, O., has recently placed on the market for use with the Packard transformer a new cut-out, which has been designed to overcome the difficulty in securing a desirable transformer cut-out perfectly safe and convenient to handle and renew, and at the same time securing an absolute and sufficient electrical contact. Fig. 1 shows the manner in which the fuse plugs project from the front of the case, so that they can be easily withdrawn or replaced. Protection is afforded by a hinged cap, which entirely covers and conceals the porcelain handle.

Thus, the transformer can be cut out of circuit and a burned out fuse replaced without the use of any tool whatever. The plugs are made interchangeable, so that a new plug can be

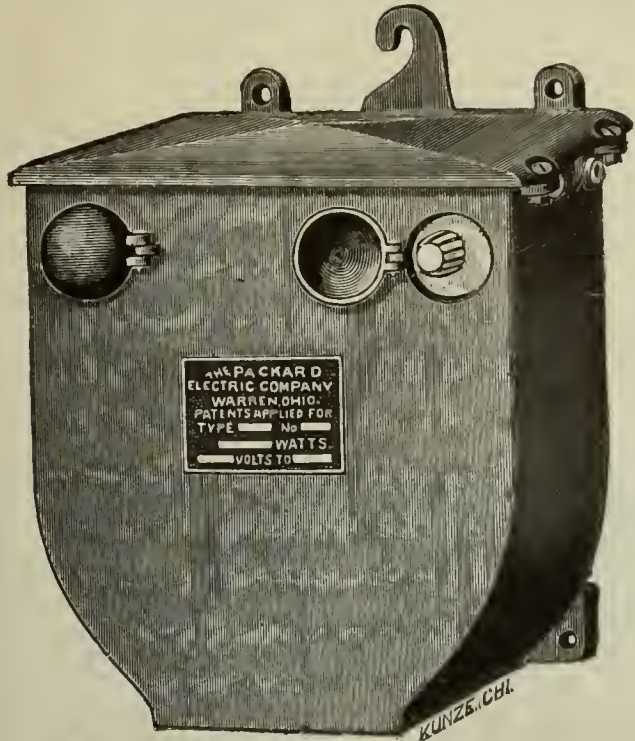


FIG. 1.—TRANSFORMER CUT-OUT.

slipped in in place of the old and the latter can be re-fused for use again at any time.

Referring to Fig. 2, it will be seen that the fuse lies along almost the entire length of the plug, one side of which is grooved for the fuse strip, thus protecting it from mechanical injury in withdrawing or replacing. The plug is provided with two metal lugs, between which the fuse is connected. One of the lugs covers the entire end of the plug; the other extends entirely through the plug, making a double contact with its corresponding metal surface within the cut-out block.

The cut-out block is a piece of porcelain divided into two

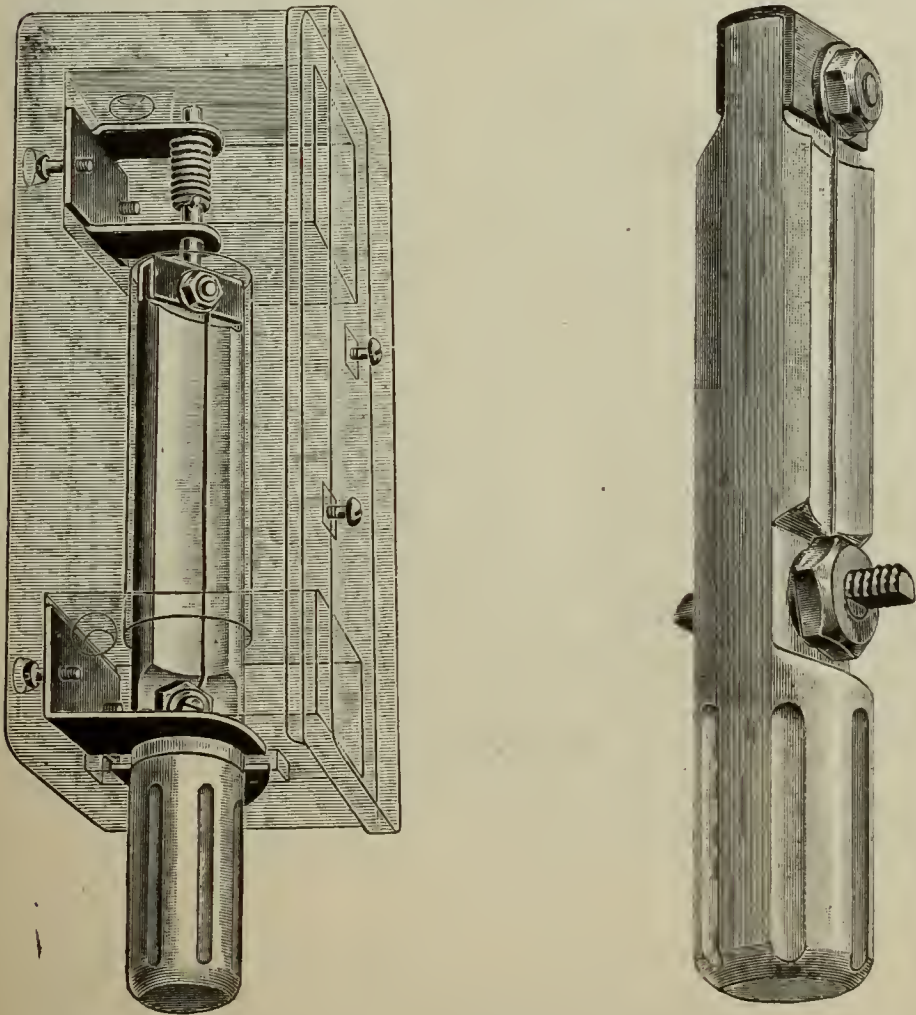


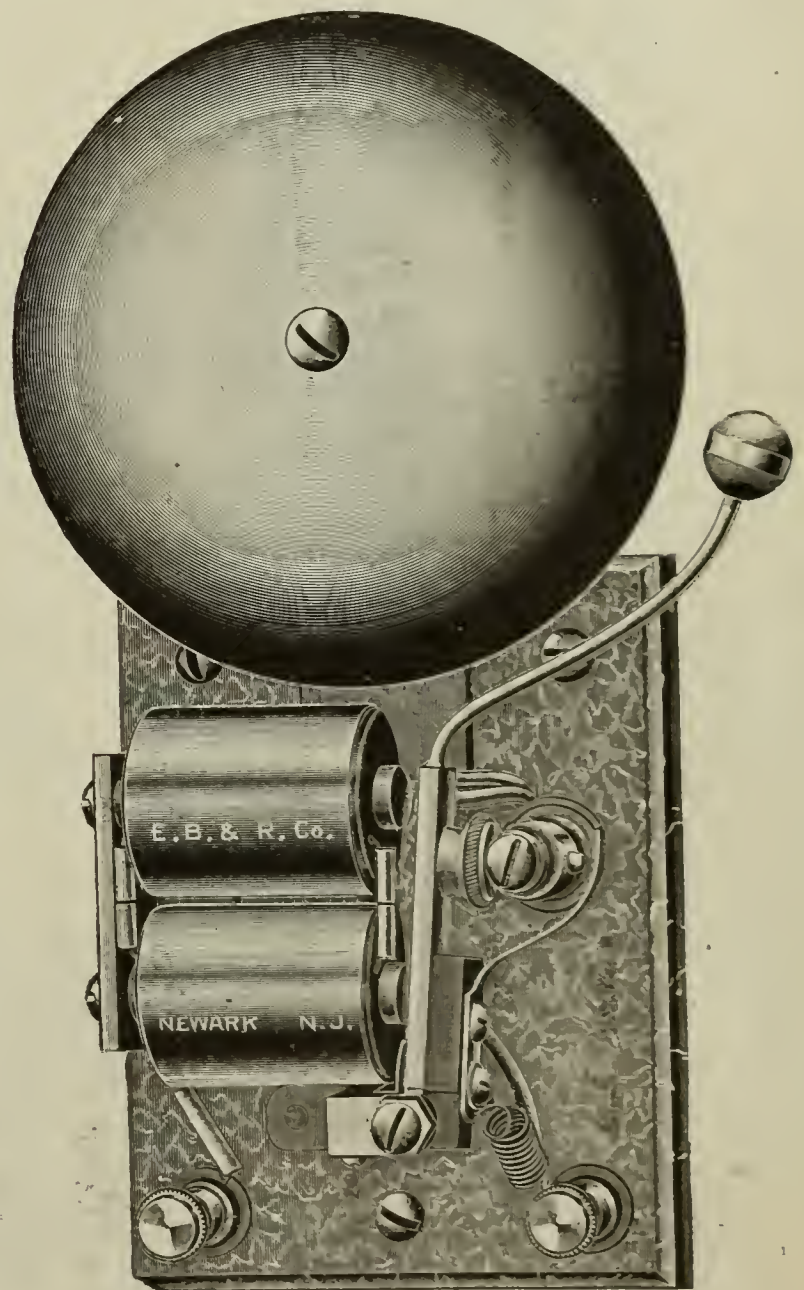
FIG. 2.—CUT-OUT FUSE AND BLOCK.

compartments, seen at either end of the block. In these is made the contact with the two ends of the plug. To insert the plug it is held with the projecting lugs in a perpendicular position, so that they will pass through the slots shown in the

first contact plate within the block. As the end of the plug comes in contact with the rod carrying the spiral spring in the second compartment, a slight pressure is necessary. This forces the spiral spring back, making a perfect contact with the metal rod at that end and allowing the double lug of the plug to pass through the two slots in the first contact plate above mentioned. A quarter turn to either the right or left throws the double lugs firmly against the first contact plate, where they are held by the pressure of the spiral spring at the other end of the plug. It will be thus seen that a perfect contact is assured at both ends of the plug.

Electric Bells on Lighting and Power Circuits.

To obviate the expense and trouble in using batteries to ring bells where dynamo circuits are available, the Electric Bell and Resistance Company, Newark, N. J., is now placing on the market bells to work on circuits of from 50 to 500 volts, either direct or alternating, and without external resistance. The novel features in these bells consists in winding a new high resistance conductor on the outside of magnet coils, and so connecting it that there is no inductive spark at armature contacts, a feature which will be readily appre-



BELL FOR ELECTRIC LIGHT CIRCUIT.

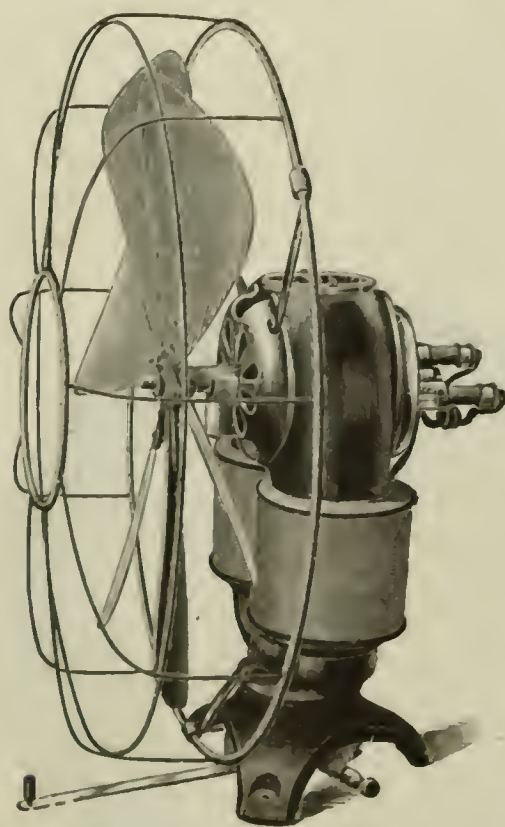
ciated by users of bells. Among the advantages aside from getting rid of the nuisance of batteries is the saving in cost of wiring, as in most cases it is only necessary to wire the bell circuits with one wire instead of two. This is accomplished by connecting the push button to the nearest service wire and running a single wire to the bell, and from thence to the nearest service wire from that point. The bells are wired the same as ordinary lamps, and have cut-outs in circuit, and with the above method for wiring the number of wires as well as trouble from bad wiring are diminished. Fire risks are lessened, as in case of a cross with another circuit or

ground, the bells do not burn out and set fire to the adjoining woodwork, but ring and call attention to trouble on the line. There is no inductive spark to oxidize the contacts, and no adjusting is required for weak or strong batteries: bells once adjusted always remain so. The bells are mounted on a marbelized slate base, which insures perfect insulation, and present an appearance and finish much superior to that of ordinary bells.

The same company is just placing on the market a 500-volt alarm bell for trolley cars, motormen's signals which have no external resistance.

Electric Fan Motor.

The type of the armature adopted in the fan motor illustrated, manufactured by Roth & Eck, 30 Market street,



FAN MOTOR.

Chicago, is a Gramme ring proportioned with a view to maximum efficiency. The brushes themselves are small carbon pencils, fitted in adjustable holders and are self-feeding; they require little attention and can be replaced at any time for one tenth the cost of copper brushes. The com-



FIGS. 3 AND 4.—SWITCH AND THEATRE DIMMER.

casting in three places. The current required for the 1-8-h. p. motor is equal to that used by one 16-c. p. lamp. The motor has self-oiling bearings, and a few drops of oil properly applied will lubricate it for a month.

We illustrate herewith some new and interesting apparatus of the Carpenter Enamel Rheostat Company, of Bridgeport, Conn.

Fig. 1 shows a new automatic switch, just placed upon the market by this company. The switch is shown in the position of "motor stopped," and also "motor running." To start up the motor the operator takes hold of the round wooden handle attached to the armature of the magnet and



FIG. 1. AUTOMATIC SWITCH.

moves it through about 120 degrees before the rheostat lever moves at all. In moving the handle through the next 120 degrees the rheostat lever moves over the rheostat contacts, gradually cutting out the resistance in circuit with the motor armature. The automatic switch will then be in the position shown by the illustration "motor running," all of the resistance being cut out and the armature being in contact with the electromagnet, which is excited by the current going to the motor. If for any cause the current supplying the motor should fail, the electromagnet loses its magnetism, and the keeper arm, actuated by a coiled spring, flies back.



FIG. 2.—REGULATING AND REVERSING SWITCH.

mutators are made of gun metal carefully insulated with mica. The speed can be regulated by the switch, giving three speeds, 2,000, 1,400 and 800 revolutions per minute. The motor is placed upon a tripod swivel base and can with little exertion be turned to face in any direction. The guard is made of heavy stiff brass wire and attached to the field

and after moving through 120 degrees it engages with the rheostat lever and the momentum of the keeper arm, together with the action of the coiled spring, drives the rheostat lever to the position "motor stopped" again.

By the use of this automatic switch, the burning out of a motor armature due to improper starting up or due to sud-

den application of current after temporary interruption in the service is entirely obviated. The switch is well designed and very compact.

Fig. 2 shows a regulating and reversing switch for traveling crane and elevator motors of large capacity, say, 30 kw., and has novel features, insuring freedom from sparking at the contacts upon reversal of current.

Fig. 3 shows a similar rheostat for a motor of 1 kw., such as are used upon jib cranes.

Fig. 4 shows a bank of theatre dimmers of the latest type of the Carpenter company. These theatre dimmers have already become standard because of their compactness and safety as regards fire.

Two-phased System for Lighting and Power.

For the past three years the Stanley Electric Manufacturing Company, of Pittsfield, Mass., has been quietly at work perfecting a two-phased alternating current system for the distribution of light and power indiscriminately from the same generator and circuit and at even the highest commercial frequency. The determination to offer nothing for sale until the system had by actual and prolonged commercial use been demonstrated thoroughly practical and entirely out of the experimental stage has been adhered to. This unusual course has delayed placing the system on the market, but, on the other hand, insures a commercial confidence not ordinarily given to new systems.

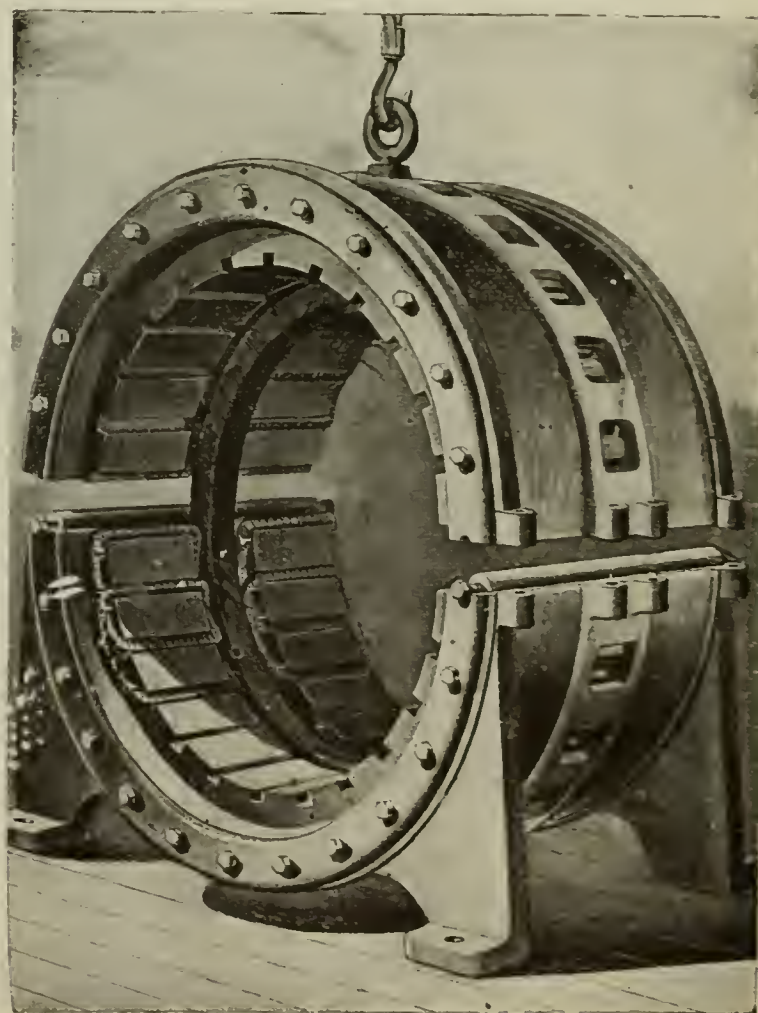
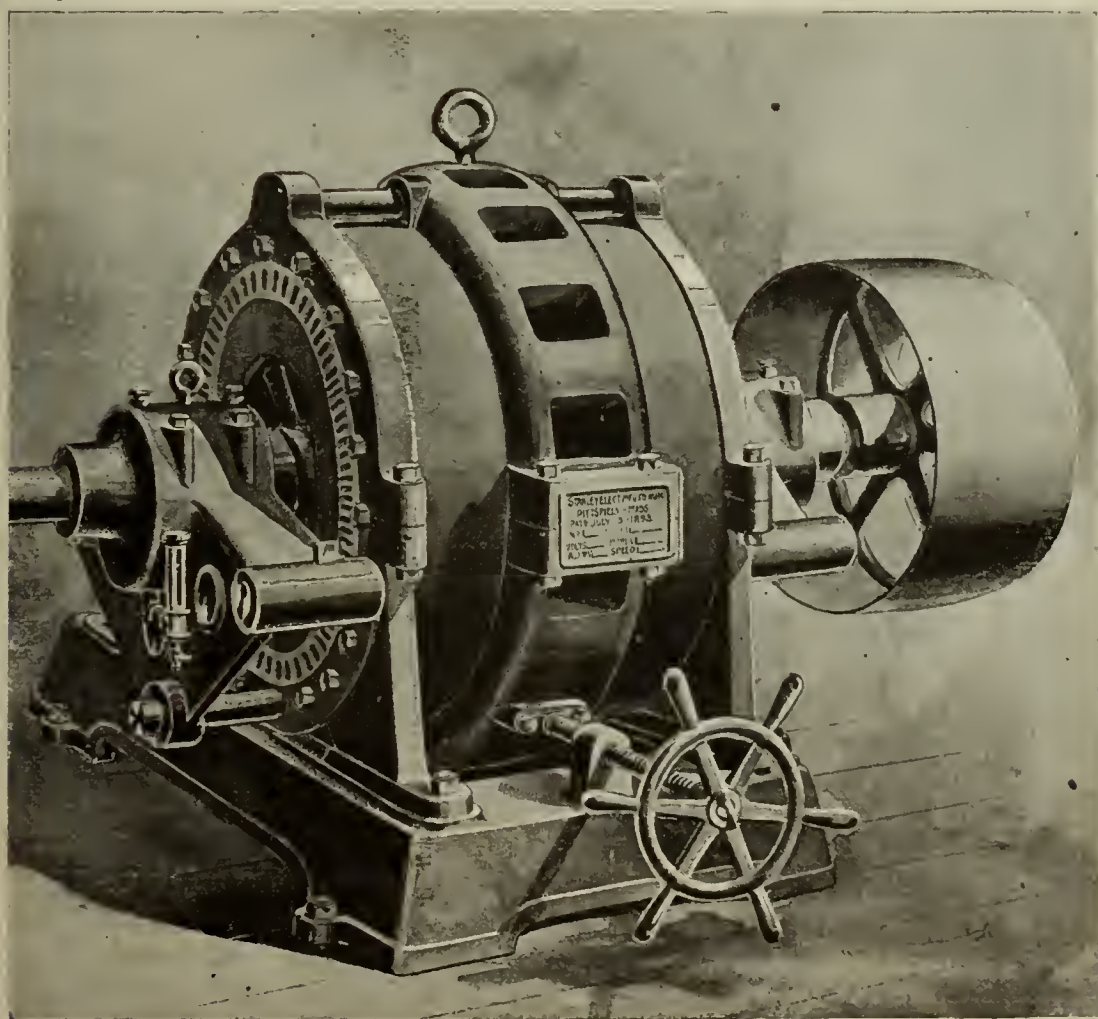
The objects kept in view by the inventors were, first, the

tribution of the same for lighting and power by a simple system not requiring the duplication of apparatus and many conversions, with consequent waste, made necessary by other plants heretofore operated.

The various apparatus included in the system are the joint invention of Mr. William Stanley, Mr. John F. Kelly and Mr. C. C. Chesney, and so closely have their labors been intertwined that the company has adopted the three initials "S. K. C." as the distinguishing mark of the various devices included in the system.

A great disadvantage of the alternating current system of distribution as heretofore applied has resulted from its not being able to furnish power service from the same mains and thus necessitating, where there is a demand for power service, the installation of direct current machinery and a separate system of distribution. With the system here described a lighting company may very largely increase its earning capital by being able to install motors on its lighting circuit. It is considered a safe statement to make that in the majority of towns of any size more can be made by furnishing power than light, as the demands of the former are fairly steady for from eight to ten hours, whereas the maximum lighting service averages only three to four hours.

The inventors call attention to the fact that their two-phased generators are fully as good and simple for lighting purposes as single-phased machines and can be used interchangeably with the present single-phased machines, and, in fact, fit in with existing systems just as well as new single-phased gen-



FIGS. 1 AND 2.—TWO-PHASED GENERATOR AND INDUCTOR.

production of a system which would permit of an economical and satisfactory service of both light and power from the same alternating generator and circuit, and one of such a character that existing light companies could operate it without discarding their present apparatus; second, a system which would make it possible for those just starting in the business to equip a station with one class of apparatus for all purposes, thus avoiding the multiplication of both circuits and apparatus necessary in the past when a company desired to furnish not only incandescent and arc lights, but power; third, to make possible the commercial transmission of the energy of water powers over long distances and the dis-

tributors. By adding one of these generators to its present equipment and by combining the two existing circuits at the station switchboard, or, at the worst, by adding one or two more small line wires, a station can be equipped for furnishing light and power indiscriminately and when the hours of power service are heavy the two-phased machine can be run on two or more ordinary two-wire single-phased circuits just as well as one or two of the old single-phased machines can be run on them. It is not necessary to throw anything away, as the present transformers and generators are just as good and useful with the proposed system as with the original ones.

Stress is laid upon the important element in this system, that as motors are started and stopped, or their loads increased or decreased, lights on the same circuit are not perceptibly influenced; also upon the fact that this system can be used with the highest frequencies, thus securing the great advantages possessed by high over low frequencies in first cost, superior regulation and economy of operation of transformers.

A detailed description of the principles of the two-phased condenser system of this company appeared in *The Electrical World* of April 29, 1893, and we illustrate herewith the more important apparatus which have since been perfected or designed for its commercial working.

The generators, of which we illustrate in Fig. 1 the type for 60 kw. and 120 kw., are all of the same electrical design, but have, however, a somewhat different mechanical structure in the larger and smaller types. The revolving part of this machine, which is shown in Fig. 2, is really the field, but is more properly termed the inductor. This is made of a steel casting upon the periphery of which polar projections of iron laminae are securely fastened. There is no wire whatever on this inductor, and consequently trouble is obviated from band wires, insulation and collectors, it being simply a mass of metal which can be put in place and revolved with a feeling of perfect certainty that nothing can happen to it.

The armature, shown in Fig. 3, is made up of laminae of iron and is stationary, constituting, in fact, the body of the

ductor at all, which when the machine is opened simply hangs in its place in the bearings. The side tables need not be kept in place except when needed, as they are removable. No special tools or appliances are necessary in any case to insert a new coil such as are required with the toothed armature type of machines on the market, in which the coil has to be forced under the teeth to keep it from being thrown out of place by the centrifugal force due to the rapid revolution of the armature.

The bearings, also shown in Fig. 3, are of the most approved self-oiling type, constructed of the best materials and very generous in dimensions.

The armature and field wires are brought out from the machine to a terminal board, shown in Fig. 1, from which the leads are taken out. With this arrangement no wires of any kind are shown festooned about the machine, everything being shipshape and neat. The terminal board consists of two heavy slabs of marble, one secured to the machine and the other forming a removable cover. This cover on its inner face is divided into partitions so that, when in place, each terminal is in a compartment by itself. It is so arranged that fuses may be inserted in the leads, if desired, as an extra precaution against short circuits. This substantial, neat and convenient form of leading the wires out of a dynamo is made possible by the entire absence of collectors or commutators. By simply changing the connections on the board the armature coils may be connected either in

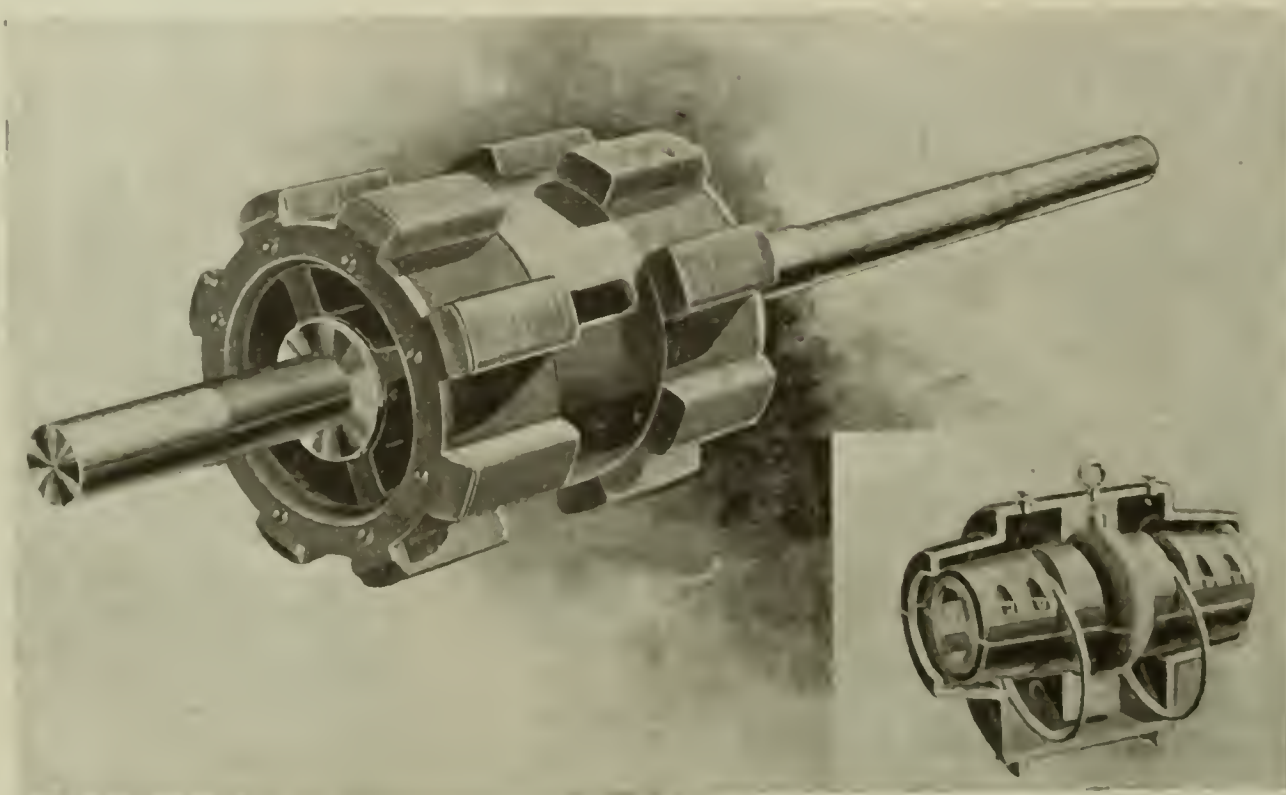


FIG. 2.—INDUCTOR OF GENERATOR.

machine. The individual coils are very small, are wound separately on forms and then secured in grooves provided for them in the laminations. Being so small and stationary it is a comparatively simple matter to insulate them to safely withstand E. M. F's. which would not be at all safe to generate in the older types of alternating machines. If a coil should be destroyed by lightning or any other cause, it can be readily replaced by the ordinary men employed about a station, as can be seen by reference to the cut. In the small machines it is only necessary to take off the top half of the bearings, lift off the top part of the armature and raise the inductor, when all the coils are easily accessible. In the machine of 240 kw. capacity, and larger, the great weight of the parts would make this plan very inconvenient in many stations, so removable side tables are furnished with this type and by turning hand screws on each side the machine can be drawn apart and all the armature coils exposed and made easily accessible. This does not require disturbing the in-

series or parallel, so that the standard machines may be connected for either 1,000 or 2,000 volts, as desired.

The field or exciting coil is circular and wound on a copper spool, which rests in the centre of the machine, surrounding the inductor. It is thus easily insulated to a very high degree and, being enclosed on three sides by the heavy copper spool, danger of breaking down of the insulation due to a discharge, caused by a breaking of the field circuit when it is fully charged, is practically removed.

The following efficiencies are given for the several types of machines:

	60 kw. Per cent.	120 kw. Per cent.	240 kw. Per cent.
Efficiency at full load	94	95	96
" " half load	91	93	94
" " quarter load	85	88	90

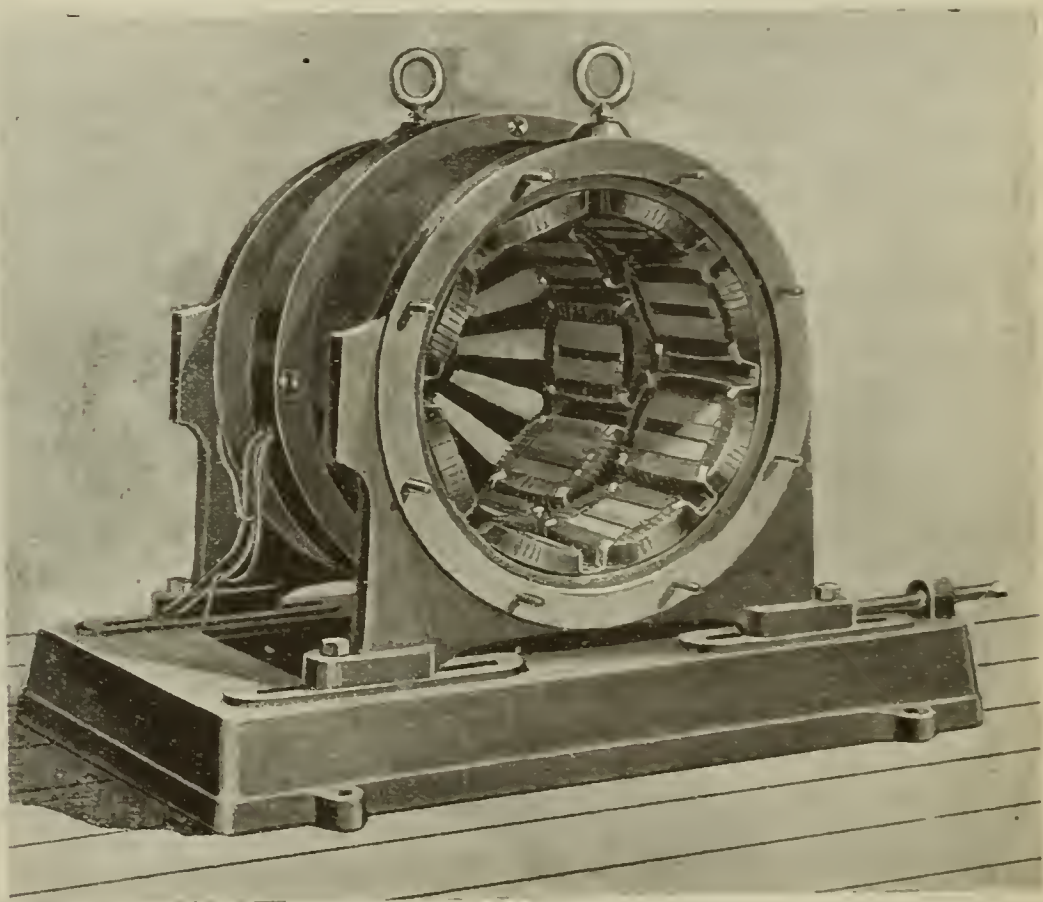
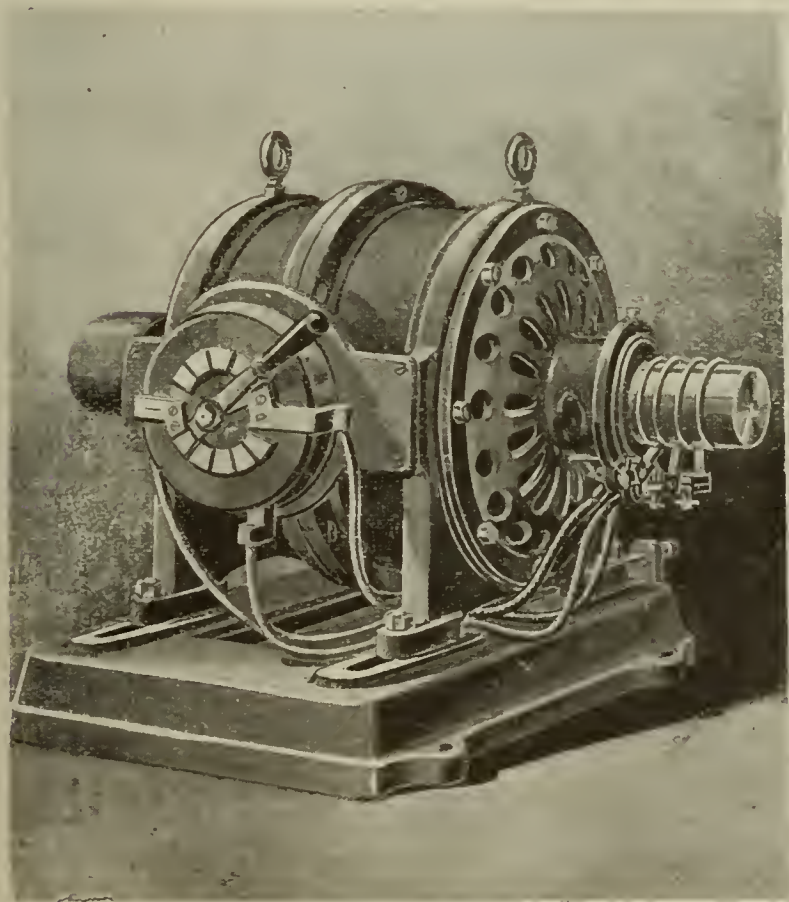
Having but one exciting coil, and so placed as to secure the best magnetic conditions, a degree of economy is obtained in the excitation of the machine which is not possible

with the older types of generators. Steel and wrought iron laminations are used where other generators are composed of cast iron, and there being no moving wire it is safe to run this type with a closer clearance than is advisable with other machines, even of toothed armature construction. The design also permits very readily of abundant ventilation, so that it runs unusually cool, not only because of this superior ventilation, but also on account of high efficiency. The maximum rise in temperature above the surrounding atmosphere is not more than 50 degrees Fahrenheit in any part of the machine after a continuous run of 24 hours at full load.

One of the most important properties of the machines is their inherent regulation. The designers have proceeded on the theory that compounding in itself is an unquestioned disadvantage, as it complicates the generator and makes commutation necessary; while it has been necessary, however, in the older types of alternating current generators not regulating otherwise within 30 or 40 per cent., the new type of generator has an inherent regulation of from 6 per cent. to 9 per cent., depending on the size of the machine and the margin of E. M. F. desired. With one of these machines the full load, excepting one lamp, can be thrown off instantly, it is claimed, without materially increasing the brilliancy of the one remaining lamp (provided, of course, the speed of the machine is constant), and this is accomplished

the best economy in transformers and in the operation of motors by alternating currents. Some of the original types of alternators used in this country, with the surface wound armature, produced a very good form of wave, but the so-called toothed armature machines (now adopted by all the principal manufacturers in order to obtain higher efficiency and less cost per unit of output) distort the wave so that instead of being in the form of a sine curve it is jagged and irregular. In the generator described the poles, both on the armature and inductor, being stamped out of sheet iron by dies, are all exactly true and perfectly formed, and as the armature is stationary there is no need of overlapping teeth to hold the coils in place, consequently the form of the current wave produced is what it ought to be theoretically, that is, a sine curve. In operating motors commercially, this is of great importance, as it permits of the more complete elimination of the false currents. In the ordinary operation of lights it is also important, because with a current of this character the energy lost in the iron of transformers (core loss in watts) is about 10 per cent. less than with the usual form of current supplied by other types of alternators.

If it is desirable to run alternators coupled in multiple it can be more easily accomplished with this generator, from the fact that the poles on any two or more machines, both on armature and inductor, being necessarily exactly alike, the form of current wave must be the same from all the machines



FIGS. 4 AND 6.—TWO-PHASED MOTOR AND FIELD.

without any extraneous regulating device whatever. It is claimed that there is no possible advantage in compounding when two or more circuits (with 10 per cent. or more loss when fully loaded) are often supplied by a single generator at times when one of them may be fully loaded and the others half or quarter loaded. The vexing problems of distribution are solved by using a closely regulating machine, and by being more liberal in the use of copper in the line. This liberality will pay for itself many times over by saving in operating expenses, by saving the first cost of all sorts of devices and by saving in repairs.

With the generator and transformers of this company, a line with a loss of 2 per cent. and good secondary wiring, it is claimed that absolute simplicity and reliability is attainable.

As has been pointed out by the inventors of this system, by Kennelly and others, the shape of the current wave generated by a machine is of great importance in order to obtain

and coincide at all times. The remarkably close regulation of the machines is also an important factor in this connection.

The alternating current motor that shall fulfill the conditions imposed by commercial service must possess the following characteristics: It must start from any position of rest with a torque considerably greater than its running torque; it must maintain an approximately constant speed under maximum variations of load and its operation must not unduly disturb the potential of the system. The further qualities of simplicity of construction and operation and of efficiency in converting electrical energy into motive power are, of course, necessary.

It is thus evident that synchronous motors cannot fulfill these commercial requirements, for they cannot start from rest with sufficient torque. Alternating current motors of the induction type, either for single or multiphase circuits,

have the disadvantages due to the false currents developed by such motors; the difficulty of making them with good starting torque without producing very excessive false currents, and the impossibility, because of these false currents, of producing a comprehensive system for both light and power fed by the same dynamo and circuits. These false currents react on and abnormally demagnetize the generator and transformers, thus introducing difficulties in regulation. They also would make necessary the use of generators, lines and transformers disproportionately large for the work to be done. In a commercial system for distribution of light and power widely throughout the city, motors which take current about in proportion to their load are essential.

Another reason why alternating motors have not been introduced in this country has been because of the high frequency here adopted, at which the false currents are much greater than with lower frequencies, and their disturbing features more difficult to overcome. One object of the Stanley company has been to produce a motor which would be commercial on the standard frequencies used in this country in order to, in a great many places, simplify the problem of adopting multiphase apparatus because of the vast amount of money already invested in generators and transformers only adapted for this high frequency.

The "S. K. C." motor, shown in Fig. 4, is novel and its principle of operation may be best described as consisting of

coils are wound separately and then secured in place. These coils are the only part of the motor connected with the circuit. Being stationary, they are easily insulated to a high degree. The applied E. M. F. on the coils is 500 volts. The same cut also shows what we term the "compensating winding," which consists of short circuited coils of high conductivity placed in the field poles for the purpose of neutralizing the self-induction of the armature. This construction increases the starting torque of the motors so that in the standard motors of different sizes at starting a torque is obtained which varies from 50 to 200 per cent. greater than the running torque at full load.

The most unique and striking feature of this motor system is the use of the condenser, the function of which is to make the motor take current in proportion to its load substantially as direct current motors do. The condensers are connected in multiple with the fields of the motor, and when so placed they supply the lagging component of the current, or, in other words, the false current. Thus, with this arrangement the false currents, instead of flowing back through the transformer line and generator, thereby disturbing the whole system, simply flow in a local circuit through the condensers. This enables alternating current motors and lights to be operated successfully from the same generator and circuit. Without condensers it is claimed that alternating current motors cannot be operated on the same

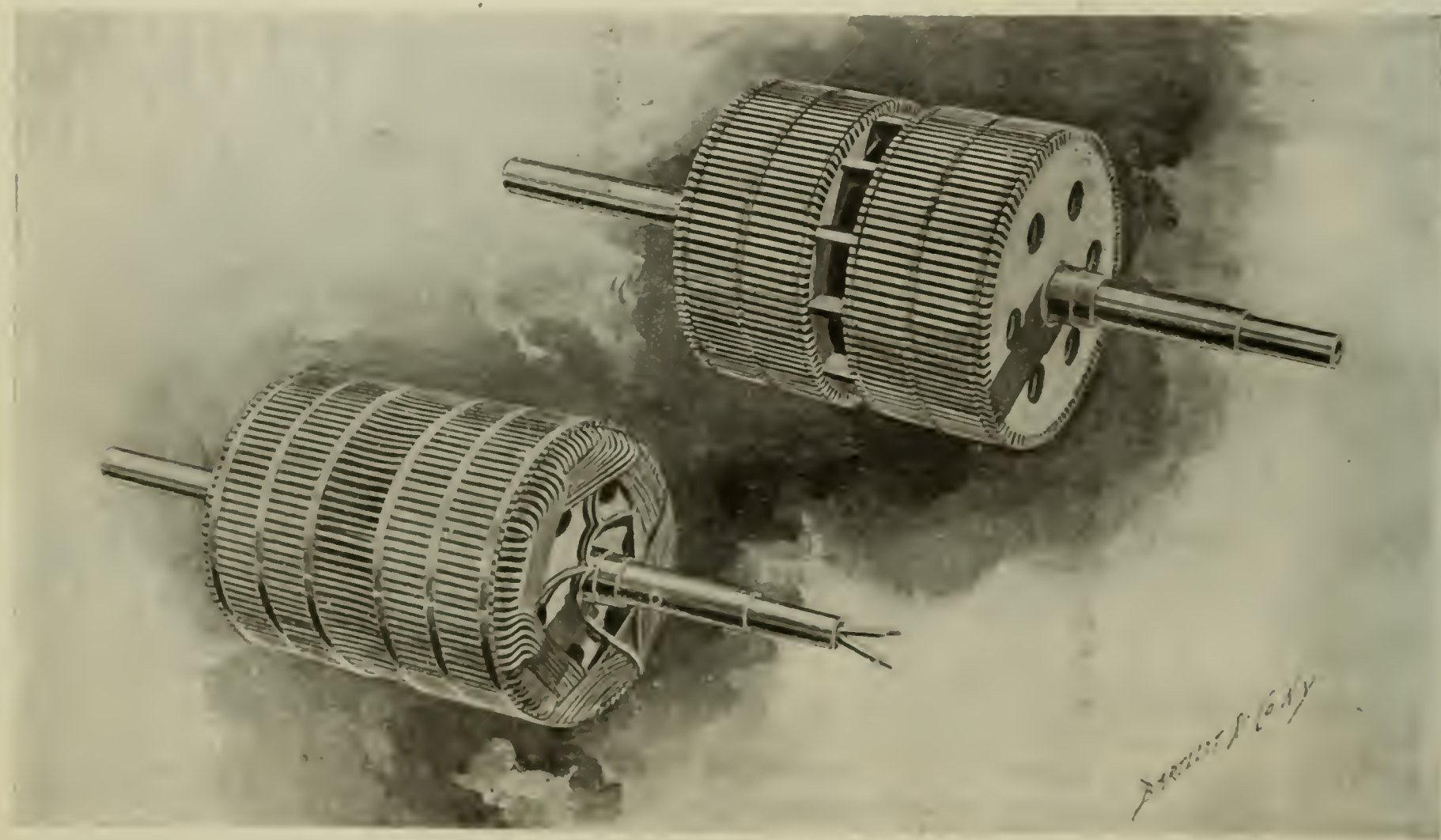


FIG. 5.—TWO-PHASED ARMATURE.

two parts, a motor proper and a rotating transformer, the two parts alternately exchanging their functions. It consists electrically of two fields, which are fed by currents differing 90 degrees in phase, and two armatures, though mechanically there is but one, as shown in Fig. 5. The winding is so connected that the wire which lies directly under poles on one armature is in series with the wire lying between poles on the other. It is clear that in this position one-half the machine acts as transformer and the other half as motor. The motor armature is shown wound and unwound in Fig. 5. The armature winding is not connected with the circuit, and consequently the only current flowing in it is an induced current.

The field construction is accurately shown in Fig. 6. The

circuit with lights on currents of high enough frequencies to meet other commercial conditions, and that there is no other company which even claims to have motors for currents of 15,000 or 16,000 alternations, nor any other motor which is being or can be successfully operated on currents of even 7,000 or 8,000 alternations and permit of lighting service from the same circuit at the same time. The condenser in use is no trouble and does not complicate the system. When once set up in place there is nothing to do to it, being like a transformer in this respect. Much study has been given for the past two years by the Stanley company to the manufacture of condensers, for commercial use with its motors, with the result that they are now guaranteed thoroughly reliable and inexpensive.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, June 9, 1894.

GENERAL ELECTRIC has displayed unusual strength in a fashion at times to mystify people. The most important development this week in connection with the General Electric Company has been the placing of the Fort Wayne Electric Company in receivers' hands. That the collapse of the Fort Wayne was not unexpected by the General Electric people is evidenced by the fact that in the annual report recently promulgated the management put the entire holding of Fort Wayne stocks at a valuation of \$1. The wisdom of this conservative anticipatory action is now amply demonstrated, and the discounting in this heroic fashion of the value of the 76,874 shares of Fort Wayne Electric stock owned on Jan. 31 has prevented the news of the receivership from having any depressing effect on General Electric stock. The only unfavorable development, viewed from the General Electric standpoint, has been the endeavor of the Fort Wayne people to escape an attachment for \$500,000 loaned by the General Electric. The Fort Wayne people claim to have reorganized their property so that the attachment is not, they say, binding. The break between the two companies fully bears out, however, the prediction made in these columns in the beginning of the year that a rupture was pending. Outside of the attention attracted to General Electric by reason of its former close relations to the Fort Wayne, the stock has been worth watching this week by reason of the operations of what is understood to be a new and powerful bull pool. The buying of the stock was started by the covering of short contracts put out some time ago. Little long stock has come out on these raids; however, and the total absence of liquidation has induced traders to buy for a time. The newly formed bull pool has been quick to make good use of this bear scrambling, and the result has been a show of strength hardly comforting to such operators as are still short. The directors are soon to hold a meeting to consider the impairment of capital and dividend questions.

THE FORT WAYNE ELECTRIC COMPANY'S officials say that the placing of it in the hand of A. J. Miller, of Fort Wayne, and E. J. Hathorne, of Boston, as receivers, was done as a preliminary measure to reorganization. Already the Fort Wayne Electric Corporation has been formed to succeed the old company, taking up all its assets. The new concern has a capital of \$1,500,000 as compared with the old company's capital of \$4,000,000. The officers also assert that the receivership is for the purpose of readjusting friendly relations with the General Electric Company, which owns nearly half of the 160,000 shares capital stock. In some quarters, however, it is hinted that the receivership is a deal more important than appears on the surface. It is claimed that, if successful, "it means a new electric company controlled and managed by the old Thomson-Houston people, and to be an active competitor of the General Electric Company." So a party said to be well informed puts it. Naturally the stock has been adversely affected by the receivership. Last week it was \$3.50 per share bid; now there is no bid at all, and it is freely offered at \$1 or even 50 cents per share.

WESTINGHOUSE ELECTRIC issues hold their own. The board of directors meet on June 27 to consider the dividend question. The talk is a little less certain this week about the declaration of a dividend on the common stock, but there is no doubt as to the big business being done by the Westinghouse company. The officials say that shipments continue above recent averages. The company is also preparing for a new and vigorous campaign of competition for local business. This is to be accomplished by means of the United States Illuminating Company, the local representative of the Westinghouse. The magnificent and efficient plant used at the World's Fair has now been completely installed in the United States company's power house, and everything is ready to supply a much improved arc and incandescent light service. The transmission of power is also a feature of the new plant. Mr. Geo. W. Hebard, who is now a director of both companies, is to be made president of the United States Company, and it is his intention to fully advance Westinghouse Electric business in New York. Mr. Jackson, who is now president of the company, will remain with it as general manager, and the name of the corporation will be changed to the United Electric Company.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES this week made another purchase of preferred stock, 513 more shares being purchased at an average price of \$97.41, as against an average price of \$96.09 for 624 shares on May 20. This makes a total of 10,468 shares of preferred stock retired to date out of profits arising from dividend and interest payments on treasury assets.

POSTAL TELEGRAPH stock has been in some request this week on renewed reports of increasing earnings and the company's improved facilities as an efficient and quick distributor of telegraphic matter.

WESTERN UNION TELEGRAPH, with the departure of the Goulds for Europe on their yachting experiment, has been neglected. The directors meet next week to declare the dividend, and will prove by making the regular $1\frac{1}{4}$ per cent. distribution how unfounded the talk of a reduced rate was.

AMERICAN BELL TELEPHONE continues in high favor. The bill for providing for the increase in the capital stock has passed the Massachusetts House of Representatives, and now goes before the Senate. The bill has met with considerable opposition, as it allows the stock of the Bell company to be increased free from all restrictions usually placed upon corporations of its class. It looks now, however, as if the Senate would favor the bill, and when it becomes a law the company will issue the stock in \$5,000,000 blocks until the whole \$30,000,000 are put upon the market. Meantime present quotations are well held on the belief that even if the bill is finally passed with more restrictions attached it cannot materially diminish the earning capacity of the company. The talk of a possible cutting of dividends during the current year is pronounced ill founded. People supposed to be well informed are looking for an extra \$3 on July 1, and believe that the present rate will be continued for some time. Earnings are excellent, even in these dull times, and of late have shown a most satisfactory improvement.

ELECTRICAL STOCKS.

	Par.	Bld.	Asked.
Brush Ill., New York.....	50	10	30
Detroit Electrical Works.....	10	2	3
Cleveland General Electric Co.....	—	85	90
East River Electric Light.....	100	—	65
Electric Con. & Supply Co., pref.....	15	15	16
com.....	12	15	17½
Edison Electric Ill., New York.....	100	99½	100½
" " " 1sts.....	—	106	106½
Edison Electric Ill., Brooklyn.....	100	102	103*
" " " Boston.....	100	117	118
" " " Chicago.....	100	130	135
" " " Philadelphia.....	100	125	127
Edison Electric Light of Europe.....	—	—	3
" Bonds.....	—	80	85
" Ore Milling.....	—	10	13
Fort Wayne Electric.....	—	1	3
General Electric Company.....	100	37¾	38
" " deb. 5's.....	—	86½	87
Interior Conduit and Ins. Co.....	100	45	55
Mount Morris Electric.....	—	—	65
Westinghouse Consolidated.....	50	36½	37
" " pref.....	50	51½	52
Western Union Telegraph.....	—	85	85½
American Bell Telephone.....	—	198	199
*Ex. Dividend.			

New Incorporations.

THE NEW ELECTRIC POWER AND LIGHT COMPANY, San Francisco, Cal., capital stock \$10,000,000, has been incorporated.

THE ELECTRIC KINDLING WOOD COMPANY, State Line, Miss., capital stock \$15,000, has been incorporated.

THE MONROE CITY TELEPHONE COMPANY, Monroe City, Mo., capital stock \$3,000, has been incorporated.

THE POPPOWITSCH ELECTRIC COMPANY, Jersey City, N. J., capital stock \$100,000, has been incorporated.

THE MUTUAL AUTOMATIC TELEPHONE COMPANY, Camden, N. J., capital stock \$200,000, has been incorporated.

THE ELECTRIC TELEPHONE CONSTRUCTION COMPANY, Cincinnati, Ohio, capital stock \$10,000, has been formed.

THE MONTEREY AND STAUNTON TELEPHONE COMPANY, Monterey, Va., capital stock \$5,000, has been formed.

THE SUBURBAN ELECTRIC LIGHT AND POWER COMPANY, Little Rock, Ark., capital stock \$50,000, has been incorporated.

THE UNION ELECTRIC COMPANY, Cleveland, Ohio, capital stock \$25,000, has been formed to manufacture electrical and mechanical apparatus.

THE TEXAS BURGLAR AND FIRE ALARM COMPANY, San Antonio, Tex., capital stock \$10,000, has been formed to maintain a telegraph and telephone line, etc.

THE SOUTHERN TELEPHONE CONSTRUCTION COMPANY, Bennettsville, S. C., has been organized with B. Hawkins as manager and W. R. Hawkins electrical expert, to do all classes of telephone construction.

BABYLON, L. I.—The Montauk, Orient and New York Telephone and Telegraph Company has been incorporated, and will connect Orient and Montauk with New York. John Bagshaw and Orange T. Fanning are interested.

THE BRADFORD ELECTRIC STREET RAILWAY COMPANY, Bradford, Pa., capital stock \$100,000, has been formed to construct, maintain and operate a street railway. The promoters are W. R. Weaver, C. P. Collins and L. E. Hamsher.

THE OCALA ELECTRIC LIGHT AND POWER COMPANY, Ocala, Fla., capital stock \$25,000, has been formed to maintain and operate a plant for light, power, etc. J. A. Bishop, H. L. Anderson and C. Thalheim, all of Ocala, are interested.

THE McDONALD MANUFACTURING COMPANY, Chicago, Ill., capital stock \$5,000, has been formed to manufacture and sell annunciators and all forms of electrical specialties and appliances. A. R. Warner, Frank Hamlin and Wm. C. Boyden are interested.

THE RYAN DYNAMO COMPANY, Hamilton, Ohio, capital stock \$10,000, has been formed to manufacture and deal in electrical machinery and apparatus, etc. The promoters are C. L. Cornell, J. M. Beeler, E. G. Ruder, J. B. Cornell, Jr., and L. A. Becker.

THE LAMPASAS WATER, ICE AND ELECTRIC COMPANY, Lampasas, Tex., capital stock \$30,000, has been formed to furnish

the public with water, ice and electric lights. W. L. Vining, J. W. Martin, C. A. Juhlin and C. L. Morgan are the promoters.

THE SWEET ELECTRIC AND MANUFACTURING COMPANY, Grand Rapids, Mich., capital stock \$100,000, has been formed to manufacture and sell machinery and electrical appliances. C. G. Kritser, S. Barnes and D. F. Smith, all of Grand Rapids, are interested.

THE TERRE HAUTE ELECTRIC RAILWAY COMPANY, Terre Haute, Ind., capital stock \$500,000, has been formed to operate an electric railway. P. P. Thomas, J. G. McNutt, M. F. Burke, Russell B. Harrison, T. Moore, Jr., and T. A. H. Hay are interested.

THE LOS ANGELES, PASADENA AND ALTADENA RAILWAY COMPANY, Los Angeles, Cal., has been incorporated by G. G. Green, Woodbury, N. J.; Andrew McNally, Chicago, Ill.; C. P. Stewart, Baltimore; G. H. Barker, Philadelphia, Pa., and others. The capital stock is \$1,000,000, and it is intended to build and operate a line between the points mentioned.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, New York, June 11, 1894.

THE LEWIS ELECTRIC COMPANY, formerly at 120 Broadway, has removed to 80 Broadway.

THE BROOKLYN HEIGHTS RAILROAD COMPANY carried nearly 400,000 passengers on Sunday, June 3, on its various lines.

A. S. DE VEAU, manufacturer of telephones, reports business very good, having orders for several hundred instruments on hand.

THE SAFETY INSULATED WIRE COMPANY is preparing to move to 225 to 239 West 28th street, where it will have better facilities for supplying the increasing demand for its well known wire.

MR. R. E. DIFFENDERFER, general manager of the Standard Electric Company, Philadelphia, was in town last week. Mr. Diffenderfer will have something interesting to show to the electrical trade very soon.

THE MOTORMEN of the Consolidated Traction Company, at Newark, N. J., have had their eyes examined, as the numerous fatal accidents on the trolley lines at Newark are said to be largely due to defective eyesight on the part of the motormen.

THE BOARD OF ALDERMEN of Brooklyn has overridden Mayor Schleren's veto of the telephone franchise granted to the New York and Eastern Telegraph and Telephone Company. The mayor wished the franchise amended to better secure the city's interests.

MR. J. W. HOLLOWAY, of the Warren Electric and Specialty Company, Warren, Ohio, arrived in the city last week and expects to remain in this vicinity for about 10 days, visiting his family, who live on Staten Island, and attending to the business of the company.

THE ARGUMENT on the motion of the Consolidated Electric Storage Company against the Electric Storage Battery Company, manufacturers of the chloride battery, for a preliminary injunction was brought to a close on the 7th inst. before Judge Green in the United States Circuit Court at Trenton.

THE GENERAL E. S. GREELEY glided into the water in the presence of 1,500 people at New Haven on June 5, but was promptly secured by a tug and taken to a wharf. She is a four-masted schooner of 2,200 tons burthen, and her owners feel assured that if there is anything in a name her success is assured.

MR. JOSEPH SACHS has opened an office at 32 Nassau street, New York, where he will practice as a devising and consulting engineer. His specialty will be in the application of electricity to new and special uses, designing the necessary apparatus or giving advice as to how desired results may be attained by electrical means.

THE EXCELLENCE of the Davidson steam pump, built by M. T. Davidson, Brooklyn, N. Y., is attested by the large number used by the United States Government in various situations. A recent installation consists of four Davidson pumps of special design aboard the U. S. battleship Texas, to be used for operating the hydraulic machinery of the turrets and heavy guns.

THE NORTH RIVER BRIDGE BILL has finally received the signature of the President, after passing both branches of Congress. If the undertaking is carried through, the transportation facilities to and from New York will be enormously increased. If it becomes a great passenger thoroughfare, as has the Brooklyn Bridge, it is quite possible that electricity will be adopted as a motive power.

ELECTRIC RAILWAYS AND THE CONSTITUTIONAL CONVENTION—Mr. Andrew H. Green introduced a resolution before the Constitutional Convention reciting the desirability of a constitutional provision prohibiting free grants of franchises, and securing greater protection of cities' interests, and calling on the mayors of New York and Brooklyn for various information in regard to street railways in those cities.

ILLEGAL SUBWAYS. At the meeting of the Board of Electrical Control last week it was said that several gas companies had been secretly laying pipes containing electrical conductors in different parts of the city in violation of the city contracts with the

subway companies. The mayor offered a resolution directing the commissioner of public works to make an investigation and have the conductors taken out wherever they were found. The mayor explained that the gas companies laid their pipes at night. One of the principal gas companies of the city had been discovered laying a gas main on one of the principal avenues for the purpose of putting in an electrical conductor for its own use.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., June 9, 1894.

MALDEN, MASS.—The West End Street Railway Company has asked the aldermen for right to lay double tracks on Highland avenue, from Middlesex Fells to Wellington line.

LOWELL, MASS.—The aldermen have refused the South Side Street Railway a location to enter the city. Because of this action the directors will not press for a location in Lawrence.

THE AMERICAN CIRCULAR LOOM COMPANY, of Boston, has removed its offices from 620 Atlantic avenue to its factory, Highland and Suffolk streets, Chelsea, Mass. Its postal address is Chelsea Station, Boston, Mass.

THE HIGHAM ELECTRIC COMPANY.—The address of this company is 164 High street (Fort Hill square), Boston, where Mr. Higham, its president, will be pleased to receive all who may wish to observe and inspect its new incandescent arc lamps.

LACONIA, N. H.—By the burning of the works of the Laconia Car Company there were consumed 20 electric cars intended for the Brooklyn, N. Y., Highland street railway, and also five others, which were to be shipped on the next day to different roads.

MR. F. A. SCHEFFLER, who has been connected with the Stirling company for the last year as its sales agent in New York, has gone to Boston, where he will co-operate with Mr. J. Bradford Sargent, the New England representative of the Stirling company. In his efforts to bring the Stirling more prominently before the steam users of that section. Mr. John MacCormack, who is very well and favorably known to the boiler trade throughout the East, succeeds Mr. Scheffler as manager of the New York office of the Stirling company.

THE DAVIDSON VENTILATING FAN COMPANY, of Boston, has added recently to its list of agencies that of the Wenstrom Electric Company, of Baltimore, whose dynamos and motors it will represent exclusively in New England, and which places it in a position to enter more actively into the electric lighting and power field. This company now represents in New England the Columbia incandescent lamp, the Stanley motors and the Norwich Insulated Wire Company, aside from its regular business of ventilating fan machinery and motors. Mr. Frank B. Parsons is the manager of the company, and is a thoroughly energetic and go-ahead business man.

THE BEACON VACUUM PUMP AND ELECTRICAL COMPANY, Boston, reports an excellent demand for its incandescent lamps, and its constantly growing business has necessitated increased space in its factory. It is selling from 3,000 to 4,000 lamps every day, and is placing on the market its new 32 and 50 c. p. lamps, of all voltages, the same as heretofore. One of its specialties is the manufacture of lamps representing all the various colors of glass, with the colors lasting. The Beacon company has recently placed itself in communication with the trade using its lamps during the past season, requesting reports of any complaints regarding their operation, to which it has received numerous flattering replies, and it is desirous of hearing from others as soon as possible—complaints as well as compliments.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
926 Monadnock Building Chicago June 9, 1894.

THE E. P. GLEASON MANUFACTURING COMPANY has removed its Chicago office to 183 Dearborn street, where the resident representative, Mr. F. L. Johnson, will be pleased to see his old friends.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, 1108-1110 St. Charles street, St. Louis, Mo., has issued a leaflet calling special attention to its 15-ampere knife switch, which sustains the well-deserved reputation for excellence which the goods of this company bear.

Canadian Notes.

OTTAWA, Ont., June 9, 1894.

LONDON, ONT.—A new offer has been received from the Chicago Installation Company for the electric railway franchise in this city. The offer concedes workmen's tickets in the morning and evening at eight for 25 cents, guarantees a one, two and three percentage as before, and undertakes all risks of a lawsuit with the present company.

OTTAWA. A bill has passed the Dominion Parliament giving the Government power to require electric railways to provide adequate shelter for their motormen. Mr. Mulock said his whole

idea was to have the motormen sheltered from the weather. The minister of railways approved of the bill. He said it was a necessity. Motormen were amply protected in Ottawa, but in some towns they were not.

MONTREAL.—The net profits of the Montreal Street Railway Company, after paying running expenses, city percentage, fixed charges, etc., as shown by the official figures for the winter six months commencing Oct. 1 last, were \$70,450, an increase of \$58,479.86 over the corresponding period of last year. During many previous winters the company only made expenses. The number of passengers carried in the last six winter months was 8,592,944, as against 7,240,553 during the previous winter. In March, 1894, the cars carried 1,517,880, against 1,227,115 for the same month last year. The average number carried per day in March, 1894, was 48,961, and in March, 1893, 38,984.

English Notes.

LONDON, England, May 30, 1894.

LAMP TESTS.—The lapse of the Edison lamp patent in this country has resulted, as was to be expected, in the consumers being offered lamps of all kinds and at all prices. One of our best managed electricity supply companies has decided to study its own interest and that of its consumers by acting as intermediary between lamp vendors and their unsuspecting prey. The company buys the lamps wholesale and sells them retail, testing them carefully en route. Already some interesting facts have come to light. English makers, it seems, are unable to cut off eight candles with any tolerable degree of accuracy; Continental makers, on the other hand, are able to do this and also to insure their watts per candle being somewhere near the mark, at any rate, at the start. Unless the home-made product either shows a longer life or a greater constancy of candle power and "wattage," it will be yet another case of our being beaten on our own ground.

THE COST OF ELECTRICAL ENERGY.—The discussion on Mr. Crompton's paper on the "Cost of Electrical Energy" came to a conclusion last Thursday; Professors Unwin and Kennedy, Mr. Druitt Halpin, of hot water storage fame, and Mr. Rosenthal, of the Babcock-Wilcox company, taking part. Professor Unwin gave some results of tests of Lancashire boilers, which showed an evaporative efficiency of 11.87 pounds of water, and generally traversed Mr. Crompton's appreciation of the water tube type of boiler and his depreciation of North country or bituminous coal. Professor Unwin also gave some valuable facts with regard to the use of superheated steam in Alsace. In one case a 500-h. p. compound engine used superheated (520 degrees) steam without any injury to the cylinders, and with an economy of 20 per cent. Professor Kennedy stated that the Westminster company, with which he is connected, had brought down the coal (Welsh) consumption per unit generated to 4¼ pounds, and he was prepared to predict a future consumption of only 3.64 pounds per unit sold. He also stated that exhaustive tests were being carried out in Belgium with a view of exactly ascertaining the losses involved by rope and belt driving. Discussing the much debated question of small central and big "peripheral" stations, Professor Kennedy pointed out that after a certain size, say 3,000 h. p. to 4,000 h. p., had been reached, it mattered not from the point of view of operating costs whether one large or several small centres were adopted. Mr. Crompton in his reply admitted the good performances of the Lancashire boiler under normal conditions, but pointed out how abnormal were the conditions of central station work. He concluded by emphasizing the value of oil-fired boilers as a standby, to contend with the heavy loads so often thrown upon a station in the day time without any warning, and lasting only for half an hour or so.

News of the Week.

Telegraph and Telephone.

MINNEAPOLIS, MINN.—The Council decided to advertise for telephones for the police signal service, as the city thinks it is paying too high a rate at present.

COVINGTON, KY.—The City Suburban Telephone Company has petitioned for right to erect poles and string wires within the city limits. The matter was referred to the committee on law and the city solicitor.

GREAT BARRINGTON, MASS.—The new telephone exchange will be under the management of the recently organized electrical firm of Evans & Whitwell, and will pass under their control on its completion, in a few weeks.

PHILADELPHIA, PA.—Mr. Klemmer introduced an ordinance granting permission to the Mutual Automatic Telephone Company to construct manholes, cables, wires and terminal for electrical purposes. The bill was referred to the electrical committee.

Electric Light and Power.

HOUSTON, TEX.—Address J. T. Browne, mayor, concerning the electric lighting contract.

HAMILTON, OHIO.—An election is to be held to vote on issuing \$50,000 in electric light bonds.

CARDINGTON, OHIO.—The city voted to issue \$25,000 in bonds for electric lights and street paving.

NEW BREMEN, OHIO.—An election will soon be held to vote on the issue of \$10,000 in electric light bonds.

EL PASO, CAL.—J. R. Perry can give information concerning an electric lighting system, which is to be established there.

ESTHERVILLE, LA.—An election will be held June 14 to vote on the question of issuing bonds for waterworks and electric lights.

BUFFALO, N. Y.—The Works of the Warren Gaslight and Electric Light Company were destroyed by fire on June 3. The loss is \$6,000.

WARREN, PA.—The plant of the Warren Gas and Electric Light Company has been burned, with a loss of \$20,000. It will be rebuilt at once.

BALTIMORE, MD.—The Brush Electric Light Company has issued \$3,154,000 in bonds for the purpose of rebuilding its works destroyed by fire last October.

SHENANDOAH, PA.—Several prominent Main street merchants and a number of leading citizens are said to be projecting a new arc and incandescent electric plant.

THE CLEAR LAKE (IA.) ELECTRIC LIGHT AND POWER COMPANY has secured an exclusive franchise for 20 years from the city of Clear Lake. It will do the city lighting. Mr. John L. Etzel is president of the company.

BEVERLY, MASS.—The aldermen have refused the Common Council a representation on the committee to make a new electric light contract; the Council proposes to even up by refusing to vote any appropriations where they are not consulted.

BROCKTON, MASS.—The City Council has offered the Edison company \$90 a year for a 1,200-c. p. arc light and \$14 for a 16-c. p. incandescent light on a five year contract. The city will also purchase an engine and dynamo for a plant to light the hall.

BOONSBORO, MD.—A special election was held June 8 to determine whether the town shall issue \$15,000 in bonds and subscribe that amount to the capital stock of the South Mountain Electric Light and Power Company. There is bitter opposition to the project.

BRUNSWICK, MO.—W. H. Finch, city clerk, may be addressed in regard to the proposed erection of an electric light plant, including one 60-h. p. engine, two 18-kw. incandescent dynamos, switchboards and fixtures, fifteen 2,000-c. p. arc lamps, two miles of circuit, three-wire system, etc.

MONTROSE, PA.—Daniel Killion, representing the Pennsylvania General Electric Company, of Philadelphia, was in town recently to confer with the borough officials in regard to an electric light plant. If the borough puts in a plant of its own, the Pennsylvania company expects to bid on the contract.

GENESEO, N. Y.—The Geneseo Gas Company has commenced the erection of a building for the electric light plant on School street. The lot fronts 150 feet. The building will be of brick, with slate roof, and fireproof. It will have two stories, 75 by 31 feet, and contain offices, engine and dynamo room, etc.

OYSTER BAY, N. Y.—At the meeting of the Town Board on June 2 an application was presented by the Electric Light and Power Company for the lighting of the streets of the village. The petition was signed by a large number of business men. The board has called another meeting for June 9, when the matter will be determined.

HARLEM, ILL.—Sealed proposals will be received until June 16 for furnishing and putting in place a dynamo, switchboard, engine, boilers, wires, poles, electric conductors and appliances according to plans and specifications in the office of the village clerk. Proposals will be received for the whole or any part of said electric lighting system. Henry C. Meier is village clerk.

ROCHESTER, N. Y.—The Niagara Falls Power Company will soon be formed in this city by Frank W. Hawley. The local directors of the concern will be Mayor G. W. Aldridge and Henry C. Brewster. The other directors will be Thomas C. Platt, Frank W. Hawley and William Mertens. The amount of the capital stock has not yet been definitely determined.

PITTSBURGH, PA.—At a recent meeting of the Alleghany public works committee bids were opened for building an addition to the Braddock avenue light plant. The lowest one was \$25,893, and Director McAfee said this was too high by \$6,000; a sub-committee was appointed to trim the plans down to a reasonable figure, when bids will be again asked. A new electric railroad scheme is on foot to open up additional territory in the East End, across the river to Homestead. Ordinances to secure the necessary authority are being prepared for presentation to councils.

EVANSTON, ILL.—The committee on lighting recommended that the proposals opened at a meeting of the Council, held April 24, for furnishing a new electric light machine for the city's plant in the third ward be rejected and the deposits returned; also that the commissioner of the public works be directed to re-advertise for proposals for furnishing one and two new 50-light dynamos, and to word the advertisement so as to include proposals that may be received from owners of dynamos that were in use in connection with the World's Columbian Exposition.

The Electric Railway.

HARTFORD, CONN.—Engineers are surveying a route for a new electric line to Windsor.

COHOES, N. Y.—Citizens are agitating the question of the local electric street car line.

LORAIN, PA.—The Hon. Tom L. Johnson will build an electric railway line in Lorain.

PHILADELPHIA, PA.—The Electric Traction Company will extend its Fifth and Sixth street lines.

NANTICOKE, PA.—Work on the proposed electric road to Glen Lyon will be commenced in about two months.

MEMPHIS, TENN.—The Citizens' Street Railway Company has made preliminary surveys for an electrical railroad to Binghamton.

VICKSBURG, MISS.—The Vicksburg Electric Transit and Lighting Company will shortly begin work on its electric railroad.

UNION BRIDGE, MD.—It is proposed to construct an electric railway from Washington Grove to Sandy Spring, in Montgomery County.

BRADFORD, PA.—An ordinance granting a franchise to the Bradford and Kendall Railway Company was referred to the street committee.

NEW BRUNSWICK, N. J.—There is some displeasure at the refusal of the Common Council to encourage an electric road for New Brunswick.

THE ATLANTA TRACTION COMPANY has been placed in the hands of permanent receivers. T. B. Rossers and W. C. Halle are the receivers.

NEW BRITAIN, CONN.—The Central Railway and Electric Company is considering plans for a belt line in the eastern portion of the city.

PHILADELPHIA, PA.—The United States has lost its suit to prevent the Gettysburg Electric Railway from building a branch trolley line to "Round Top."

ALLENTON, PA.—The Inter-County Electric Railway Company is looking for a route to Mauch Chunk, and is likely to get control of the Mauch Chunk Railway.

BEDFORD CITY, VA.—A meeting was held Saturday in the interest of the electric road that it is proposed to build from Lynchburg to Bedford City. Mr. H. Hogan, of Burton's Creek, was the secretary.

PHILADELPHIA, PA.—Ordinances granting the Citizens' Clearfield and Cambria Railroad Company and the Citizens' Passenger Railway Company the right to lay tracks and use electric motors were passed.

BROOKLYN, N. Y.—The Coney Island Railroad Company, an organization composed of citizens of Gravesend, has determined to construct a trolley line along Surf avenue to Gravesend, from West Brighton to Sheepshead Bay.

HOBOKEN, N. J.—A mass meeting was held in the Hoboken city hall protesting against the privilege being granted to the Jersey City, Hoboken and Rutherford Electric Railway Company to lay tracks through First street.

BROOKLYN, N. Y.—The Brooklyn City Railroad Company is seeking to extend its trolley line, and is meeting with some opposition by the Coney Island, Fort Hamilton and Brooklyn Railroad Company, which desires the same privilege.

NEW YORK, N. Y.—The promoters of the White Plains, New York and Mamaroneck, and the New York, Elmsford and Silver Lake railroads, to be operated by electricity, are anxiously awaiting the granting of a franchise by the board of trustees.

LAWRENCE, MASS.—The Lawrence, Lowell and Haverhill Street Railway Company has begun the work of extension of its line through Lowell, Milton and Haverhill streets to Barker's grove. The present intention is to have the line completed by July 1.

PHILADELPHIA, PA.—The Councils' committee on street railways has agreed to report favorably upon the bill for the construction of the Brown and Parrish street electric railway. The East End passenger railway bill was also reported favorably.

HAMMOND, IND.—A project is on foot to run an electric street car line through West Hammond and Burnham, and to make connections with the Calumet Electric Railway; this arrangement would land passengers in the heart of Chicago in less than an hour's time.

SAGINAW, MICH.—The Union Street Railway Company will soon commence the erection of its power house. The plant will be located on South Tilden street, one block north of the Everett power house. It will be equipped with all modern apparatus, and will cost \$25,000.

SINKING SPRING, PA.—Citizens of Sinking Spring voted in favor of granting right of way for an electric road from Reading to Womelsdorf, but were opposed to connecting the Reading and Southern Railroad at Shillington, desiring the road to run direct to Reading.

BLOOMFIELD, N. J.—Samuel Moore, of Bloomfield, has obtained the signatures of many of the citizens of that town in favor of the use of electricity on the Suburban Traction Company's lines. He will present the petition to the township committee at its special meeting next Saturday night.

BALTIMORE, MD.—The commissioners of Baltimore County

have granted permission to the Canton, Sparrow's Point and North Point Railway Company to lay tracks on certain streets and roads, and to build an elevated structure on Clinton street, provided the road cannot be constructed otherwise.

AMSTERDAM, N. Y.—Lawrence Caten, of Gloversville, has been visiting Amsterdam in the matter of the proposed electric road between Akin and Fulton. Among those interviewed was Civil Engineer Moak, but the latter will make no definite statement, stating merely that the road will eventually be built.

LANCASTER, PA.—A charter was granted by the State Department for the Mohnsville and Adamstown Railroad Company, with a capital stock of \$75,000, to run from Mohnsville, Berks County, to and through the borough of Adamstown, Lancaster County, a distance of $7\frac{1}{2}$ miles. L. T. Custer is president.

DETROIT, MICH.—The company that proposes to build an electric railway between Port Huron and Lexington has filed articles of incorporation. It is capitalized at \$200,000, the incorporators being Edgar A. Brennan and T. W. Bainbridge, of Toledo, and William C. Maybury, George Schaffer, William Nichols and C. W. Harrah, of Detroit.

AMSTERDAM, N. Y.—There is a project on foot to build an electric road between Richfield Springs and Oneonta, a distance of 34 miles. The cost is estimated at \$7,000 a mile. The road will, if constructed, carry freight as well as passengers, and have stations at Schuyler's Lake, Oakville, Hartwick, South Hartwick, Mt. Vision and Laurens.

LOCKPORT, N. Y.—Mayor Atwater has received word from Reed & McKibbin, contractors of the Lockport electric railway, that they will deposit \$5,000 with the city treasurer as a guarantee that they will have the electric road in Lockport running by Sept. 1, 1894, if an extension of time is granted them to that date. The time has been granted.

RANDALLSTOWN, MD.—James G. Floyd, representing the Barrows Electric Street Car System, of which C. H. Barrows, of Willimantic, Conn., is the inventor, has made application to the officers of the Randallstown, Harrisonville and Granite Rapid Transit Company to build and equip the road with the barrows system, and the petition will be considered at a meeting to be held this week.

BUFFALO, N. Y.—The Crosstown Street Railway Company, of Buffalo, has made application to the Common Council of the city of Buffalo for permission to construct, extend, maintain and operate a street surface railroad, to be operated by electric power over, along, under and upon Hertel avenue, easterly from Elmwood avenue to Main street, so as to connect with the railway tracks in Main street.

BROOKLYN, N. Y.—The highway commissioners of Jamaica, at a meeting June 3, granted to the Long Island Electric Railroad a franchise to lay tracks on New York avenue and Rockaway road within the town limits. A similar franchise for Liberty avenue was granted the same company a short time ago. The granting of these franchises is the preliminary step to the construction of a trolley road from Brooklyn to Hempstead.

HOMESTEAD, PA.—The Homestead and Highland Street Railway Company has resumed work, and it is thought cars will be running by fall. The street railway company recently entered into a contract with Mr. Brown to cross the bridge with cars. Work on the Brown bridge, which spans the Monongahela River from Brown's Station, on the Baltimore and Ohio Railroad, to Ann street, Homestead, has also been resumed.

Miscellaneous Notes.

ACROSS THE OCEAN IN A SECOND.—The result of the Derby race was received by the United Press from the office of the Direct United States Cable Company just one second after it was filed in London.

MR. CHAS. G. ARMSTRONG recently read a paper before the Chicago Electrical Society on "Street Lighting by Alternating Arcs," which predicts that alternating arcs will become largely used for street lighting on account of their superior efficiency.

THE RICHMOND ELECTRIC CLUB, of Richmond, Va., has been formed, and has the best wishes of The Electrical World for its success. The officers are Geo. A. Tower, president; T. L. Martin, vice president; Harrison Tabb, secretary; F. J. Craigie, Jr., treasurer. The executive committee consists of Messrs. Maurice W. Thomas, Henry E. Tresnon, Harry D. Winn and Charles P. McCluer.

PURDUE UNIVERSITY, through the untiring efforts of its president and the co-operation of the faculty and board of trustees, has so far repaired the loss which its magnificent new engineering laboratory suffered recently from fire, that after Sept. 15 next the regular engineering work of the University will not be embarrassed. Not only has a complete restoration of all that was lost been provided for, but many additions are to be made, so that the laboratory will be better equipped than ever for work in all the departments of engineering.

THE EDITOR, THE ELECTRICIAN AND THE COUNCILMAN.—A Western newspaper has the following: "The acting city electrician is full of volts, amperes, ohms and all that sort of electrical gibberish, but all this scientific gabble does not prove him to be an expert electrical engineer qualified to make chemical and electrical tests that require years of special training. The most

amusing part of all these mummeries are the learned disquisitions of that eminent glass insurance scientist, Councilman Wheeler. What Wheeler does not know about electrics would eat through several 24-inch water mains, and pass through all the gas pipes from Alpha to Omaha."

TROLLEY PATENT SUITS.—The Westinghouse Electric and Manufacturing Company has filed an answer in the United States Circuit Court in the trolley patent suits brought by William M. Schlessinger for himself and as trustee for Susan McDuffee and Albert H. Williams, against the Philadelphia Traction Company and the Westinghouse company. In the answer the Westinghouse company denies that Schlessinger was the first inventor and that he is entitled to the exclusive use of the invention and improvements. Regarding one of the patents, it is asserted in the answer, on information and belief, that Schlessinger surreptitiously or unjustly obtained it for what was in fact invented by others who were using reasonable diligence in perfecting and adapting the same. The inventors referred to are Thomas A. Edison, Hiram S. Maxim, Frank J. Sprague, Leo Daft, Charles J. Van Depoele and John C. Henry.

THE NATIONAL SCHOOL OF ELECTRICITY.—We have received a communication from Prof. J. P. Barrett stating that the members of the faculty of the National School of Electricity are now actively engaged in the work of preparing the educational course. Every lesson, after its preparation by some member of the faculty, is sent to, and is to have, the approval of the other members before it is published. The course is to be of a practical nature, and the management of the school makes no promise to fit students for expert electrical service after taking the course. The prospectus issued states specifically that taking the course will not fit any one for expert service. It is intended, however, to be sufficiently elementary and exhaustive to give students an insight into the science, and to introduce them, as it were, to the subject in a way that will permit them to prosecute its study in an intelligent and comprehensive manner, and if taken in connection with either practical or theoretical work, will aid them in their attempt to master the subject. The course is to be practical to the extent that apparatus is to be employed in the demonstration of principles and in full explanation of theories and practice. The particular member of the faculty who writes a particular lesson specifies at the end of the lesson the apparatus required, and particularizes as to its use. The apparatus called for is to be invariably provided and employed. It may serve for fuller information in regard to the details of the operation of the school to give a few of the facts concerning the organization of classes in Chicago, where a most promising commencement has been made. There are now organized for work nine classes, and new classes are being organized almost every night. These classes contain from 30 to 75 members. They meet one evening in each week. The instructors are young men thoroughly familiar with the theoretical side of the subject by virtue of college courses, and who have had practical experience in the laboratories and factories, and in commercial positions in the large companies. The best people, and those most competent to judge of the probable usefulness of this course, are stated to be actively interested in its success in Chicago, and have made personal efforts to that end. Bishop Fallows gave the weight of his influence in behalf of the organization by presiding at a meeting for the organization of the first class. The management of the Armour Institute have supported the movement to the extent of identifying the school with the electrical department of that institute, by inviting the organization of a class in the institute, and by active co-operation towards its success. Professor Stine, professor of electrical engineering of the institute, will personally direct the course of instruction, and will aid in every way the success of the undertaking. It has been the intention to feel carefully the way before prosecuting the work of organization of classes outside of Chicago, with a view to the perfection of details. It is now the intention to vigorously prosecute the work in all of the states of the Union.

Trade and Industrial Notes.

THE IOWA ELECTRIC AND CONSTRUCTION COMPANY, Des Moines, Iowa, has closed a deal by which it has obtained the exclusive franchise for an electric plant at Eagle Grove, Iowa, upon which work is already commenced.

HUEBEL & MANGER, manufacturers of electrical goods, 286-290 Graham street, Brooklyn, report business very good. They have been receiving large orders of late for their improved style F iron frame pivoted armature bells. They are being used extensively in hotels, factories and large buildings for fire alarm and other purposes where a good reliable bell is needed.

THE WALLACE ELECTRIC COMPANY, Chicago, has in preparation a folder describing the various styles and sizes of fan motors which they are now handling. This folder will contain a full description of direct and alternating current motors, battery fan motors and exhaust fan motors. This latter motor is made with a 24-inch fan, and is the only motor of its kind now on the market swinging a 24-inch blade.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is calling prominent attention to the fact that the wonderful effects in fancy illumination which form such an attractive feature of the Masonic Temple Roof Garden and Scenic Theatre are produced entirely by Packard lamps furnished by the Electric Appliance Company. Several thousand Packards of all sizes, shapes and colors are used in producing the beautiful effects.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has issued a catalogue of its fan motors for the present season, which shows that important improvements have been made in interior details. One of the features of these motors is that the speed of the fan can be both regulated and reversed, the former by merely shifting a regulator stud projecting through the front, and the latter by reversing the position of the stud.

THE SHERBORNE ELECTRIC INSTALLATION AND DORSET POLYTECHNIC COMPANY, Dorset, England, sends us circulars describing the Sherborne combination engines and dynamos, and an electric bicycle lamp. The former are from 4 to 12 lamps capacity and portable. The lamp and lantern weigh five ounces and storage battery 1 pound 5 ounces for seven lamp hours, and 2 pounds 12 ounces for 20 hours.

THE GEORGE L. COLGATE COMPANY, 136 Liberty street, New York, recently incorporated by George L. Colgate, well known in electrical circles, reports that it has received several nice orders lately for the various specialties it is handling. Its latest acquisition is the purchase from Mr. W. A. Vail of all rights, titles and interest in his swinging ball lightning arrester. This company also handles the Star electric moulding, the McIntosh insulating paint, the Whitney instruments, the McNutt lamp, Simplex wire and a general line of supplies.

CHAS. A. SCHIEREN & CO., 45 Ferry street, New York, report that trade has been quite good of late, there having been quite a demand for the best grades of leather belting. They are now making two 28-inch double belts for Newark, N. J.; two 18-inch double belts for the Geneva Brush Electric Company, Geneva, N. Y.; two 22-inch double belts for Brooklyn; two 54-inch double belts for the Allentown Traction Company, Allentown, Pa.; two 54-inch belts for the City and Suburban Railway Company, Baltimore, Md. Two 32-inch double belts have been shipped to the Richmond (Ind.) Light, Heat and Power Company, and a 50-inch double belt—second order—for the Steinway Railway Company, Astoria, L. I.

E. P. ROBERTS & CO., Cleveland, Ohio, have obtained the services of Mr. W. B. Stewart as a partner in their firm. Mr. Stewart has had 29 years' practical experience in steam engineering and general machinery, and eight years in electric light and electric railroad work. He is an exceptionally fine machinist, and the firm considers itself very much strengthened by the addition. The consulting business of this successful company is at the present moment flourishing; 10 engines and dynamos are being placed under their specifications and awaiting their tests, as well as several boilers and some miscellaneous machinery; also the preliminary estimates for a 30-mile electric road and a number of wiring plans, one of their specialties, the mechanical and electrical design for a 15-ton elevator and of some special machinery, and two legal cases, for which they are technical experts.

THE ELECTRIC STORAGE BATTERY COMPANY, Drexel Building, Philadelphia, announces that after a series of exhaustive tests covering a period of six months, conducted at the Edison laboratory by Mr. W. K. L. Dickson, Mr. Edison's consulting electrical engineer, the chloride accumulator has been adopted exclusively for operating the Edison kinetoscope. The following is Mr. Dickson's letter announcing the result of his test: "At your request it gives me great pleasure to state that after testing the leading makes of storage batteries in connection with the Edison kinetoscope, I have given the preference as to capacity, mechanical construction and durability to your chloride accumulator, which stands unique among its competitors, marking an important stride in the right direction, and being capable of application to varied uses."

THE COLBURN ELECTRIC MANUFACTURING COMPANY, Fitchburg, Mass., has supplied dynamos for the following plants recently installed by the Missouri Electric Repair Company, 16 South Ninth street, St. Louis: One 50-light incandescent dynamo for the Victoria Flour Mill Company, St. Louis, Mo.; one 100-light incandescent dynamo for the J. L. Ennis Candy Company, St. Louis, Mo.; one 100-light incandescent dynamo for the E. O. Stanard Milling Company, St. Louis, Mo.; also one 100-light incandescent dynamo for the E. O. Stanard Milling Company, Alton, Ill.; one 40-light incandescent dynamo for the Alton (Ill.) Roller Milling Company; two 350-light incandescent dynamos for the Nicholson Hotel, Nashville, Tenn.; one 80-light incandescent dynamo for the C. C. Shelton Milling Company, Chattanooga, Tenn. These dynamos, Mr. Tyler states, are remarkable machines. They are of very high efficiency, and will carry a load of 15 per cent. more than their rating. When full load is on the dynamo the brushes can be rocked for a space three-quarters of an inch without sparking at the commutator in the slightest degree or the voltage changing, and they regulate within 2½ per cent.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

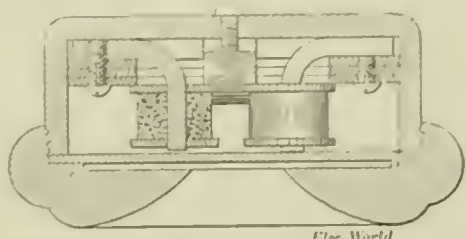
OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. **THE HAYDEN-BOOKER MANUFACTURING COMPANY,** 2140 DeKalb St., St. Louis, Mo.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED MAY 29, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

520,406. MAGNETO TELEPHONE; A. F. Boardman, Somerville, Mass. Application filed March 24, 1894. A casing for a ring magnet, combined with a magnet by means of a non-magnetic yoke whose ends engage the ring magnet secured at its middle to the casing. (See illustration.)



NO. 520,406.—MAGNETO TELEPHONE.

520,412. INSULATOR; C. E. Conover, Cincinnati, Ohio. Application filed May 20, 1893. In an insulator, a line wire groove transversely thereof, two bends, and a groove arranged diagonally with the line wire groove and leading outward from it to the end of the insulator and forming thereby ears, one at each end of the line wire groove for retaining the line wire therein.

520,427. CIRCUIT CLOSER; G. W. Hey, Syracuse, N. Y. Application filed March 11, 1893. This comprises a lever provided with one of the terminals of an electric circuit, a second lever provided with the other terminal of the electric circuit, and a connection between the levers connected to one of the levers with a lost motion.

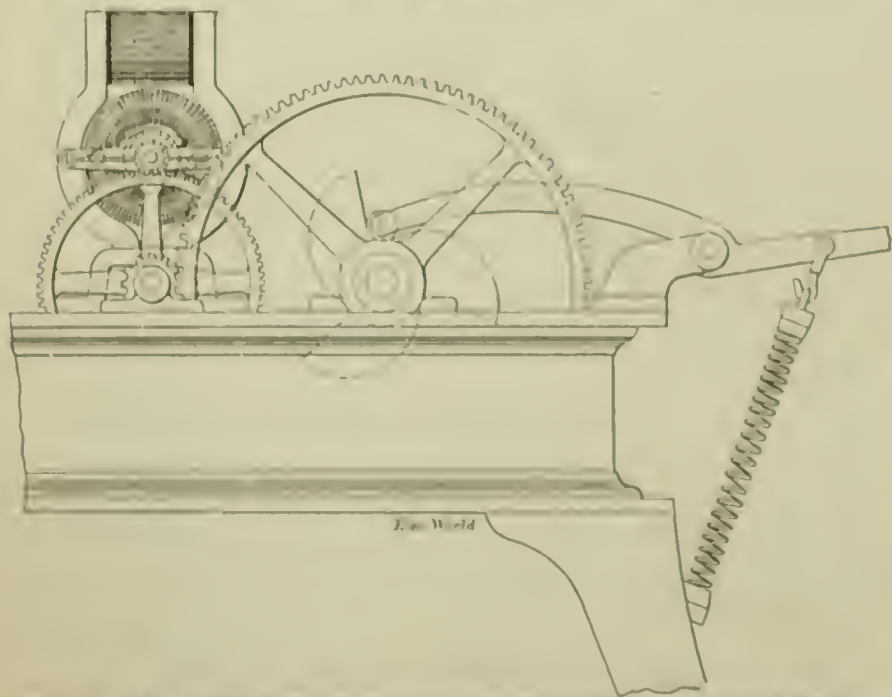
520,429. ELECTRIC BATTERY; S. H. Hoggson, St. Louis, Mo. Application filed March 6, 1893. In a battery having cells arranged in series and connected by adjacent terminals, the combination of a spring clamp, a coil above the clamp, and the terminal of an adjoining cell.

520,445. ELECTRIC CIGAR LIGHTER; D. Misell, New York, N. Y. Application filed Dec. 5, 1893. The combination of a battery jar with a spring plunger, a zinc element secured thereto, a pair of battery wires, an incandescent coil and a guard provided with an opening and with a socket back of the opening.

520,467. SPEAKING ATTACHMENT FOR TELEPHONES; W. Weber, Philadelphia, Pa. Application filed Feb. 15, 1894. This comprises a flexible speaking tube, a rigid arm, and means to hold the delivery end of the flexible tube contiguous to the transmitting diaphragm.

520,474. SWITCH; H. P. Ball, Bridgeport, Conn. Application filed March 12, 1894. This comprises a piece of sheet metal bent upon itself to form a switch blade, two sides of which are connected by a loop or fold, and a handle secured to the switch member by a single pin passing through the loop.

520,520. SAFETY SYSTEM FOR RAILROADS; W. H. Elkins, Cambridge, Mass. Application filed Oct. 22, 1892. This consists of a circuit closed by the presence of two trains on the same track, the resistance of the circuit varying as the trains are closer together and containing translating devices adjusted to translate a given current into a signal.



NO. 520,585.—ELECTRIC CLOCK-STRIKING MECHANISM.

520,543. TESTING SYSTEM FOR MULTIPLE SWITCHBOARDS; C. E. Scribner, Chicago, Ill. Application filed Aug. 24, 1891. A responsive device for test circuits, an electromagnet having a coil included in the test circuit, in combination with a transmitter having a diaphragm of magnetic material adapted to vibrate against the pole of the magnet, the contacts of the transmitter being included in a local circuit with a battery and a coil adapted to act inductively upon the circuit of a telephone.

520,547. FIRE ALARM APPARATUS; F. J. Thunhorst, Alle-

gheny, Pa. Application filed Feb. 26, 1894. The combination of an electric signal, a spring arm, a wire secured to the arm and to a fixed support, a series of tension cords of inflammable material engaging the wire, inflammable cords connecting the tension cords, and non-combustible links between the ends of the connecting cords.

520,585. ELECTRIC CLOCK STRIKING MECHANISM; C. D. Warner, Ansonia, Conn. Application filed April 6, 1893. The combination of a bell hammer actuating device, an electric motor and its circuit for operating the device, a time circuit armature acting to close the motor circuit, and a locking device acting to hold the armature in closed circuit position during the time of striking. (See illustration.)

520,602. INSULATOR; H. H. Luscomb, Hartford, Conn. Application filed March 19, 1894. This comprises a metallic case, insulating material therein, and the case having an intumed lip at its lower edge in contact with and forming a protection for the lower edge of the insulating material.

520,606. INSULATOR; L. McCarthy, Boston, Mass. Application filed Sept. 23, 1892. This comprises a case, a connecting piece therein and insulating material to insulate it therefrom, and a cap secured in place by bending the edges of the case over the cap, the connecting piece being provided on that portion which is outside the case with a shoulder.

520,614. ELEMENT FOR SECONDARY BATTERIES; S. A. Rosenthal and V. C. Doubleday, London, England. Application filed Dec. 5, 1892. This comprises a corrugated plate provided with a connecting tang, an active material, and an inclosing casing or box.

520,620. ALTERNATING CURRENT MOTOR; W. Stanley, Jr., Pittsfield, Mass. Application filed Feb. 1, 1894. This comprises a compensating synchronous motor having a plurality of circuits corresponding to and connected with those of the working motor, and clutch mechanism between the motors.



NO. 520,748. METHOD OF OPERATING ELECTRIC MOTORS.

520,661. ELECTRIC RAILWAY SIGNAL; C. Selden and H. V. Riley, Baltimore, Md. Application filed Feb. 16, 1894. This comprises two pairs of magnets oppositely arranged, the armatures thereof connected together, the armature of one pair adapted to be polarized during the energization of the magnets controlling the same, whereby upon the simultaneous energization of both magnets a bias is created in favor of the magnet operating the polarized armature.

520,673. THERAPEUTIC ELECTRODE; W. B. Farrar, Greensborough, N. C. Application filed April 5, 1894. An electrical apparatus comprising a supporting base having plate electrodes and a stand supporting the hand electrodes, said stand being detachably mounted on the base.

520,710. ELECTRIC RAILWAY SIGNAL; C. Selden, and H. V. Riley, Baltimore, Md. Application filed Feb. 16, 1894. This comprises two oppositely arranged magnets, the winding of one magnet being a continuation of the winding of the other, two armatures moving in unison, and a locking device for holding the armatures in position.

520,737. TROLLEY WIRE SUPPORT; B. J. Jones, Sioux City, Iowa. Application filed Feb. 5, 1894. This comprises a triangular supporting piece adapted to fit a bend in the trolley wire, its outer surface being on a plane with the wire, in combination with a bridge piece, a stirrup strap and means for adjusting the stirrup strap.

520,748. METHOD OF OPERATING ELECTRIC MOTORS; J. S. Bancroft, Philadelphia, Pa. Application filed Dec. 10, 1892. A rheostat switch regulating current to the field of the generator, a rheostat switch admitting current of a constant potential to the field of a motor, in combination with an interlocking device between the two switch levers. (See illustration.)

520,758. CONDUIT RAILWAY TROLLEY; W. Lawrence, New York, N. Y. Application filed Aug. 17, 1892. A plate formed in parts, insulating material around the same, a casing binding the parts together, and arms pivoted to one of the parts, the arms having contact wheels journaled therein.

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CRITICISM VS. ABUSE.

Our London contemporary, the "Electrical Review," in an editorial paragraph rather dictatorially and somewhat churlishly written, disposes of Dr. Pupin's method of long distance and submarine telephony and rapid telegraphy in a short leader, in which it is stated that the arrangement is old, is founded on fallacies, and instead of increasing working speed tends to do exactly the reverse; it further says that the question is not one of opinion but of stubborn fact, and predicts that a trial on an artificial cable would demonstrate that the system would not work. We will not discuss any question of fallacy or priority in the entire absence of any facts to support the charges made, but merely ask if our contemporary considers this method of criticism legitimate from any standpoint, scientific or otherwise. With all due consideration to its authority, it cannot expect in these days, when mere dicta, if even from Kelvins, are not accepted lacking demonstration, that such criticism can be considered legitimate. Dr. Pupin gives a very logical demonstration of the principles upon which the system so summarily criticised rests, and, however fallacious, they cannot be thus dismissed by mere assertions which, in the absence of any support, can justifiably be accepted as the mere expressions of prejudice. Such declarations belong in the same category with Lardner's declaration that ocean steamships were impossible, and with the Professor's condemnation of the principle of the incandescent lamp, and should be considered out of place in this day, when authority per se, even when as high as that of our esteemed contemporary, has little weight in the entire absence of facts to support it.

STORAGE BATTERIES.

We print elsewhere an abstract of the excellent paper by Mr. W. W. Griscom on storage batteries, read at the Philadelphia meeting of the American Institute of Electrical Engineers, which is one of the most useful contributions to the subject yet made. Important points brought out in the paper are that our knowledge of the chemical changes which occur in charge and discharge are still very incomplete, and that the internal conditions of the battery are constantly changing with reference to each other to a degree never heretofore suspected. That plates with precisely the same history and in precisely similar situations in a battery should give off currents varying as high as 30 per cent. is indeed singular, as is another fact mentioned, of neighboring plates presenting differences of potential to each other of .25 volt. In stead of the simple actions supposed to take place in storage batteries we learn that, on the contrary, every stage of charge and discharge presents different phenomena, and that local actions in a cell may assume very large proportions. The great diversity of opinion among professional electricians as to the commercial value of storage batteries is referred to, and rightly considered, we think, to be due entirely to whether experience was had with batteries worked beyond their actual capacity, on the one hand, or used well within it on the other. We cannot agree, however, with the conclusion that there is no necessity for changing the present rating in order to avoid the danger limit being continually approached, nor can we see the force of the argument that it is sufficient if a factor of safety is instead used. In all other branches of business a rating is supposed to be such that the thing to which it refers can be safely used at the capacity rated. A 50 h. p. steam engine means an engine that can be safely worked at 50 h. p., and there is always a margin on the

safe side, not the reverse, as with storage batteries. Those who have installed storage batteries know how difficult it is to keep a battery under ordinary circumstances from being overworked, and the difficulty there would be in inducing a purchaser to work it below the rate which entered into the price paid. It is very poor policy for a manufacturer to adhere to a rating when he knows that the consequence in very many cases will be failures of batteries of which he will have to bear the onus. To meet competition the nominal rating might be retained, but with the definite understanding that it is merely a nominal rating, and not to be confounded with another—the real rating of a battery for working purposes.

CENTRAL STATION STATISTICS.

In the Digest is an abstract from a recent paper on German central stations, which is particularly interesting in view of the data given in regard to storage batteries, which are now at last commencing to be adopted in this country for central station use. It will be seen that in four stations the machinery is run continuously at its highest capacity and in others with a load factor above .8. What this means is evident from a study of the recent report of the Massachusetts Board of Gas and Electric Light Commissioners, where apparently only two stations have load factors above .2. We may here remark that the Massachusetts report, admirable as it is, would have its value very largely enhanced if it included the load factors of the various stations and the annual output in kilowatt hours. Without one or both of these quantities some of the most valuable deductions from the otherwise very complete data can only be very roughly made. The large part which accumulators play in some of the German stations is also shown by other figures, the percentage of the total output taken from batteries being as high as 74.7 per cent., the lowest being 15 per cent. The efficiencies are not notable, except in their uniformity, the highest being 82 per cent. and the lowest 80. This is watt hour efficiency, of course, the ampere hour efficiency in any case showing little or nothing. The average price per kilowatt hour for electrical energy for lighting is very high, 18 cents, which is more than the usual charge in this country, but the average would probably be much less, as differential rate systems of charge are greatly in vogue on the Continent.

INDUCTANCE AND REACTANCE.

The London "Electrician" welcomes the two names, "inductance" and "reactance," adopted at the Philadelphia meeting of the American Institute of Electrical Engineers notwithstanding its expressed policy of disapproval of the multiplication of names of physical quantities. It refers to the doubt that has existed as to the meaning of the former term, some writers using it to express the coefficient of induction and others implying by it a quantity of which the coefficient of induction and current frequency are joint functions, and points out that the ambiguity has probably been due to the absence of a name for the latter quantity, which is now supplied by the term "reactance." This latter term is also pronounced a distinctly good one, "conveying, as it does, by contrast with 'resistance' the idea of an elastic reaction as opposed to an inelastic or power dissipating reaction." Now that our esteemed contemporary has relaxed its policy of opposition to the introduction of new names into electrical science, we trust that it will weigh carefully the advantages of the new names for the magnetic units before it puts up the bars again. In this connection we beg to call attention to the futility of the resistance that was encountered by some of the other names now so firmly fixed in electrical science, and to point out the weakness of opposition to a measure which, instead of being revolutionary, merely completes

an accepted system of rational nomenclature. It will indeed be a losing battle fought against a measure with this recommendation and one which would introduce a simplicity well illustrated, for example, by the contrast of the expressions, "sixteen thousand C. G. S. lines of force per square centimetre" and "sixteen kilogausses."

UNDERWRITERS' ELECTRICAL INSPECTION.

We learn from a newspaper that the Hartford, Conn., city council, owing to some recent fires of mysterious origin, employed an electrical expert to make an inspection of electric light wiring in buildings of the city, who has reported defective wiring in no less than fifty-seven offices and stores in the business part of the city, including two large hotels, and the city, as a consequence, has taken steps toward having the defects corrected. Almost every building inspected was reported more or less lacking in the requirements for safe wiring. Assuming that the defects reported were real ones, and that the buildings in which they were present carried insurance, the question naturally arises, why was the wiring passed by the electrical insurance inspector? It is no small reflection on electrical insurance inspection if, notwithstanding the great money interest at stake by insurance companies, city governments are thus compelled to revise the work of underwriters' experts in order to protect the community from fire. The rules of the International Electric Association of Underwriters' Experts, which, we presume, are in force at Hartford, are certainly sufficiently rigorous, and we very much doubt if any city government would attempt to add to their severity. Some time ago we referred to what seemed to be the absurdity of having city inspectors of interior wiring in view of the great interest of underwriters to secure the most rigid inspection, but this comment apparently does not apply to Hartford. We also learn that in some cases local underwriters' associations modify, both by omissions and additions, the above set of rules notwithstanding the great care taken in their preparation. In view of the extended examination to which each of the clauses was subjected by a large number of competent experts, who also had the assistance of advice from recognized scientific authorities, the necessity of such revisions is questionable. In many instances they are probably due only to the human weakness of desiring the credit of superior knowledge, or are the result of personal idiosyncrasies which should have no place in a matter where so much is at stake. There would seem to be a necessity for a national body for the regulation of insurance inspection, supported by the insurance companies, to which the experts of the various underwriters' associations would be subject as far as the proper observance of rules was concerned, and whose general inspectors would have supervisory authority over local inspectors. Then all revisions thought necessary could be submitted to this general body, which, with the aid of its consulting scientists, would be more likely to arrive at correct conclusions than would individual local inspectors. While insurance inspection is in very much better shape than it was two years ago, there is yet abundant room for improvement along the lines indicated, and it does not seem that any further progress of importance can be made until authority is given to some central body over inspection rules, and, through its general inspectors, over local inspectors.

Indicating Primary and Secondary Circuits in Drawings.

Mr. Hospitalier suggests that a uniform system might be adopted to distinguish between primary and secondary circuits on drawings, by adopting a red color for the former and blue (or black) for the latter, and remembering the same by a sort of analogy with the arterial and venous blood circuits.

O. B. Shallenberger.

In any list of the half-dozen great electricians whose labors have done most to advance the United States to the pre-eminent position she now occupies in the field of practical electricity, the name of O. B. Shallenberger would unquestionably appear, yet his personality is perhaps less familiar to the general electrical public than that of very many of its lesser lights. Of a retiring disposition and singularly averse to publicity, he has been content with the personal recognition freely accorded by those whose appreciation is based upon direct knowledge of merit alone, being otherwise apparently satisfied with the consciousness of his great share in the remarkable technical achievements of the company with which his name is indissolubly connected.

Oliver Blackburn Shallenberger was born at Rochester, Pa., in 1860. In 1877, at the instance of his uncle, who was then a member of Congress from Pennsylvania, he entered the United States Naval Academy as a cadet engineer. From the commencement he took a leading position in his class, and even at this early date became known for the excellent judgment, which afterwards was such a large factor in his success. About this time Prof. N. M. Terry had begun to develop the excellent course in physics which has added so much to the reputation of the Naval Academy, and Mr. Shallenberger had no sooner entered upon that study than he began to take a special interest in the department of electricity. His inclination from the first was toward original and experimental work, and among other experimental apparatus he constructed at that time—1880—was a Maxim lamp. It may here be remarked that Mr. Shallenberger's course at the Naval Academy was contemporary with that of Duncan, Sprague, Hasson, Wilkes and several others whose names are well known among electricians. After his graduation in 1881, Mr. Shallenberger made a cruise in the Mediterranean, during which he was present at the bombardment of Alexandria; he returned to the United States in 1883 and resigned from the Naval service the following year in order to give his whole attention to electricity.

In 1884 he became connected with the Union Switch and Signal Company, of Pittsburgh, as assistant in its newly organized electric light department. His abilities were at once apparent and the following summer he was selected to take charge of the setting up and operation of the Gaulard & Gibbs apparatus, imported from Europe by Mr. Westinghouse, at which time his practical acquaintance with alternating currents began. After Stanley's experiments at Great Barrington, Mass., and other experiments conducted at Pittsburgh by Mr. Shallenberger, the alternating current system was adopted, the Westinghouse company was organized and he was appointed chief electrician.

Mr. Shallenberger was one of the earliest to bring to bear upon the practical operation of alternating current systems of distribution the knowledge acquired by theoretical training. He manifested not only a clear comprehension of the theoretical and mathematical problems involved, but also a

marked ability to practically design and proportion apparatus.

During the rapid development of the alternating current system that immediately followed its adoption, Mr. Shallenberger was responsible for the electrical design of all the apparatus, personally superintended tests, and designed, erected and operated the pioneer transformers at Lawrenceville, Pa., located four miles away from the generators. Later he designed a great part of the central station apparatus required for the system, such as compensating voltmeters, synchronizers, etc., and contributed a large share of ideas for the design of generators and transformers.

Early in the operation of alternating current machinery it was considered a difficult matter to couple alternators in parallel, and Mr. Shallenberger was the first in America who succeeded in doing this. In order to determine the relative position of the phases so that the machines might be coupled together when in synchronism, he devised an ingenious phase detector for indicating the relations of the phases of respective electromotive forces, and thus insure the coupling in parallel when the machines arrived in step with each other.

Among the most important of Mr. Shallenberger's numerous inventions is the system of operating incandescent lamps in series with a shunt of high self-induction around each lamp. This system is extensively used for street lighting. The most beautiful of his inventions is undoubtedly the electric meter, and the history of its development is a good illustration of the alertness of Mr. Shallenberger's mind in grasping and applying the laws governing electrical phenomena.

One day, while observing the operation of a newly devised alternating current lamp, a small spiral spring became detached from some portion of the mechanism and fell upon an extended flange or disc at the end of the main magnet of the lamp. By a fortunate coincidence, the structure of the lamp was such that the spiral spring rested in a position where it was under the influence not only of the lines of force proceeding directly from the magnet coil, but also of those from the end of an extended core of soft iron wires. Some one present was about to replace the spring in its proper position when Mr. Shallenberger noticed that it had assumed a slight rotation about its longitudinal axis. Being unable to account for this action upon any previously known laws he made a careful study of the phenomenon. For instance, he placed the spring in a small glass tube and held it in a similar position and found that its rotation was caused, not by any jar of the lamp, but by electrical or magnetic action. He immediately realized the applicability to the operation of a meter of the force thus discovered to underlie the movement of the spring, and then commenced a series of experiments which Mr. Shallenberger conducted in rapid succession, all aiming to produce the simplest form of motive device to be operated by and to measure alternating currents. Within three weeks from the original experiments with the arc lamp (April, 1888), he had produced the Shallenberger meter in practically the same form as it now exists, and of which more than 80,000 are now in operation.



O. B. SHALLENBERGER.

After active work until 1891 Mr. Shallenberger was obliged to retire on account of ill-health, and spent a year in Colorado. During the past year, however, he has again taken up experimental work at his laboratory at Rochester, Pa., and is now consulting electrician to the Westinghouse Electrical and Manufacturing Company. The laboratory, where he now spends the majority of his time, is equipped with all the modern electrical apparatus required for careful tests and researches, and his time is largely devoted to investigations into the more advanced electrical problems. In addition to his purely technical work, Mr. Shallenberger has acted as expert upon electrical matters in a large number of patent cases.

That Fifty Thousand Dollar Prize.

In order to relieve itself of the odium connected with the recent sham electric railway competition of the Metropolitan Traction Company, the New York State Railroad Commission has issued a circular letter to competitors giving the correspondence leading to the withdrawal of the offer. In reply to an equivocal letter of the Traction company, the commissioners state their regret that the withdrawal of the offer had not been announced earlier. "Such notification," they say, "would have permitted the board to inform the public and the legislature of the abandonment of the offer, and it would seem in justice, particularly to the persons who have been induced by the publication of the offer to make application for permission to compete for the prize, that such notice should have been given."

The Berliner Patent.

Arguments were begun June 14 before Judge Carpenter in the United States Circuit Court at Boston in the suit of the United States Government to annul the Berliner patent of the American Bell Telephone Company. The bill of complaint states that Emil Berliner, of Germany, filed in the Patent Office at Washington on June 4, 1877, an application asking a grant of letters patent for certain improvements in combined telegraphs and telephones alleged in said application to be invented by him. The application rested in the Patent Office until Nov. 17, 1891, or about 14 years after the application was first filed, and the patent was granted on that day, but to the American Bell Telephone Company as assignee of Emil Berliner.

The United States contend that the Bell company controlled the Berliner patent during this period before the issuing of the letters patent, and that it made no attempt to secure the letters patent in that time, which was probably due to the fact that it was enjoying the privileges of the Bell patent, which controlled the electric transmission of speech. It is charged that the patent was unlawfully obtained and issued by the Commissioner of Patents, and is an illegal grant and ought to be annulled, for reasons, and further, as an act of duty and justice toward the citizens of the United States, whose rights and privileges are unlawfully and unjustly abridged by the Berliner patent.

Report on a Municipal Plant.

City Engineer Keating, of Toronto, Canada, has submitted an exhaustive report to the city council on the subject of street lighting, accompanied by data showing the cost of electric lighting in a large number of cities lighted by contract and in 18 cities lighted by works owned by the corporation, and the result of the inquiry is claimed to show that cities can do lighting much cheaper by owning the plant than by contract. From the report we abstract the following:

"Some of the reasons why municipal plants are able to

show a smaller annual cost than those owned by private companies are as follows: 1. In the construction of a municipal station the municipality saves the profit that a private company would of course expect to make. 2. A city is generally in a position to borrow money at a lower rate of interest than a private company. 3. Most of the plants owned by private companies in the large cities were put in some years ago, when the cost of electrical appliances was greater than it is to-day, while their efficiency was less. 4. In the construction of a private plant capitalists will not risk investing money unless they are assured of receiving good dividends, while all that the municipality requires is a sufficient return to pay the cost of running, including interest on the outlay, with a margin for renewals.

"There is throughout the continent a strong tendency developing toward municipal ownership of street lighting. Detroit is now installing a first-class electric lighting plant of its own, under the control of a public lighting commission. Minneapolis is also moving in the same direction. I am now in communication with the Cataract Construction Company, of New York, regarding the transmission of power from Niagara Falls, but no definite offer has yet been made by the company. There appears to be a difference of opinion amongst electricians as to the feasibility of conveying power from this source such a distance to compete with the stream.

"During 1893 the city paid \$135,243.17 for street and park lighting, of which sum \$105,293.56 was for electric lights and the balance for gas lamps. We have now in the city of Toronto about 1,000 arc lights and 1,100 gas lamps distributed throughout the city for street lighting purposes. The estimate given below is for a plant of 1,300 arc lights of 2,000 c. p., burning all night and every night, the intention being to shut off and discontinue all or nearly all of the gas lamps. The capacity of the proposed station will be sufficient to run about 1,500 lights.

"The estimated cost of a plant for 1,300 lights is as follows: Buildings, etc., \$42,000; engines and boilers, \$60,000; dynamos, \$40,000; poles, line and wires, \$100,000; lamps, \$40,000; add 10 per cent. for contingencies, \$28,200; total cost, \$310,000. This estimate is considered liberal, and I may say is largely in excess of the figures of those with whom I have corresponded. The estimated cost of operating this plant per annum is as follows: One chief engineer, \$1,500; one electrician, \$1,500; assistant engineers, \$2,000; two dynamo tenders, \$2,100; fifteen trimmers, \$7,500; two inspectors, \$1,600; two linemen, \$1,200; one helper, \$600; one driver, \$500; one clerk, \$800; one machinist, \$700; keep of horse, etc., \$175; coal, \$39,420; carbons, \$10,409; oil, waste, etc., \$2,000; interest 4 per cent. and depreciations, 6 per cent., on \$310,200, \$31,020; total, \$106,324. On the above basis the annual cost for 1,300 lamps would be \$81.78 each, and for 1,500 lamps \$75 each per annum; the city at present pays \$108.58 per lamp per annum."

English Journalism.

A prominent and well known London technical journal, dated May, 1894, announces quite seriously that it has just received information to the effect that the electric railway has developed wonderfully in America! It adds, by way of explanation, that the electric railway is most extensively used for traction (!) in place of horses. We are glad to be assured of the fact that a railway is used most extensively for traction purposes, but we are curious to know for what other purposes it is sometimes used in England. We fear that this news item got shipwrecked in its transit across the ocean a number of years ago and has just been picked up by a stray vessel and transmitted to its destination, where it was published without the editor's knowledge. Or perhaps it is an English joke.

SWITZERLAND AS THE PRESENT ELECTRICAL CENTRE OF EUROPE

BY FREDERICK BATHURST.

The switchboard, in the generating house, is of the simplest nature, containing only low tension apparatus, such as the measuring instruments for the exciting current and main controlling switches for the generators and exciting machines.

Upon leaving the converters the high tension conductors are brought out through glass tubes having hard rubber mountings, and taken directly through the nearest window onto double-shed insulators, completely protected on the outside from birds or missiles, by the wire netting before mentioned. The disposition of these wires is such that no one can reach them without purposely climbing over the converter cases to do so. It speaks well for the design of this plant and the future operation of the system that up to the present no accident has occurred by which any one has received a serious shock.

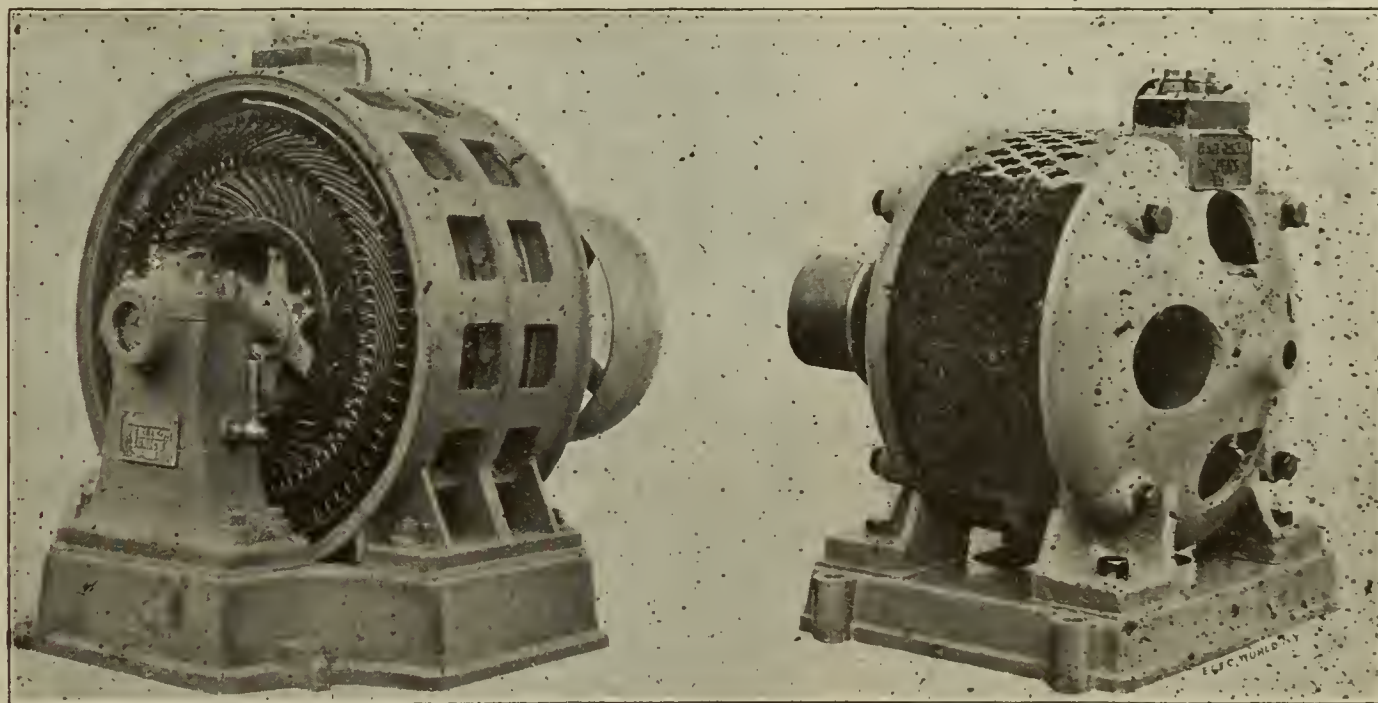
Before the leading wires from the converters are directly connected to the line wires, which come into the netting at one end and run the length of the building outside, there is in-

About every fourth pole is provided with a ground plate and a wire which passes up the side so as to act as a lightning conductor rod.

Although breakdowns on such a long length of line do occur, hitherto they have been unimportant as regards the satisfactory and continuous working of the plant. Upon the same posts, at an average distance of 2 feet 6 inches, below the four line conductors, two telephone wires are run.

The arrangement of the line where it crosses a public highway is interesting, an auxiliary guard wire netting being placed under the conductors, so that, in case of breakage, it is impossible for the ends to fall within reach of passers-by. On one or two occasions the high tension current has got onto the telephone wires, but no damage beyond the fusing of the ends or safety lengths has resulted.

The generator attendant has instant warning of the trouble by the extra "buzz" of his converters. He is amusingly graphic in his description of this method of recognizing the occurrence of a "fault." Several fatalities have occurred in Switzerland from the telephone wires being on the same



60 H. P. AND 3 H. P. THREE-PHASED MOTORS.

serted a short length of thin silk-covered copper wire (about 2 feet of No. 24 B. & S. gauge) upon each of them. These lengths act both as safety fuses and lightning arresters. In case of the disruption of any of them, the attendant before replacing them telephones to the works, and the generators are temporarily shut down during the few minutes the operator requires. The two converters in use are connected onto the line wires in parallel.

The line consists of four bare copper wires, each four millimetres in diameter (equivalent to No. 8 B. & S.) Only three of these conductors are used, the others being held in reserve. The line has a total length from station to works of 24 kilometres, that is, 15.35 miles.

In the construction of the line, consideration was given to the desirability of having as few points of support as possible, so that the spans are often 100 metres (110 yards) long.

posts, but in every case it has been where they were placed above the line conductors. The recognized practice now is to place them below.

Where the line has to cross a railway track the practice has hitherto been to insert a length of underground cable, but owing to the trouble at these points, the railway companies now recognize the necessity of their being continued overhead, ordering, perhaps, the erection of an iron work supporting frame to obtain solidity.

In connection with recent discussions on alternating current transmission, it is interesting to note that this line is provided with an ample circular mileage cross-section, for with an average potential of 13,000 volts and a load approximating 340 kw. the loss in transmission is only about 2.1-2 per cent.

The high pressure current is received at the Oerlikon end in a similar way to that in which it leaves the generating sta-

tion, the converter arrangements being duplicated, but the ratio of retransformation is different, the shop system being supplied at 190 volts.

Distributed throughout this large establishment there are 40 motors, varying in capacity from 3 to 80 h. p. and running at speeds from 2,000 to 500 revolutions per minute.

A continuous current man can hardly fail to be "converted" into an alternating one when he examines and watches the operation of these motors, which, without commutator or brushes and minus a comparatively huge starting box, do every kind of work required of them in a machine shop, running perfectly without even the usual minimum of attention.

A 60-h. p. standard motor, with eight poles, which runs at 750 revolutions, is shown herewith. These figures are given upon the basis of 50 cycles per second and are the speeds of the armature when running light; it is estimated that on full load there is a "slip" of 4 per cent.

A 3-h. p. standard motor is also shown, which has four poles and runs at 1,500 revolutions; for those applications where slower speed is desired, it can be designed with 6, 8, 10 or even 12 poles, when the speed will become 1,000, 750, 600 or 500 revolutions, respectively.

Interior views of the shops are given below, illustrating the practice of placing the smaller motors on bracket supports built into the wall. In this way floor space is econo-

insertion of a resistance in the armature circuit, which, when starting up, is cut out in the ordinary way, or by the intervention of special or extra converters, in which the number of active coils in the secondary circuit can be adjusted to the speed of the motor. By these arrangements the armatures are protected from excessive currents and from disturbing the remainder of the circuit. All these motors can be overloaded as much as 50 per cent. without mishap, and the speed with such overload does not drop more than 10 per cent. Power for power, they are individually lighter than continuous current machines, occupy less space and present less chance for electrical or mechanical injury.

It is perhaps the cut which illustrates one of the 10-ton shop cranes, which more than any of the others brings home the conclusion that this system is eminently suited to the requirements of factory work. These cranes are fitted with three motors, two of 3-h. p. capacity for the traversing and the cross travel of the trolley carriage, respectively, the others of 9-h. p. capacity for hoisting. The movements actuated by the two small motors are controlled without any other apparatus except a double headed three-pole switch, the blades being thrown either to one side or the other, as "forward" or "reverse" is required. The 9-h. p. motor has a simple form of iron feed resistance box with six contacts. This is small and compact, and can be seen in the cage.

This crane, as operated by three-phased motors and the screw gearing of the Oerlikon pattern, is probably unique in its simplicity of construction and operation.

The first cost of shop tools of this nature will now no



INTERIOR VIEWS OF SHOPS SHOWING BRACKET MOTORS.

mized and both motor and belting placed out of reach of the workman, either for accident or experiment. In Fig. 6 the motor in the foreground is one of 6-h. p. capacity, has six poles and runs at 1,000 revolutions. The simplicity of the wiring and starting arrangements is evident; all that is required is a three-pole switch fitted with safety fuses.

The motor will start from rest, with or without load, gaining its proper speed some 20 or 30 seconds after the switch blades have been thrown in.

One of the cuts shows two 12-h. p. motors having six poles and running at 1,000 revolutions. They are arranged above a fitting bench and the same simplicity of controlling arrangements is apparent.

In some instances, depending upon the size of the generating plant and the capacity of the individual units employed, special starting arrangements are made, either by the

longer be the factor militating against their adoption in any machine shop of any pretension.

The last view indicates that the Oerlikon works have long passed the experimental stage in the manufacture of machines for this system. It represents the frame and stationary armature of a 300-h. p. generator, which is to generate 5,000 volts when running at a speed of 250 revolutions. The machine is designed for use in a steam power plant, the usual form for turbine driving in a water power plant being horizontal.

Those who have seen this installation and distribution of power must conclude that the three-phased system can immediately compete with a continuous current distribution, weight for weight of material employed, and have many advantages in application, and particularly in long distance transmissions, and prove safer and more economical.

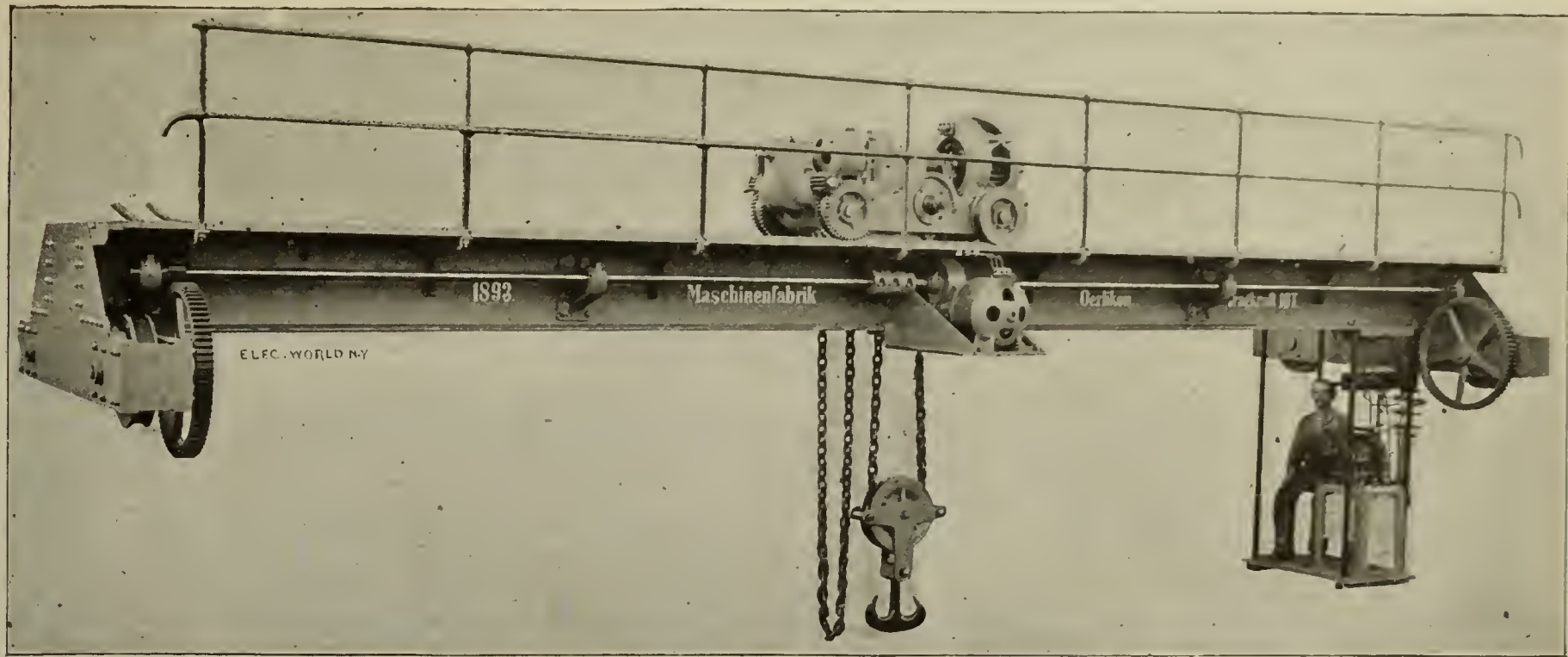
The motors are simpler, mechanically and electrically, cheaper and more compact, and never burning out, prove positively reliable.

To Mr. C. E. Brown, who is now concentrating his attention on the two-phase system, must be given the credit for the first commercial development of this installation, but he

Measurement of Phase Difference.

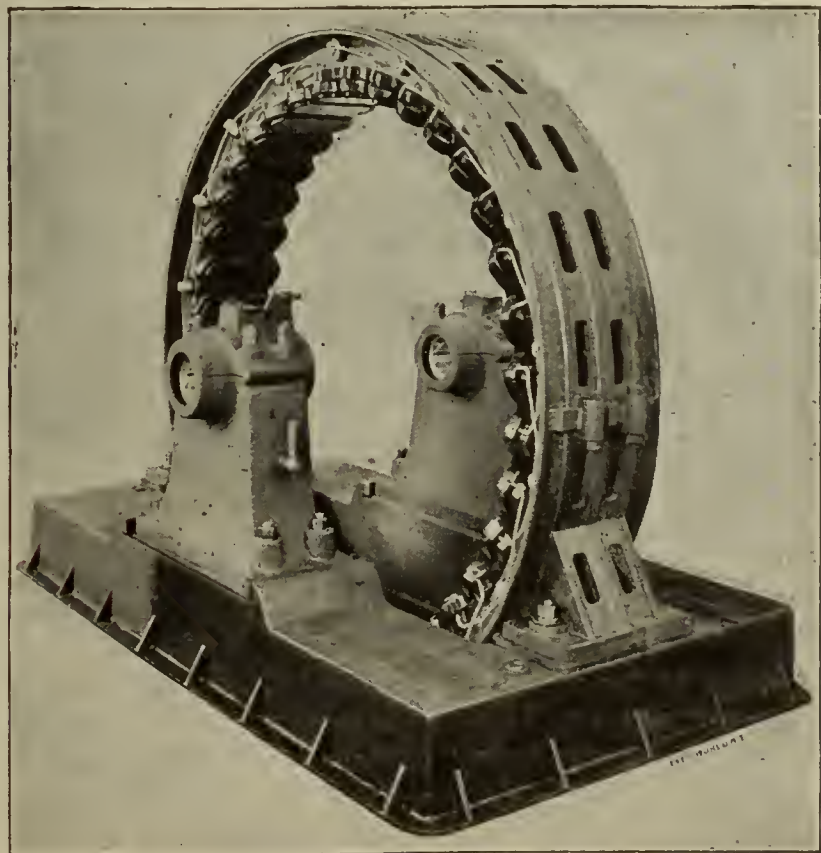
BY W. STUART-SMITH.

In The Electrical World of Feb. 10, 1894, I explained the principles of an instrument for giving the phase angle between a current and its E. M. F., and at the same time



SHOP CRANE OPERATED BY THREE-PHASED MOTORS.

has been equally ably seconded in his pioneer work by Messrs. Huber and Kolber, who have effected the important work of standardizing types and sizes, so that the system can be placed on the market, but whether it is a two or a



FRAME OF 300 H. P. THREE-PHASED GENERATOR.

three phased system, those who have seen the recent developments in Switzerland will admit that they are here finding an application that has no comparison in any other country.

A New Definition of a Dynamo.

According to a London contemporary a reporter asked whether a dynamo was not a kind of reservoir and was told that "it was a kind of boiling tank to keep the electricity hot."

showing the shape of the two waves. At the close of the article I mentioned another instrument for showing the phase angle only, but did not state the principle involved, because I considered it would have a commercial value, and I intended taking out a patent for it.

The principle involved is that of showing the angular difference in position between two shafts revolving at the same speed, and as the paper read by Dr. Bedell at the annual meeting of the Institute of Electrical Engineers at Philadelphia shows that this principle is being considered, I give here a description of the instrument as I intended it to be made for use in central stations and generally where the phase angle is desired for practical reasons. I described the instrument verbally to Mr. William Rosenbaum last February.

One form is as follows: Two small motors would be set in line with each other, one having a hollow shaft, through which passes the shaft of the other, the two being concentric. The motors would have field magnets symmetrical in all parts so that if the entire machine was revolved there would be no tendency to vibration. One of the motors would be in the main circuit and run in synchronism with the current, and the other would be connected across the circuit and run in synchronism with the E. M. F. Each shaft would be provided with a slight stiff band and one of the shafts would also carry a disc which would be graduated in degrees, a greater or smaller portion of the circumference representing 360 degrees, depending upon the number of poles in the motors. Both motors would, of course, have the same number of poles.

Both hands being against a stop, and consequently the reading of the scale being zero, if switches be closed, putting the two motors in their respective circuits, they will soon come into synchronism, one with the current and the other with the E. M. F., and the hands will take up positions making an angle with each other which is the angle of effective phase difference. This angle cannot be read, however, as the hands are revolving at high speed, but a simple clutch can be arranged to secure them in their relative positions and the switches being opened and the motors stopped the angle can be read off the scale. Or, otherwise,

let a brass casing be placed over both motors and secured to the two fields; a spider will enable this casing with its enclosed motors to be secured to the shaft of a third small motor set to run in a direction opposite to the first two. Now, when the first two are running and have settled into their respective positions, if the third motor be started it will turn the casing, motors, dial, etc., in the opposite direction with the same speed at which the first two motors are revolving. The effect will be that the hands will appear to stand still and the only motion seen will be an increase or decrease of the angle between them as the load on the dynamo changes. The motors can be small, as the first two have only to overcome their own friction, and the third can be any small motor revolving at the same speed as the other two.

Instead of the motors being on the concentric shafts they can be separate and be connected to the shafts by bevel or other gearing. There being no angle between the shafts start the motors and when they have settled into synchronism with their respective circuits lock the shafts together record. This would be the simplest form for station work, and the reading could be taken in a few moments after closing the switches.

On the Measurement of the Power of Polyphased Currents—III.

BY ALEXANDER D. LUNT.

Framing this expression in words, it may be said that the mean power expended in a polyphased system is represented by the summation of a series of quantities, each found by obtaining the mean product of the current in each line conductor by the difference of potential between the terminal of that conductor and the terminal of some one conductor nominally selected as a standard. Thus, in a system of n line wires there will be $n - 1$ such products necessary to represent the mean power. In order to obtain the mean expended in the system, it is only necessary to ascertain the mean value of each of the separate products by the use of an electro-dynamometer or any other means of measuring the mean power of a simple alternating current, as will be referred to later.

It will thus be seen that the power of a polyphased cur-

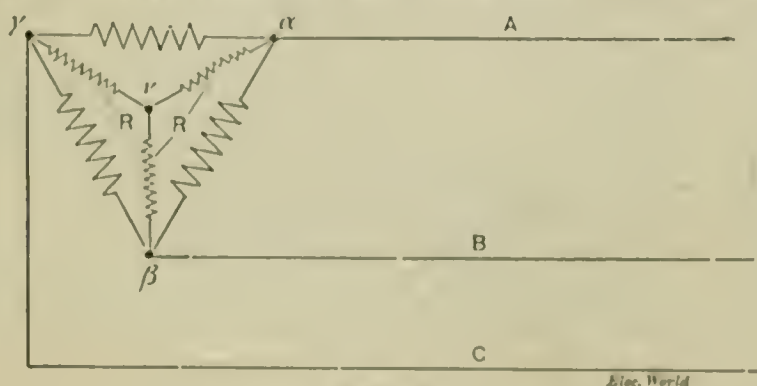


FIG. 3.

rent is not such a complex quantity as might at first be thought.

Hitherto the above result has been reached either in a less natural way, or on assumptions based on the form of the circuit in which the energy is utilized.

The above expressions may easily be transformed so as to correspond with formulae given by other writers. Thus, adding (3), (4), and (5),

$$3\rho = A(\alpha - \gamma + \alpha - \beta) + B(\beta - \gamma + \beta - \alpha) + C(\gamma - \alpha + \gamma - \beta) \quad (6)$$

$$= A[3\alpha - (\alpha + \beta + \gamma)] + B[3\beta - (\alpha + \beta + \gamma)] + C[3\gamma - (\alpha + \beta + \gamma)]$$

whence

$$\rho = A\left(\alpha - \frac{\alpha + \beta + \gamma}{3}\right) + B\left(\beta - \frac{\alpha + \beta + \gamma}{3}\right) + C\left(\gamma - \frac{\alpha + \beta + \gamma}{3}\right)$$

a formula identical with that derived by M. Blondel.* In the application of this formula it is necessary to make such connections between the terminals as to produce at some point on those connections an intermediate point having a potential $\frac{\alpha + \beta + \gamma}{3}$. This may be done by joining the terminals through equal resistances R , which preferably should be large and as nearly non-inductive as possible. The connections are shown diagrammatically in Fig. 3. Call

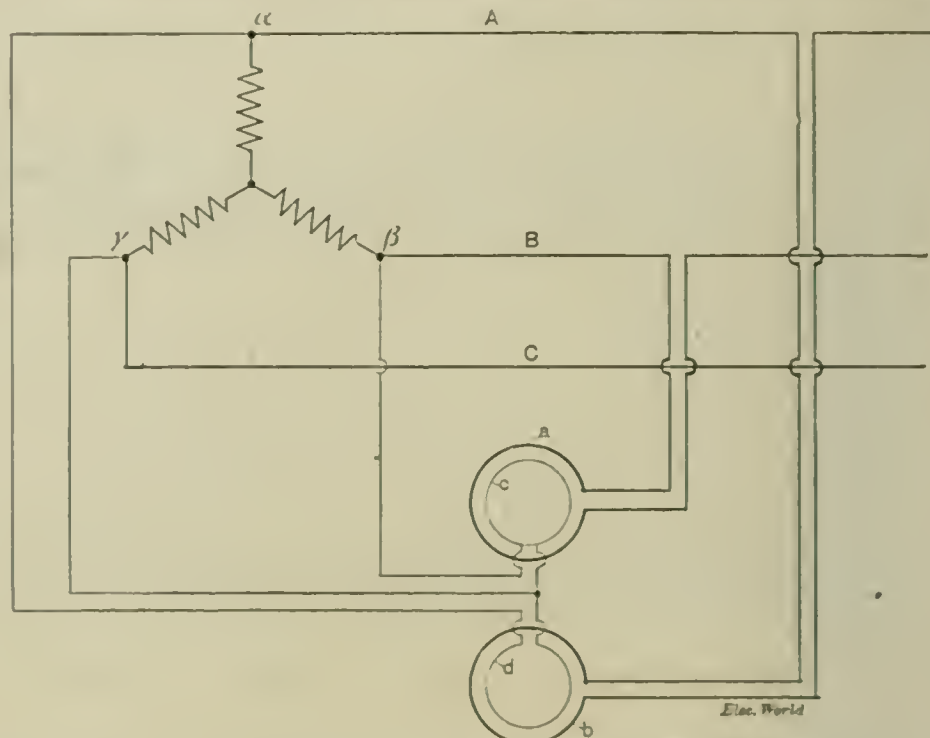


FIG. 4.

the potential of this junction v . Then from the principle of continuity it is evident that

$$\frac{v - \alpha}{R} + \frac{v - \beta}{R} + \frac{v - \gamma}{R} = 0,$$

whence

$$v = \frac{\alpha + \beta + \gamma}{3}.$$

Hence, by this method the mean power of a polyphased system is the sum of the several integrated products of the current in each line wire by the difference of potential between the point v and the terminal corresponding to the line wire.

If the differences of potential between the principal conductors or line wires be denoted by Δ_α , Δ_β , Δ_γ , such that $\Delta_\alpha = \alpha - \beta$, $\Delta_\beta = \beta - \gamma$ and $\Delta_\gamma = \gamma - \alpha$,

then by substitution in (6) it follows that $\rho = \frac{1}{3} [A(\Delta_\alpha - \Delta_\gamma) + B(\Delta_\beta - \Delta_\alpha) + C(\Delta_\gamma - \Delta_\beta)]$ which is identical with a formula deduced by Herr Georges.** It is, however, much more inconvenient to use than either of the equations indicated above, since it requires six measurements to be made instead of either two or three.

In the two methods last indicated the mean power is to be obtained as in the first method, by measuring the mean products of current and difference of potential, as indicated by the relations of the instantaneous values expressed by the equations for the instantaneous values for power.

All of the above methods are general and are perfectly applicable to practical measurements, and do not depend on the form of the circuit in which the energy is expended, and, as will be noted, are not coupled with any restrictive hypothesis.

It will be observed that in obtaining the above formulae no account whatever was taken of the manner in which the terminals of the line wires might be connected, the derivation being concerned only with the number of line conductors and the respective potentials at the terminals of those conductors. Since two and three phased systems each in general

* "Lumiere Electrique," Jan. 21, 1893, page 139.

** "Elektrotechnische Zeitschrift," 1891, page 212.

employ three line wires, it thus becomes apparent that the mean power of each system may be measured in identically the same manner, so that in either case, given the three line wires and the three terminals, the measurement may be carried out irrespective of the connections between those terminals and with entire disregard as to whether a two or a three phased system is being dealt with.

In carrying out the measurements in practice any of the usual methods of measuring the mean power of variable or alternating currents may be employed in making the separate measurements. The ordinary alternating current wattmeter furnishes probably the most convenient and perhaps the most accurate means for this purpose. The instrument should be constructed with as little self-induction as possible in the series coil, as well as in the so-called fine wire coil. If the impedance of the series coil be negligible, it will not then be necessary, when the said coil is introduced into one of the line wires, to likewise introduce a coil of equal impedance into the other line wires, as would otherwise be necessary for the purpose of preserving the symmetry of the system and preventing a redistribution of the currents therein.

Likewise, if the fine wire coil be of such character as to permit a non-negligible current to pass, then, as before, precautions must be taken to prevent any change in the distribution of the currents when this coil is connected in place, and this may be done by placing similar coils in like manner between the other conductors. Other precautions necessary in particular cases will readily suggest themselves.

In place of the ordinary wattmeter used in making the separate readings, one may employ instruments especially constructed to reduce the number of readings necessary. Such an instrument may consist of a mechanical combination of a number of wattmeters in such a manner that the readings of all the wattmeters are added together and appear as a single reading of the combination wattmeter. This result may be accomplished by placing the required number of movable coils rigidly secured together on a single axis, but free to turn about the common axis, and with the corresponding fixed coils secured in proper relation therewith. There should, of course, be no mutual induction between any of the coils. The turning moments due to the several pairs of fixed and movable coils may thus be added together, and in this manner the number of readings required in measuring the power of a polyphased current may always be reduced to unity.

The application of such a dynamometer to the measurement of the power of a three-phased current is illustrated in Fig. 4, wherein *a* and *b* are fixed coils and *c* and *d* the corresponding movable coils. The movable coils are so connected as to produce a turning moment in the same direction about their common axis. The turning moment thus produced may be measured by any suitable means, such as the usual spring and dial of the ordinary Siemens dynamometer. After calibration of the instrument the reading thus obtained gives at once the value required. The power of a polyphased current may thus be measured by a single reading.

Diseased Germs Transmitted Through Telephone Circuits.

That diseased germs are deposited on the mouthpieces of microphones and are thereby conveyed to other persons using the same instruments is an old and well-known fact, but the editor of a prominent Philadelphia daily, who has a dangerously small amount of knowledge about electricity, puts new life into this statement by explaining to the public that even diseased germs are now transmitted over telephone circuits, and he warns the public not to converse by telephone with any person having a contagious disease.

A Method for Measuring Telephonic Currents and Electromotive Forces.

BY HARRIS J. RYAN.

In some investigations that have recently been undertaken in the laboratories of Sibley College, at Cornell, I have employed the following method for the measurement of telephonic currents and E. M. Fs. Reference is made to the accompanying diagram, in Fig. 1. A modified form of dynamometer is used. The swinging coil is wound with from 50 to 100 turns of fine wire, through which the telephonic current is passed. About the swinging coil a strong alternating field in unison with the telephonic current is produced by passing a suitable alternating current through the field coil, with regard to which more will be said later on. The zero method is used for measuring the forces exerted on the swinging coil. The zero position of the coil is taken, so that it receives no induction from the powerful alternating field in which it is placed. A D'Arsonval galvanometer is so mounted and arranged that its coil may be rigidly attached

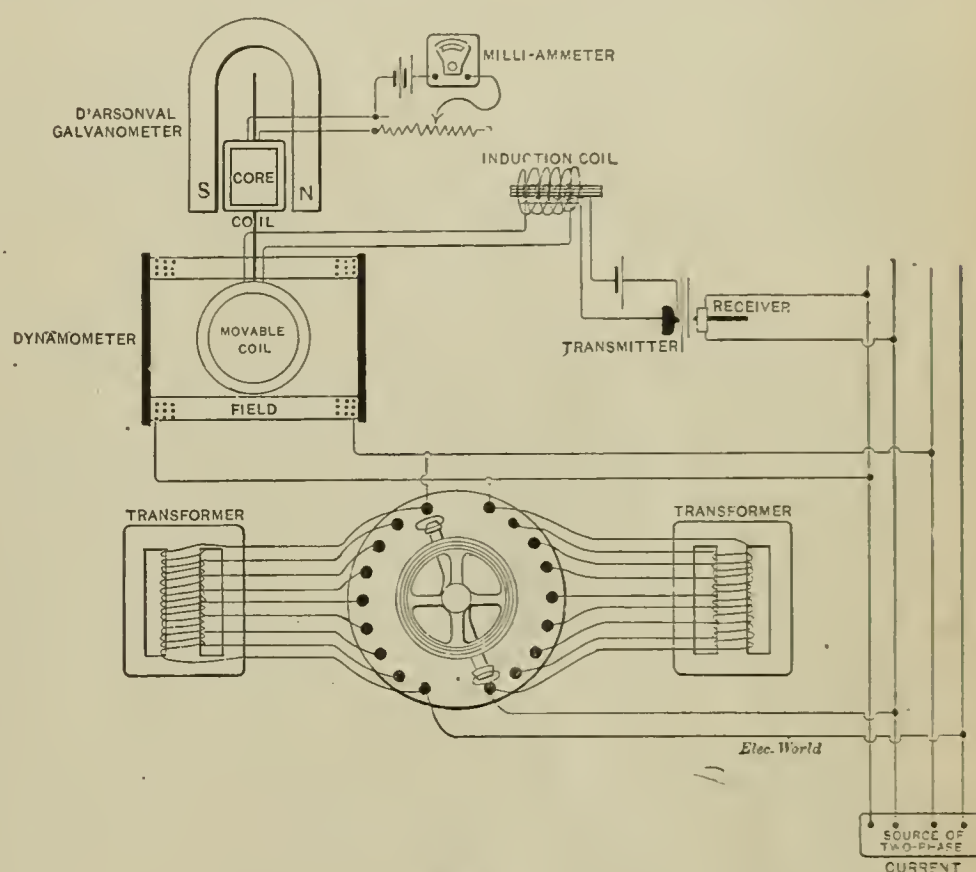


FIG. 1.

to the swinging coil of the dynamometer. Direct currents are established through the D'Arsonval coil in such a direction as to set up a moment that is opposite that produced by the telephonic current in the coil of the dynamometer. When the dynamometer coil is thus brought back to zero, the current through the D'Arsonval coil is taken as a measurement by calibration of the telephonic current, and is read on the Weston instrument.

In order that the field coil of the dynamometer may be brought into unison with the telephonic current, the note sounded in front of the transmitter is produced by one of the currents from a two-phase alternator. The current through the field coil of the dynamometer is delivered from a special two-phase transformer that affords the delivery of any desired phase. Those who have read Mr. Scott's recent valuable paper before the National Electric Light Association will understand readily the principles of operation of this transformer. Two coils that are surrounded by closed magnetic circuits of laminated iron are connected to the two-phase circuits of the alternator, as indicated in the diagram. From the turns of these coils taps are taken off at proper intervals, and led to respective points on the contact switch. The contact switch enables one, by turning the hand wheel, to connect in series certain amounts of E. M. F. from one of the phases with desired amounts of E. M. F. from the other. These amounts are chosen so as to maintain the resultant

E. M. F. constant in amount but differing in phase by about five degrees from point to point on the contact switch. The diagram in Fig. 2 illustrates a graphic method for obtaining the interval values of E. M. F. that should occur between the contacts on the switch, so as to obtain a constant resultant E. M. F., whose phase position is uniformly changed from contact to contact. When the interval amounts of E. M. F. cannot be obtained by the use of complete turns in

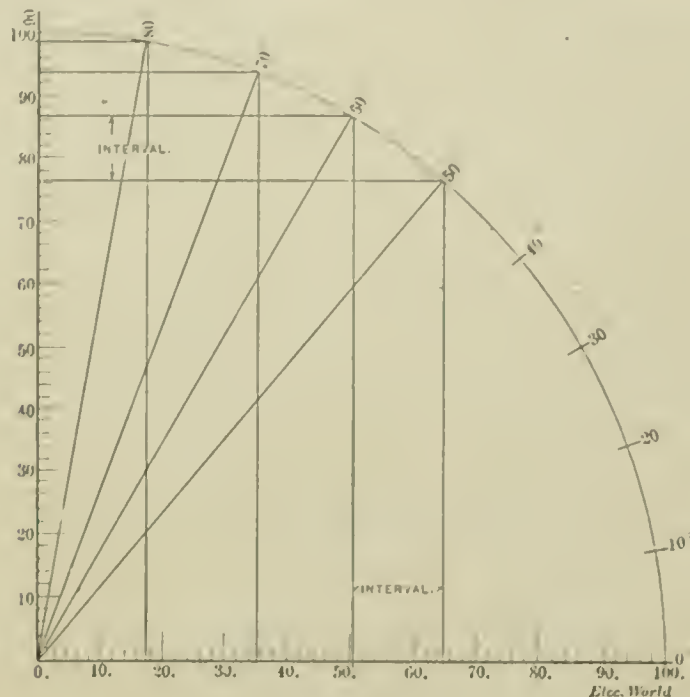


FIG. 2.

the transformer, the loops are taken out at a point that is nearest the required point, and on their way to the contact switch are led around a smaller auxiliary magnetic circuit excited by a primary winding that is subjected to the same phase pressure as the coil from which the loop is brought. Such an auxiliary electromagnetic circuit is provided for each of the two phases. The turns of the primary and the cross-section of the magnetic circuit are so designed that the E. M. F. generated in five turns will be equal to that developed by one turn in the main coils, which is about one volt.

One recognizes promptly when the field current of the dynamometer is in unison with the transmitter current in the moving coil, since at this point a change of the phase of the field current in either direction will diminish the moment tending to turn the suspended coil.

The calibration of such a measuring apparatus is made with Weston direct current instruments in an obvious and simple manner. A voltmeter is used for measuring the current through the suspended coil.

Spirals of annealed silver foil, arranged according to Mr. Weston's well-known method, are used for leading the small currents into the suspended dynamometer coil and the D'Arsonval galvanometer coil.

The same method is readily adapted to the measurement of telephonic E. M. F.s. Other methods can be employed for shifting the phase of the field coil current, but the above method we have thus far found to be the simplest and best.

Electric Nomenclature and Terms.

According to a French journal, Mr. Hospitalier, the leading French advocate of definite and universal electric terms, is announced to give a lecture on "Polymorphiques" transformers and generators, by which term is probably meant those machines which generate or transform different kinds of currents.

A Profitable Business.

At a recent meeting of the Institute in Philadelphia one of the members was heard to remark to another that to be both a consulting electrical engineer and a contractor was like being both a doctor and an undertaker.

Magnetic Formulæ.

BY REGINALD A. FESSENDEN.

In a recent issue of The Electrical World the statement was made that the relation expressed by the formula $\lambda = a + b \mathcal{H}$ (where λ is the ferric reluctivity or $\frac{\mathcal{H}}{\mathcal{B} - \mathcal{H}}$) is not a physical law, but merely an empirical statement.

It is undoubtedly true that Mr. Kennelly may have hesitated to put this formula forward as a physical law, in spite of the fact that all experiments made to test this rule have only the more firmly proved its correctness.

In the opinion of the writer, expressed at various times during the last two years, this formula is not only the expression of a physical law, but it is the only definite magnetic law expressing a relation between the quantities which enter into the formula for the flux in a ferric circuit, of which we are sure; and it is also believed that it is to the development of this law that we must look for any satisfactory quantitative law of magnetization.

This is for the following reasons:

1. It holds, within the limits of experimental accuracy, and with pure iron, between the limits of $\mathcal{H} = 1$ or 1.1-2 to $\mathcal{H} = 150$, and probably higher. It holds for iron, nickel and cobalt. It holds, with the slight modification necessary, for the hysteresis curve of soft irons. It, therefore, stands upon the same kind of ground as Newton's laws of motion, whose only proof is that they hold in all cases where they have been tested, but in regard to whose physical meaning we are absolutely ignorant.

2. It can readily be thrown into a form in which it is analogous to the expressions connecting the relation between stress and strain in a great number of other cases.

This is best seen by expressing the ferric reluctivity, λ , in terms of the ferric induction, $F (= \mathcal{B} - \mathcal{H})$.

We have

$$\lambda = a + b \mathcal{H}. \quad (1)$$

Therefore, since $F = \mathcal{H} / \lambda$

$$\mathcal{H} = a F + b F \mathcal{H}. \quad (2)$$

Substituting for $\mathcal{H}$ in the right hand member, its value as given in (2), we get $\mathcal{H} = a F + a b F^2 + b^2 F^3 \mathcal{H}$.

Continuing this process, we get

$$\mathcal{H} = a F + a b F^2 + a b^2 F^3 + a b^3 F^4 + \dots + a b^n F^n + \dots + b^n F^n \mathcal{H}.$$

This series is convergent for all values of $\mathcal{B}$, for, since $F = \mathcal{H} / \lambda = \mathcal{H} / (a + b \mathcal{H})$, it is evident that $b F$ is always less than unity (except, of course, when a is zero, as Mr. Kennelly has shown it is in the case of nickel stretched by a certain weight, when $\lambda = b \mathcal{H}$).

(It is also easily shown that the last term, $b^n F^n \mathcal{H} / a$ is negligible.)

Therefore,

$$\mathcal{H} = a F \sum_{n=0}^{\infty} b^n F^n,$$

or dividing both sides by F

$$\lambda = a \sum_{n=0}^{\infty} b^n F^n.$$

This expression is of a type very commonly met with in physical problems, and it means simply that, when any given induction has been attained, that the magnetic resistance is proportional to the zero, first, second, third, etc., powers of that induction.

This is an extremely simple law. The writer has not attempted, as yet, to work out a theory which should give this law, but at first sight it would appear comparatively a simple matter. We know, from the various modified forms of Van der Waal's equation, and from the experiments of Pictet, Amagat, and others, and the work of Tait and other physicists, that the distance between the surfaces of two adjoining iron atoms is on the average 20 to 50 per cent. of the diameter of the atoms themselves. We may also suppose, with

Prof. Fitzgerald and others, that the magnetism of the iron atoms is due to a current circulating in a non-resistant path round the atom. We know approximately the sizes of the atoms, the magnetic moment of an atom, and, therefore, the quantity of electricity circulating on the atom. Therefore, the problem becomes: Having given the distances, dimensions, current fluxes, etc., as above, to show that, when a steady state is set up, that if a certain number of atoms be turned (as in Prof. Ewing's theory), that the reluctance is proportional to the series of the powers of the induction produced.

3. The beautiful simplicity it introduces into all magnetic calculations where the permeability varies with the induction. Mr. Kennelly has already indicated its uses in dynamo calculations, but there are a number of derived formulae which have great use.

Take, for instance, Mr. Carichoff's paper on the design of electromagnets. Here we have to make $\frac{d\mathcal{H}}{d\mathcal{B}}$ in the air gap equal to $\frac{d\mathcal{H}}{d\mathcal{B}}$ in the iron. By the use of the formula, we

can write at once, $\frac{d\mathcal{H}}{d\mathcal{B}} = \frac{a}{\lambda^n} = a / (a + b \mathcal{H})^2$,

and so solve the problem immediately, without making any drawing. This equation is got from the equation $\mathcal{B} = \mathcal{H} / (a + b \mathcal{H})$, by differentiation, and is of use in other problems.

It is for the above reasons that the writer believes the formula $\lambda = a + b \mathcal{H}$ to be a physical law, and not an empirical relation, and to be the fundamental law of ferromagnetism.

Practical Notes on Dynamo Calculation—VI.

BY ALFRED E. WIENER.

14.—Weight of Armature Winding.

A copper wire of 1 circular mil ($= \frac{1}{1,000,000} \times \frac{\pi}{4}$ sq. in.) area weighs .00000303 pound per foot of length; our armature conductor of δ_a^2 circular mils sectional area, therefore, has a weight per foot of .00000303 $\times \delta_a^2$ pound. And the total L_t feet of it, used in winding the armature, will weigh:

$$lb._a = .00000303 \times \delta_a^2 \times L_t; \quad (28)$$

$lb._a$ = weight of bare armature winding, in pounds;

δ_a^2 = sectional area of armature conductor, in circular mils, from formula (4);

L_t = total length of armature conductor, in feet, formulæ (19) to (27), respectively.

In case of round gauge wires, the product .00000303 $\times \delta_a^2$ is contained in the gauge table under the heading "lbs. per foot," and consequently the bare weight of the winding is found by simply multiplying the respective table-value by the total length, L_t , and, eventually, by the number of wires, p , stranded in parallel.

If, in case of heavy rectangular or wedge-shaped armature bars, the cross-section, δ_a^2 , is given in square inches, the numerical constant in the above formula (28) should be replaced by 3.858, this being the weight per foot of a copper bar of 1 square inch sectional area.

When standard gauge wire is to be employed in winding the armature, it is desirable to know the weight of the winding, including its covering, particularly in the case when insulated wire, such as is obtainable from wire manufacturers, is to be used. This covered weight of the winding can be expressed as a multiple of the bare weight, by the equation:

$$lb._a = k_s \times lb._a = .00000303 \times k_s \times \delta_a^2 \times L_t \quad (29)$$

in which k_s is a constant depending upon the ratio of the bare diameter of the wire to the thickness of its insulation. In the following Table XXI. these ratios and the corre-

sponding values of k_s are given for all standard gauge wires likely to be used for winding armatures, for single and for double cotton covering:

TABLE XXI.—WEIGHT OF INSULATION ON ROUND COPPER WIRE.

Gauge of Wire.	Diam. of Wire (bare) inches.	Single Cotton Insulation.				Double Cotton Insulation.			
		Thickness of insulation, inches.	Ratio of bare diam. to thickn. of insul.	Weight of insulation in per cent. of wire	Weight of cov'd wire per lb. of bare, k_s	Thickness of insulation, inches.	Ratio of bare diam. to thickn. of insul.	Weight of insulation in per cent. of wire	Weight of cov'd wire per lb. of bare, k_s
1	.300					.020	15	2.28	1.0228
—	.289					.020	14.45	2.32	1.0232
2	.284					.020	14.2	2.33	1.0233
3	.259					.020	12.95	2.40	1.024
—	.258					.020	12.9	2.40	1.024
4	.238					.020	11.9	2.50	1.025
—	.229					.020	11.45	2.55	1.0255
5	.220					.020	11	2.65	1.0265
—	.204	.012	17	2.20	1.022	.020	10.2	2.85	1.0285
6	.203	.012	16.9	2.20	1.022	.020	10.15	2.86	1.0286
—	.182	.012	15.15	2.27	1.0227	.018	10.1	2.87	1.0287
7	.180	.012	15	2.28	1.0228	.018	10	2.90	1.029
8	.165	.012	13.75	2.33	1.0233	.018	9.17	3.20	1.032
—	.162	.010	16.2	2.24	1.0224	.018	9	3.25	1.0325
9	.148	.010	14.8	2.30	1.023	.016	9.25	3.15	1.0315
—	.144	.010	14.4	2.32	1.0232	.016	9	3.25	1.0325
10	.134	.010	13.4	2.36	1.0236	.016	8.4	3.55	1.0355
—	.1285	.010	12.85	2.40	1.024	.016	8	3.75	1.0375
11	.120	.010	12	2.50	1.025	.016	7.5	4.10	1.041
—	.1144	.010	11.4	2.55	1.0255	.016	7.1	4.35	1.0435
12	.109	.010	10.9	2.66	1.0266	.016	6.8	4.60	1.046
—	.102	.010	10.2	2.85	1.0285	.016	6.4	5.00	1.05
13	.095	.010	9.5	3.10	1.031	.016	5.9	5.55	1.0555
—	.091	.010	9.1	3.25	1.0325	.016	5.7	5.85	1.0585
14	.083	.007	12	2.50	1.025	.016	5.2	6.60	1.066
—	.081	.007	11.6	2.54	1.0254	.016	5.1	6.80	1.068
15	.072	.007	10.3	2.80	1.028	.016	4.5	7.80	1.078
16	.065	.007	9.3	3.15	1.0315	.016	4.1	8.60	1.086
—	.064	.007	9.1	3.25	1.0325	.016	4	8.80	1.088
17	.058	.007	8.3	3.60	1.036	.014	4.1	8.60	1.086
—	.057	.007	8.1	3.70	1.037	.014	4.1	8.60	1.086
18	.051	.007	7.3	4.20	1.042	.014	3.6	9.60	1.096
—	.049	.007	7	4.40	1.044	.014	3.5	9.80	1.098
19	.045	.005	9	3.25	1.0325	.012	3.75	9.30	1.093
—	.042	.005	8.4	3.55	1.0355	.012	3.5	9.80	1.098
20	.040	.005	8	3.75	1.0375	.012	3.33	10.10	1.101
—	.036	.005	7.2	4.30	1.043	.005*	7.2	5.60	1.056
21	.035	.005	7	4.40	1.044	.005*	7	6.00	1.06
22	.032	.005	6.4	5.00	1.05	.005*	6.4	6.60	1.066
23	.028	.005	5.6	6.00	1.06	.004*	7	6.00	1.06
24	.025	.005	5	7.00	1.07	.004*	6.25	7.00	1.07
25	.022	.005	4.4	8.00	1.08	.004*	5.5	8.00	1.08
26	.020	.005	4	8.80	1.088	.004*	5	8.80	1.088
27	.018	.005	3.6	9.60	1.096	.004*	4.5	9.60	1.096
28	.016	.005	3.2	10.40	1.104	.004*	4	10.40	1.104
29	.014	.005	2.8	11.25	1.1125	.004*	3.5	11.25	1.1125
30	.013	.005	2.6	11.65	1.1165	.004*	3.25	11.65	1.1165
—	.012	.005	2.4	12.05	1.1205	.004*	3	12.05	1.1205
—	.011	.005	2.2	12.45	1.1245	.004*	2.75	12.45	1.1245

* Double Silk: 1 mil of silk insulation taken equal in weight to 1.25 mil of cotton covering.

15.—Armature Resistance.

The electrical resistance of the armature winding can be determined by the total length of wire wound on the armature, and from the sectional area of the conductor. If R denotes the total resistance of the armature wire, all in one continuous length, and if the machine has P pairs of magnet poles, and, therefore, $2P$ electrically parallel armature portions, then the armature forms the combination of $2P$ parallel branches of $\frac{R}{2P}$ ohms resistance each (see Fig. 13). The joint resistance of these $2P$ circuits, that is the actual armature resistance, will consequently be

$$r_a = \frac{R}{(2P)^2} = \frac{R}{4 \times P^2}$$

The total resistance, R , of all the armature wire in series can be calculated from the total length, L_t , and the sectional area, δ_a^2 , of the conductor by the formula

$$R = L_t \times \frac{10.5}{\delta_a^2}$$

where 10.5 is the resistance, in ohms, at 15.5° C (= 60° Fahr.), of a copper wire of 1 circular mil sectional area and

1 foot length, and of a conductivity of about 98 per cent. of that of pure copper. The quotient $\frac{10.5}{\delta_a^2}$, for commercial copper, or $\frac{10.32}{\delta_a^2}$, for chemically pure copper, represents the resistance per foot of the armature conductor, and can.

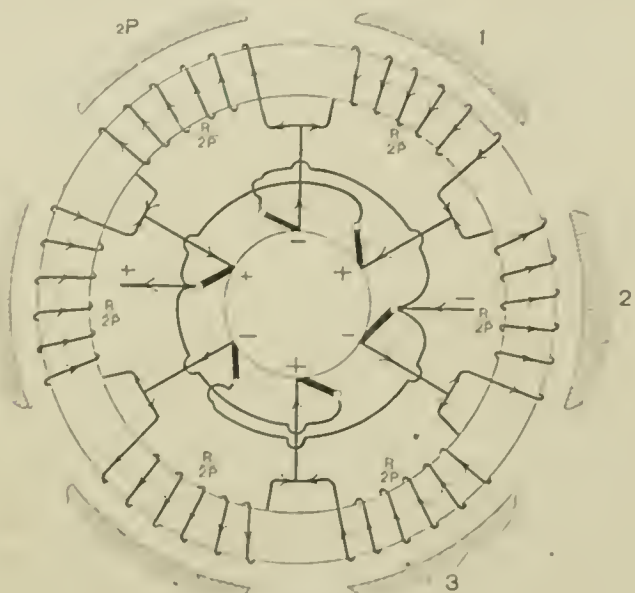


FIG. 13.

for every standard size of wire, be taken from the wire gauge table.

Introducing the value of R into the above equation, we obtain the following formula for the resistance at 15.5°C. , of any armature having a single conductor:

$$r_a = \frac{1}{4 \times P^2} \times L_t \times \left(\frac{10.5}{\delta_{a1}^2} \right). \quad (30)$$

r_a = resistance of armature winding at 15.5°C. , in ohms;
 P = number of pairs of magnet poles, eventually half the number of parallel armature portions;

L_t = total length of armature conductor, in feet, formulae (19) to (27), respectively;

δ_{a1}^2 = sectional area of armature conductor, in circular mils, formula (4).

In an armature, each conductor of which consists of p parallel strands of wire of δ_{a1}^2 circular mils sectional area, there are $2P$ parallel circuits of p wires each, or altogether $2 \times P \times p$ parallel circuits of $\frac{R}{2 \times P \times p}$ ohms resistance each; the joint resistance, therefore, is

$$r_a = \frac{R}{4 \times P^2 \times p^2},$$

and since in this case the total resistance of the whole armature wire in series is

$$R = L_t \times p \times \left(\frac{10.5}{\delta_{a1}^2} \right),$$

we obtain for the resistance at 15.5°C. of any armature winding consisting of p strands of wire of δ_{a1}^2 circular mils sectional area, the formula

$$r_a = \frac{1}{4 \times P^2 \times p^2} \times L_t \times p \times \left(\frac{10.5}{\delta_{a1}^2} \right) = \frac{1}{4 \times P \times p} \times L_t \times \left(\frac{10.5}{\delta_{a1}^2} \right). \quad (31)$$

In formulae (30) and (31) the number of pairs of poles, P , is to be replaced by half the number of parallel armature portions if these two numbers differ from each other.

In order to obtain the armature resistance at any other temperature, higher than 15.5°C. , add 1 per cent. for every 3 degrees centigrade over 15.5° . The resistance, r_a , at 15.5°C. , being known, the armature resistance at T centigrade consequently will be

$$(r_a)_T = r_a + \frac{1}{100} \times r_a \left(\frac{T - 15.5}{3} \right) = r_a \times \left(1 + \frac{T - 15.5}{300} \right). \quad (32)$$

16.—Energy Losses in Armature.

There are three sources of energy dissipation in the armature, which are transformed into heat: (1) Overcoming of electrical resistance of armature winding, (2) overcoming of magnetic resistance of iron, and (3) generation of electric currents in the armature core.

a.—Energy Dissipated in Armature Winding.

The energy required to pass an electric current through any resistance is given, in watts, by the product of the square of the current intensity, in amperes, into the resistance, in ohms. The energy absorbed by the armature winding, therefore, is:

$$w_a = C^2 \times r'_a, \quad (33)$$

where w_a = energy dissipated in armature winding, in watts;

C = total current generated in armature, in amps.;

r'_a = resistance of armature winding, hot, in ohms;

see formulae (30), (31) and (32).

The total current, C , in series wound dynamos, is identical with the current output c ; in shunt and compound wound dynamos, however, C consists of the sum of the external current, c , and the current necessary to excite the shunt magnet winding. The amount of current passing through the shunt winding is the quotient of the potential difference, e , at the terminals of the machine, by the resistances of the shunt circuit, r_m , that is the sum of the resistance of the shunt winding and of the regulating rheostat, in series with the shunt winding.

For the resistance, r_a , of the armature winding, when hot—in order to be on the safe side in determining the armature losses—that at about 75°C. should be taken, or, according to formula (32) the resistance, r_a , at 15.5°C. , multiplied by $\left(1 + \frac{75 - 15.5}{300} \right) = 1.2$.

The energy dissipated in overcoming the resistance of the armature winding, consequently, can be obtained from the formula:

$$w_a = 1.2 \times \left(c + \frac{e}{r_m} \right)^2 \times r_a. \quad (34)$$

If w_a is to be computed before the field calculations are made, that is to say, before r_m is known, it is sufficiently accurate for practical purposes to express, from experience, the total armature current, C , as a multiple of the current output, c ; and, therefore, we have approximately

$$w_a = 1.2 \times (k_e \times c)^2 \times r_a \quad (35)$$

and in this the coefficient k_e can be taken from the following table:

TABLE XXII.—TOTAL ARMATURE CURRENT IN SHUNT AND COMPOUND WOUND DYNAMOS.

Capacity in Kilowatts.	Shunt Current in per cent. of Current Output.	Total Current, as Multiple of Current Output, k_e .
1	15%	1.15
25	12	1.12
5	10	1.10
1	8	1.08
2.5	7	1.07
5	6	1.06
10	5	1.05
20	4	1.04
30	3.5	1.035
50	3	1.03
100	2.75	1.0275
200	2.5	1.025
300	2.25	1.0225
500	2	1.02
1000	1.75	1.0175
2000	1.5	1.015

(To be continued.)

Some Storage Battery Phenomena.*

BY W. W. GRISCOM.

The study of a complete curve of discharge of a storage battery discloses three rather sharply defined changes in P. D., and after allowing for the effect of internal resistance, it is found that the changes are those of the E. M. F., and possibly a resultant of three or more sets of chemical reactions. The conversion of $H_2 Pb_2 O_5$ into $H_2 Pb_2 O_7$ in the positive plate would account for the abnormal rise of E. M. F. at the end of charge, and if it be assumed that the latter compound is not stable but will yield ozone gradually, this would account for the steady fall of E. M. F. on interrupting the charging current. The chemist will easily see the relation between these reactions, and the presence of peroxide of hydrogen and the continual evolution of oxygen from the positive plate, and the fact that a charged cell gradually loses its charge, maintaining for days a higher temperature than the air. The differences in temperature between certain plates of a cell and even between different parts of the same plate, many of them very minute, are due to at least two causes, the liberation or combination of sulphuric acid on the one hand, and $C_2 R$ on the other.

It may be considered proven that in a storage battery with plates of nearly equal capacity, the changes in the positive plate determine the characteristic curves of potential on discharge, and that the changes in the negative plate determine the characteristic curves of potential at the end of the charge.

A curious feature in charge is the intersecting of the curves of the positive and negative plate at several different points. At the beginning of charge the two plates are at nearly the same potential; the positive potential then rises rapidly until it reaches 2.22 volts, when it begins to rise in a straight line strictly proportional to time. The negative, on the other hand, rises gradually until it reaches 2.18 volts, then it rises rapidly, intersecting the positive curve in 14 1-2 hours and at 2.24 volts, and continuing to rise until it reaches 2.40 volts in 16 3-4 hours; thereafter it remains constant for the five hours which the positive requires to reach the same potential. Within the working limits of charge and discharge, the negative does not vary 2 per cent. in P. D., and ultimately the positive shows more capacity than the negative.

In some experiments described, the curious phenomenon was presented of variations of current amounting to 30 per cent. in plates manufactured rigorously alike, kept in parallel and subjected to like treatment during their previous life. In cases where the discharge is pushed below 1.8 volts even more serious differences have been observed, amounting to a variation of 225 per cent., one reading being 2.8 amperes, another 6.4 amperes for perfectly good new plates carefully treated.

Perhaps a still more curious fact was the differences of E. M. F. of the plates in the same cell discharging through equal resistances and connected finally in parallel to the same circuit—the E. M. F. ranging from 1.60 volts to 1.85 volts for neighboring plates in parallel in the same cell, at the same time. On interrupting the circuit at the end of the discharge of a cell, a considerable flow of current, as might be expected, passed from one plate to another and it was hours before the batteries reached equilibrium after the external circuit was open.

The discharge of one positive into its neighbor was a rather unexpected result. It had been thought that if one plate had less capacity than its neighbor it would simply stop discharging at a certain point, but that its E. M. F. would always be equal to that of its neighbors and that, therefore, no current would flow. The explanation of the phenomenon appears to be that the deficient plate keeps on discharging

at a lower rate than the perfect plate, and finally reaches a much lower point of discharge. On interrupting the current the plate which has not been discharged so far rapidly recovers a higher voltage than its neighbor and, therefore, discharges into it. This effect must also take place in the different parts of any one plate, and may be a cause for the formation of peroxide on the surface of a negative plate after a discharge, a phenomenon which has been remarked by too many observers to be ignored.

The two outside negatives give more than their proportional amount of current on discharge, the current being actually less than on the other plates, the potential remains higher, and the discharge is therefore a little greater. This in turn affects the positives next to them and these positives are usually the first to disintegrate in a carefully used cell. This fact was most noticeable in batteries used on the Eckington and Soldiers' Home Railway at Washington, where out of 45,000 positive plates there did not occur a single instance of buckling, and yet the outside positives always showed greater disintegration than the others.

The tendency of one part of a plate or one portion of peroxide to discharge faster or slower than its neighbor is one of the reasons which has led to the adoption of equipotential methods of connecting up the several plates of the storage battery. It is to be noted that these phenomena occur to a serious extent only when the batteries are discharged below 1.95 volts of potential difference per cell.

The experiments afford the most complete proof of the irregularity of the chemical actions which produce the electromotive force of the battery. Now one plate is given current, now another. And most remarkable of all, the different sides of the same plate exhibit differences of potential at their terminals which can only be attributed to differences of internal resistance, both in the electrolyte within the plates and in the porous active material itself.

The active material during charge and discharge is undergoing chemical change irregularly, not merely in the different plates, but in the different sides of the same plates, and as the active material is made up of large numbers of little pellets isolated from one another by the grid, the conclusion seems inevitable that one side of a given pellet is active to a different degree from the other side. It is not necessary to conceive that the E. M. F. generated on one side of a pellet is as different from the E. M. F. of the other side as would be indicated by the potential difference at the plate terminals. The more reasonable conception appears to be that the internal resistance of one side of a pellet is sometimes greater, sometimes less, than that of the other side, varying with the unequal chemical action. But I cannot escape the conclusion that there must be some real difference of potential and consequently local action—not merely between the parts of the grid, but between opposite sides of the same pellet or paste. This would account for the fact observed by Ayrton that a working cell is always above the temperature of the air—even when its own temperature is falling in discharge.

As to the latter phenomenon, as the addition of sulphuric acid to water raises the temperature, it is natural to infer that the removal of the acid from the water will lower the temperature. The former occurs on charge and the latter on discharge.

The potential of the cell is partly due to the degree of charge of the positive, partly to that of the negative and partly to the electrolyte. If a couple be removed to a stronger or weaker electrolyte the E. M. F. will rise or fall accordingly, so that the measurement of the P. D. of the terminals is not an invariable indication of its condition of charge, particularly if one plate is further discharged than the others. The variations of specific gravity of the electrolyte are practically determined by the ampere hours of using

* Abstract of a paper read at the Philadelphia meeting of the American Institute of Electrical Engineers.

charge, barring local action, short circuiting, change of temperature and a gradual sulphating of discharge positives when idle.

The variations of internal resistance of the cell afford a valuable indication of the condition of its active material, and therefore of its degree of charge. These variations have been attributed to various sources, but as yet our knowledge is not sufficient to afford a convincing explanation.

Experience shows that it adds greatly to the life of a cell and brings other advantages, to stop the charge between 2.1 and 2.45 volts and to stop the discharge at 1.9 or 1.95 volts. The positive plate is usually made of greater capacity than the negative, but the propriety of so doing is doubtful, as it may lead to over discharging the negative.

In a storage battery where the possible chemical reactions are complex the changes are governed by the P. D. as well as by the current; perhaps the current governs the amount of chemical action and the potential the kind. If a plate pasted with red oxide of lead is opposed to a plain lead grid in a forming bath the formation of peroxide proceeds evenly and uniformly in the well-known way, and the same is true if opposed to a pasted plate. But if it be opposed by another positive plate a different action ensues and the unformed plate cannot be properly converted to peroxide until the other positive has been completely reversed in a negative, this raising the P. D. of the cell.

It has been observed that when a single positive is suspended freely a great distance from the negative in the centre of a large jar the buckling is invariably away from sunlight. The plate may be turned around and moved quite close to one negative or the other, yet the buckling repeats itself invariably from the light. As a consequence, it would seem that storage batteries should be kept in the dark.

The rare phenomenon of automatic discharge of a positive plate was encountered in a case where a cell was reversed experimentally. The reversing charge was continued for 470 hours, or three times the normal capacity of the cell, and a potential of 2.41 volts obtained, charging rate being low. The current was then interrupted, the E. M. F. gradually fell to 2.92 volts in a perfectly normal way, but after 35 minutes the battery suddenly entered a state of violent, almost explosive, ebullition, giving off pure oxygen in immense quantities. Fifteen minutes later the cell was quiescent, the voltage had fallen to .84 and the specific gravity to the lowest point reached 470 hours before. Two or three days later the E. M. F. was zero.

Perhaps the most striking peculiarity about the modern storage battery is the diversity of opinion among professional electricians as to its utility and commercial value. Broadly stated, the European consensus of opinion, both technical and commercial, may be said to be in favor of storage batteries. The American view until now has been mainly the opposite. Storage batteries are almost always an economical success abroad, while here they have been too often an economical failure in the past. And the reason is that the Europeans always demand a margin for safety, while the Americans, with less capital and keener competition, are tempted to sail too close to the wind.

A storage battery continually worked to its commercial rating is a commercial failure. A storage battery worked sufficiently within its capacity is invariably a commercial success. A battery's discharge should be stopped after its E. M. F. has fallen to 2 volts or at farthest to 1.9, unless it be desirable to draw upon its reserve. It should be understood that a full discharge, that is, to 1.8 volts, is working a battery to the danger limit and is inadvisable, for the reason that the regulation is troublesome, the efficiency is low, dangerous molecular changes take place (as indicated by changes of internal resistance and changes of electromotive force, as well as occasional buckling), uneven plates discharge into one another after the circuit is interrupted, and the life of

the battery is diminished. In watching with the closest scrutiny a considerable number of plants, aggregating perhaps some millions of plates, and classifying the failures and successes, it was found that when a battery was exhausted to its full capacity daily its life did not exceed 500 discharges, but wherever it was worked within two-thirds of its capacity complaints were unknown.

It is natural to ask why the rating should not be changed so that the owner of the battery would not be tempted to work it to the danger limit. That is a commercial question. In these days of close commercial figuring it would be difficult to sell a battery which appeared, *ceteris paribus*, to cost 50 per cent. more than its competitors. The present rating is strictly accurate and has the sanction of custom the world over. It is only necessary for the engineer to remember to add 50 per cent. of the capacity as a factor of safety to his maximum load, just as he allows several hundred per cent. in calculating the strength of a bridge, or an axle. This additional amount is not a dead loss in investment. It produces many countervailing advantages. It saves the necessity for regulation in most instances. It provides a very effective and safe reserve for cases where the charging apparatus breaks down and for many other cases, and it improves the actual efficiency of the battery, which rises from about 80 per cent. to nearly 90 per cent. when used with a sufficient reserve. And for cases where it is necessary to maintain a constant difference of potential, such as electric lighting, it raises the efficiency much more, because in these cases the commercial efficiency must be rated not from the average point of electromotive force but from the lowest point to which the battery falls on discharge, and when used in this way the P. D. drops only 2 1-2 per cent. All the E. M. F. above the lowest point must be wasted in order to secure regulation, unless the troublesome method of regulating by the introduction of extra cells is adopted. In circuits where this regulation is of no consequence as, e. g., motor circuits for cars, all the E. M. F. is utilized in increasing the car miles per unit of energy.

A storage battery for trolley systems or other central stations for the production and utilization of electricity has heretofore been regarded in this country as a very expensive addition to the plant, but this is not always the case. There are many opportunities for introducing storage batteries as a part of the original plant without increasing the cost, as, for example, in cases where the maximum output is two or three times greater than the average output. In a calculation with Emery's figures for a basis for the steam plant, it is shown that a 1,000-h. p. direct system would cost \$92,500, and a 1,000-h. p. storage system \$91,250.

The following conclusions are stated:

1. That the chemical reactions in a storage battery cell must be complex, in order to account for the curves of E. M. F., temperature and internal resistance.
2. That the current and the E. M. F. of the component plates of a cell, and of each part of each plate, are constantly fluctuating, in spite of the fact that no source of electricity can compare with a storage battery for steadiness and constancy.
3. That by reducing the normal output of a battery by about 30 or 40 per cent. the discharge can be mainly confined to one set of chemical reactions, thus prolonging the life of the battery.
4. That the negative and positive plates are apt to get out of step, therefore the battery should be given an occasional overcharge when necessary, but only when necessary, to get them in line again.

Steam Engines for Electric Lighting in Germany.

At the beginning of the year 1893 1,407 engines of a total of 76,045 h. p. were used in the kingdom of Prussia for the production of electricity.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

COMPILED FROM
PRINCIPAL FOREIGN
ELEC. WORLD, N.Y.

ELECTRICAL JOURNALS
BY CARL HEDING

ELECTRO-PHYSICS.

Afterglow of Geissler Tubes.—A paper by Mr. Kirn is reprinted in the Lond. "Elec.," June 1, from the "Wied. Ann.," No. 6, page 381. It gives the results and spectroscopic observations made of the afterglow and shows that the phenomenon of the extinction of this glow is the exact reverse of that which takes place when bodies begin to glow. Regarding the cause of the afterglow, he states that he believes that it is the result of a chemical modification of the contents of the tube.

Leyden Jar Discharges.—A communication by S. Alfred Varley on "A Call for More Imagination as a Factor in the Progress of Physical Science, and a Few Remarks on Maxwell's Electrical Theory," is published in the Lond. "Elec. Rev.," June 1. He claims that Mr. Wimshurst has demonstrated conclusively that Leyden jar discharges pass through the mass of a conductor, and are not confined to the outer layer; he claims to be able to demonstrate that Leyden jar discharges are not oscillatory if some one else will pay the expenses of the demonstration, but he does not describe how he proposes to demonstrate it.

Effect of Light on Electric Discharges.—A paper by Prof. Koenig on this subject is abstracted briefly in the "Elek. Zeit.," May 24.

Atmospheric Electrification.—In a note in the Lond. "Elec.," June 1, it is stated that according to the observations of Mr. Lachner, the St. Elmo's fire has shown the fact that when snow falls in large flakes the electricity is almost always positive and when it consists of dust-like particles negative electricity is developed.

Resistance of Selenium.—In a communication to the Lond. "Elec. Rev.," June 1, Mr. Mayhew claims that he was the first to discover, in 1872, that the resistance of selenium changes when exposed to light.

Vortex Theory of Electrodynamics.—"La Lum. Elec.," June 2, contains the first part of a mathematical article by Mr. Blondin on this subject.

Reflection of Waves.—A paper by Messrs. Sarasin & Birkeland from "Comptes Rendus" is reprinted in "La Lum. Elec.," May 26.

MAGNETISM.

Earth's Magnetism.—A description of an instrument used in the Russian Observatory for the absolute determination of magnetic declination is given in the "Elek. Zeit.," May 24. In another note in the same issue it is shown that the sun and moon and possibly the planets also have an influence on the earth's magnetism; Mr. Wild discusses the subject and concludes from some quantitative calculations that these effects would be small, those from the planets being probably inappreciable.

Magnetic Properties at Different Temperatures.—Mr.

Curie's paper, mentioned in the Digest June 9, is very briefly abstracted in the Lond. "Elec.," June 1.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Testing of Transformers.—The "Elek. Zeit.," May 24, abstracts from the official report of the Frankfurt Exhibition the results of the tests with Mordey, Schuckert and Oerlikon transformers. At full load the loss in the heating coils was 2.3 and 2.5 per cent. in the Mordey, 2.36 in the Schuckert and 1.75 per cent. in the Oerlikon transformer; in the two former the loss in the iron was independent of the load, but in the Oerlikon the loss rose with an increase in load, like the loss in the copper; the efficiency of the small Mordey transformer was 94.5 per cent. and of the large one 96.3, of the Oerlikon and Schuckert 94 per cent., all at full load.

It discusses, though not very clearly, the accuracy and the precautions of the method of testing transformers by means of a wattmeter. A short abstract of this is given in the Lond. "Elec. Eng.," June 1.

Testing Alternate Current Motors.—See abstract under "Transmission of Power."

Municipal Testing of Meters.—According to the "Elek. Zeit.," May 24, the Austrian Government has decided that all electric meters used by consumers must be calibrated and officially stamped by the government; a brief description of the conditions is given.

Measuring Phase Difference.—In an article by Mr. Engelmeier in "La Lum. Elec.," May 26, he describes the experiments of Von Ettingshausen and Puluj and the new combination of the Lissajous mirrors, mentioned in the Digest May 19.

Calculating Polyphase Currents.—A paper by Mr. Blondel from "Comptes Rendus" is briefly summarized in the Lond. "Elec. Eng.," June 1, in which the formulas are given for a "new simplified method for calculating polyphase alternating currents."

Power of Three-phase Circuits.—Some formulas from an article by Dr. Froelich are given in the Lond. "Elec. Eng.," May 25.

Combined Ammeter and Voltmeter.—An instrument is described in the Lond. "Elec. Eng.," June 1, which has two pointers and two scales, one reading amperes and the other volts.

ARC AND INCANDESCENT LIGHTS.

Lamp Tests.—According to the Lond. "Elec.," June 1, an exhaustive examination of a large number of lamps is now being made by Mr. Preece, the report of the tests being intended for a communication to the British Association; the lamps will be run for more than 3,000 hours.

Incandescent Lamps of Variable Candle Power.—A new lamp mentioned in the Lond. "Elec. Rev.," June 1, contains

two filaments, presumably of different candle powers each, connected with a switch, by means of which they may be connected singly, in series, or in parallel, giving four different degrees of illumination.

Incandescent Lamp.—In the continuation of Mr. Bainville's serial in "L'Élec.," May 26, he discusses the bulb, the support of the filament, the mounting and the securing of the filament. A translation of this article is being given in the Lond. "Elec. Rev."

Best Efficiency of Incandescent Lamps.—See abstract under "Advantages at Constant Voltage."

Cored Carbon Litigation.—A decision in favor of Siemens is announced in the "Elek. Zeit.," May 31; also more fully in the "Elek. Echo," May 26.

TRANSMISSION OF POWER.

Transmission of Power.—The conclusion of Mr. Bouchérot's article, mentioned in the Digest June 9, is published in "La Lum. Elec.," May 26. A description is given of the agricultural machines driven by the two-phase motors on the Meiner farm, in which two two-phase motors of 15 and 20 h. p. and one single-phase motor of 1 1-2 h. p. are used; the advantages of using such motors instead of continuous current motors are pointed out. Curves are given for both the double and the single phase motor, showing the current, the speed, the efficiency and angle of lag for different outputs, the efficiency being very high, especially in the two-phase motor; he describes a method for testing, in which the efficiency is calculated from the loss, all of which are determined separately; the loss due to the resistance in the short circuited armature is determined by the power at the pulley and the loss in the velocity; the results of the direct determinations and those obtained by this method are given in parallel columns, showing that for two-phase motors the latter method can be used, but for single phase the efficiency is from 2 to 3 per cent. too high. The efficiency of the whole transmission is 61.3 per cent. for a mean load on all the three motors. The arrangement for starting the motors is described, but not very clearly; it appears to consist of a combination of a transformer for increasing the current, with self-induction coils, of which different portions can be put into circuit.

ELECTRIC RAILWAYS.

Electric Traction.—An editorial article in the Lond. "Elec. Rev.," June 1, discusses the recent statements of Prof. Kennedy regarding electric traction, quoted from several sources and maintaining that his estimate of an efficiency of 35 per cent. is nearer correct than any made by his critics.

Mountain Railway.—A very good description, together with some illustrations, of the recently installed rack and pinion electric railway on Mont Saleve, near Geneva, is given in the "Elek. Zeit.," May 24.

Budapest Railway.—A short description and a few figures, although containing nothing new, are given in the Lond. "Elec. Eng.," June 1.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Central Station Statistics.—A very good and interesting set of statistics of 21 central stations in Germany for one year, from 1892 to 1893, is given by Dr. Gusinde in the "Elek. Zeit.," May 24. They were collected for the Union of the Representatives of Central Stations. The tables do not admit of being abstracted; they contain information of considerable interest to central station managers; out of the 21 stations all but two use accumulators. Among some of the general deductions are the following: The weight of the copper in kilograms in the whole distribution per hektowatt hour of the total output of the station is given for each of the stations and averages between seven and nine, one of the lowest figures, 3.07, being for the alternating current station in Cologne; the lowest is 1.78, for the small station

in the city of Muelhouse. Another column gives the average load on the generators in percentage of the normal, and as most of the stations use accumulators, the figures are quite high, four of them being 100 per cent. and ranging in others to 80 per cent. and some lower; for the only alternating current station the figure is not given. The efficiency of the accumulators for the year is above 90 per cent. in ampere hours for most of the stations, reaching as high as 98 in one of them, while in watt hours the average is somewhat less than 80 per cent., the highest being 82 per cent. Another column gives the ampere hours from the accumulators in per cent. of the total output of the station, a figure which varies considerably, the highest being 74.7 and the lowest 15. The average price per kilowatt hour appears to be a little over 18 cents, from which a reduction is made for larger quantities; for other purposes than light the average cost appears to be almost half and in some cases even less. A few of these figures are abstracted in the Lond. "Elec. Eng.," June 1.

Advantages at Constant Voltage.—In an article by Mr. Claude, the first part of which is published in "La Lum. Elec.," June 2, he points out the great advantage of keeping the voltage at the consumer's end of the circuit absolutely regular and shows that in the three-wire system this is not possible; he claims that in the future this fact will be of very great importance and that it is an inherent defect in the three-wire system. From the life of a 16-c. p. lamp, run at different efficiencies, he constructs a curve, the abscissae of which are the cost per lamp hour and the ordinates the watts per candle, the price of the lamp being taken as 40 cents and the cost of the energy 20 cents per kilowatt hour; this curve has a minimum at about two watts per candle, which is therefore the best efficiency at which the lamps should be used; if the lamps cost only 20 cents, he finds a second curve having a minimum point at 1.7 watts per candle; at present, however, the lamps are used (in France), as a rule, at 3.5 to 4 watts per candle, at which point the curves are almost superposed, showing that at that efficiency the price of the lamp makes but very little difference in the total cost, but for a lower consumption per candle there is a gain both in the cost of the lamp and in the cost of the energy; to use lamps at as good an efficiency as 2.5 watts per candle is, however, almost impossible on the present circuits (in France), even at the price of 20 cents per lamp, on account of the variations in the voltage. What should be striven for, therefore, is absolute regularity in the difference of potential and an efficiency of 2.5 watts per candle with a tendency toward two watts per candle.

Electric Power in Workshops.—A paper by Mr. Selby Bigge is abstracted briefly in the Lond. "Elec. Eng.," June 1. It is stated that in a number of different workshops he found that when a motor was running a shop with a large number of small lathes and other like instruments, more power was absorbed when the tools were not in use than when they were doing normal work. He believes that rolling mills can, and will, be operated electrically. He cites a number of cases showing the advantages in using electric motors; in one factory the saving was 30 tons of coal per week; in a factory in Liege the saving was as three to seven; in another five or six engines and four boilers were replaced by one engine, one boiler and one dynamo, and the resulting saving was two tons of coal out of three per day; the same ratio was reported in other cases; the efficiency in the Liege factory was 71.3 per cent.

Cost of Electrical Energy.—A continuation of the discussion of Mr. Crompton's paper is published in the Lond. "Elec. Rev.," June 1, and is limited almost entirely to the mechanical engineering features. The same issue contains a long editorial on fuel economy, and likewise the second part of an article by Mr. Booth, also devoted to the mechanical engineering features. The discussion is

given somewhat more fully in the Lond. "Elec.," June 1, in which issue the paper is also discussed editorially. The Lond. "Elec. Eng.," June 1, publishes Mr. Crompton's reply to the discussion.

Three-Wire Distribution with a Single Dynamo.—A translation of the article, with illustrations, mentioned in the Digest May 12, is published in the Lond. "Elec. Rev.," June 1; the system was described and illustrated in the Digest Feb. 3.

Engine Power at Central Stations in Prussia.—The "Elek. Zeit.," May 24, publishes, from the official statistics, the number of steam engines and their total power used for generating electricity, and their sub-division into different classes of work; the total at the beginning of last year was 1,407 steam engines with a total of 76,045 h. p.

Dust Destructors.—A report of different systems proposed for the Chelsea Vestry is reprinted in the Lond. "Elec. Rev." and "Elec. Eng.," June 1.

Steam Turbine.—A description and cross-section of the Parsons steam turbine are given in "La Lum. Elec.," May 26.

Brighton.—A description of the Brighton station, including a number of illustrations, among them the complete connections of the switchboard, is published in the Lond. "Elec.," June 1; the three-wire system, with low tension continuous currents and accumulators, is used.

Christiania.—Some tabulated figures regarding the operation of this station are given in the "Elek. Zeit.," May 31.

Insurance Rules.—The "Elek. Zeit.," May 31, publishes at considerable length a discussion by Dr. Gusinde of the proposed modifications of the insurance rules in Germany.

Lightning in High Tension Circuits.—A peculiar case is described in the Lond. "Elec. Rev." and "Elec. Eng.," June 1, by Mr. Preller, in which some high tension circuits in Switzerland were struck by lightning.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Storm Indicator.—A device is described by Mr. Engelmann in the "Elek. Zeit.," May 31, for notifying the central station and subscribers of the approach of a storm, so that the telephones can be cut out of circuit. The system seems to be worked out quite completely and involves a somewhat complicated system of connections, a diagram of which is given. At the most distant points of a system of telephone wires and on elevated points are placed electroscopes with a fixed and a movable aluminium plate, which latter is deflected by atmospheric electrification; when the deflection is of a sufficient amount a local circuit is closed through a relay, which starts an alarm signal at the nearest station, where it is transmitted to the subscribers; after a quarter to one-half a minute the apparatus is set again and if the electrification is still present the alarm bell will continue to ring.

Long Distance Telephony.—In an article by Mr. Anizan in "La Lum. Elec.," June 2, he shows that improvements in long distance telephony are no longer to be sought for in the line but in the instruments; he describes a combination of his bi-telephone (double telephone) with the arrangement described in the Digest May 19, involving two switches, one of which adjusts for long or short distances and the other, which affects the bi-telephone, to be moved when one is talking or listening, as it cuts out portions of the resistance of the receiving telephone.

Vienna and Berlin are to be connected by telephone this year.

Loudness of Some Microphones.—The "Elek. Zeit.," May 24, publishes the results for ten different microphones, giving their relative values as represented by the product of the resistance and the capacity at which audibility ceases; they are all of European manufacture; attention is called to the fact that the figure is higher for instruments with a horizontal diaphragm than with a vertical one.

Telegraph Poles.—A summary is given in the "Elek. Echo," June 2, by Mr. Arens, of some of the principal for-

mulae for calculating the mechanical strength of poles for overhead lines.

Electric Signals for Men-of-War.—The Lond. "Eng.," March 30, contains an article on this subject.

ELECTRO-CHEMISTRY.

Primary Battery.—A Royal Society paper by Mr. Swan, abstracted in the Lond. "Elec.," June 1, describes experiments with a cell made with fused lead as positive electrode, carbon as negative and fused PbCl_2 as electrolyte, the depolarizer being chlorine in the form of a gas; it was found very necessary to expose the carbon to the action of the gas and electrolyte alternately in rapid succession; the lead dissolves as chloride of lead and is deposited on the carbon, where it is immediately reconverted to the chloride by the chlorine gas; the E. M. F. was 1.40, the theoretical being 1.7942 volts. The cell has a very low internal resistance and admits of great current density; a current of one ampere was given with 10 to 12 square centimetres of carbon plate; the internal resistance and depolarization decrease when the output increases, thus giving an almost constant voltage.

Erving Accumulator.—According to an illustration and brief description in "La Lum. Elec.," June 2, the cathode consists of copper on the outside of porous cups and connected with sheets of zinc; the anodes are formed of lead with 2 per cent. of silver, surrounded by a paste of peroxide of lead and sulphate of aluminium in the porous cups; the electrolyte is a solution of ammonia and acid bisulphate of mercury; during the charge the anode is oxidized and the amalgam is deposited on the cathode; during the discharge the cathode is oxidized and the hydrogen is deposited on the anode; no data are given about the output.

Tanks for Electrolysis.—For the electrolysis of solutions which contain acids it is stated in "La Lum. Elec.," May 26, that a protecting cement may be made of a mixture of pure, finely powdered asbestos with a thin solution of silicate of soda, as little alkaline as possible; the inside of the tank is painted with this cement.

The Electrolysis of Fused Electrolytes.—According to information from England, received by the compiler, the most important features in the Vautin process of the production of chlorine and soda from fused salt, described in the Digest June 2, were originally invented by an American.

Chromium.—According to "La Lum. Elec.," May 26, chromium may be obtained by electrolysis, deposited on a carbon filament such as that of an incandescent lamp, in a bath of 10 to 15 grams bisulphate of potash, 100 grams of chrome alum and 100 grams of water; the bath is replenished with chrome alum.

Simultaneous Production of Soda and Lead.—The Lyte process is briefly described in "La Lum. Elec.," May 26; it is a combination of the Solvay process for the production of soda, with a process of a treatment of litharge and argentiferous lead, thus producing simultaneously soda, chlorine, lead and silver.

Electro-Chemistry.—"La Lum. Elec.," May 26, describes the production of several mineral colors by electrolysis.

MISCELLANEOUS.

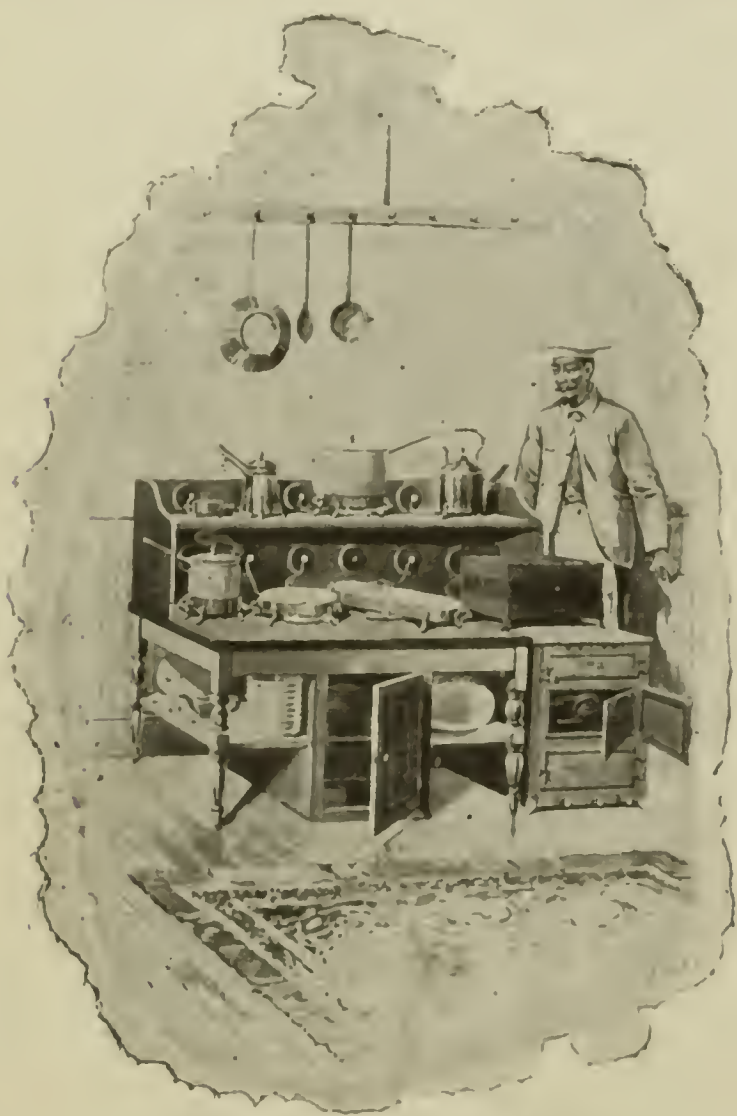
Diphtheria.—According to an article from "Cosmos," abstracted in "La Lum. Elec.," May 26, Mr. Erede has found that the bacteria of diphtheria perish in the light, and he suggests treating the disease by applying the light from an incandescent lamp, or from reflecting prisms, to the diseased parts of the throat.

Electric Launches.—A brief description of a few recently constructed launches used in Berlin is given in the "Elek. Zeit.," May 24.

Biographical.—A biography of Dr. Zetzsche is given in the "Elek. Zeit.," May 31. The death of the noted physicist, Dr. August Kundt, is announced in the "Elek. Zeit.," May 31. A short biographical notice is also given in the same issue.

Electric Cooking.

For several months the Central Electric Heating Company has been operating in a room adjoining its offices in the Havenmeyer Building, New York, an electric kitchen, where daily an excellent lunch is cooked by electricity and served to those fortunate enough to obtain an invitation to witness and materially appreciate the results of this latest demonstration of the marvellous applicability of electricity to the needs of man. As the result of a gustatory experience we can testify to the excellent manner in which the food is cooked, to the absolute cleanliness of which the processes admit and to the entire absence of distressing heat. From the construction of the apparatus and visual evidence as to the certainty with which they admit of an exact result being obtained, we can also testify to the reasonableness of the claim that with electrical cooking apparatus not only may an ordinary servant rival a skilled chef, but the latter may, through its use, produce results far beyond present possibilities in



AN ELECTRIC KITCHEN.

cooking, not only on account of the absolute control of temperature, but also from the ideal manner in which the heat may be applied.

As to the economical side of the case, the cost of electrical energy as fuel under average conditions at the average power rates charged at present may be greater than fuel directly burned, but there are compensating advantages gained which more than offset the additional cost, if any. Of these are the saving of attendance and of time, freedom from dirt, coolness of the kitchen and the absolute uniformity of heat and ability to regulate it. There is no discomfort, no noxious gases from combustion, and the temperatures attained are constant, so that the question of the discretion of the cook is eliminated and better results obtained than can possibly be reached from the approximate temperatures of surfaces heated by combustion. The heat generated for cooking is almost entirely utilized in actually accomplishing the work of cooking, unlike the case of the ordinary range. There is no bringing in of coal or carrying out of ashes or raking of fires, it being much easier, it is needless to say, to turn a switch and have

the heat energy introduced on a small wire than to handle coal and ashes. Moreover—and this is an important point in relation to relative cost—there is no heat wasted, except a very small amount by radiation.

We give a view of an electric kitchen of sufficient capacity to prepare the meals of from 15 to 25 people daily.



PORTABLE STOVE.



SAD-IRON.



CHAFING DISH.

but which, however, is arranged more after the lines of an ordinary kitchen than necessary. Owing to the cleanliness of the apparatus and processes, and the minimum of heat, there is no reason why the apparatus might not be so installed as to render the kitchen in exact keeping with the other apartments of even the most artistically furnished house.

The various apparatus illustrated require little explanation. The heat is produced by resistance wires or ribbons disposed between double sides or bottoms. The electric current, either direct or alternating, is turned on or off by a switch, and it is scarcely necessary to remark that there is no danger in handling the various devices, as they are constructed for use only with the safe currents used for house lighting. The utensils can be moved and attached anywhere there is an electric outlet by a simple plug; a lamp, for example, may be taken out of a bracket or chandelier, and the plug substituted, provided, of course, the current capacity of the apparatus is not greater than that of the lights or wiring.

Three sizes of ovens are shown. The smallest size, with one compartment 13 inches wide, 18 inches deep, and 9 inches high, is arranged for two different degrees of heat. The next larger has the same sized compartment, but with an additional one of the same width and depth and 4 inches high, for keeping articles warm or for slow baking. The largest size has an additional cooking chamber 7 inches high, with one heat. Meats roasted in these ovens have all the qualities that meats roasted in front of a fire have and do

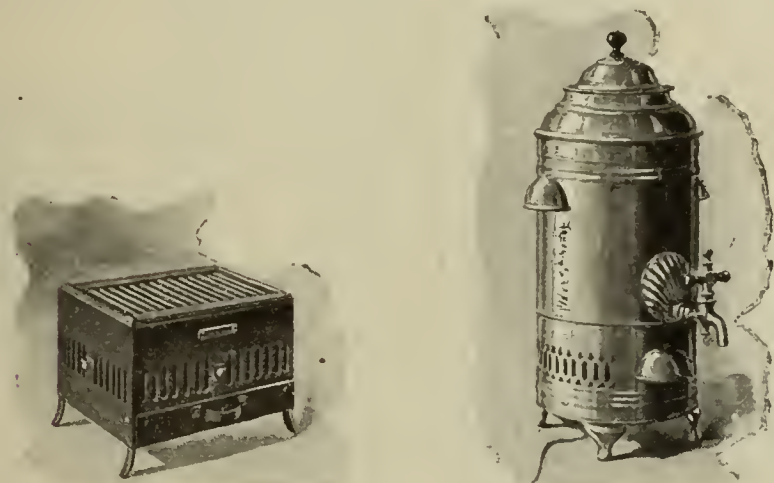


ELECTRIC OVENS

not require basting or watching. They are cooked more evenly and in less time, while retaining a larger percentage of the nutritious juices. After the exact time required for cooking any material has been ascertained, it can be put in the oven and left there for the proper time without further attention, and, as a bread-baker, it is far more efficient than

present methods. These ovens give a steadier and more effective heat and do their work more perfectly in every way than the ordinary range oven. The degree of heat can be readily adjusted to the work and the "quick" or "slow" oven obtained with certainty whenever required.

The portable stoves, which also answer for griddles, are made in various sizes and shapes to adapt them to the usual sizes of the ordinary kitchen utensils to be found in every household. An assortment of them will entirely take the place of the range or stove. They are conveniently portable and furnish a uniformly heated surface more effective than the top of a hot range or stove heated by the alcohol lamp or gas flame. They are equally well adapted for use in the

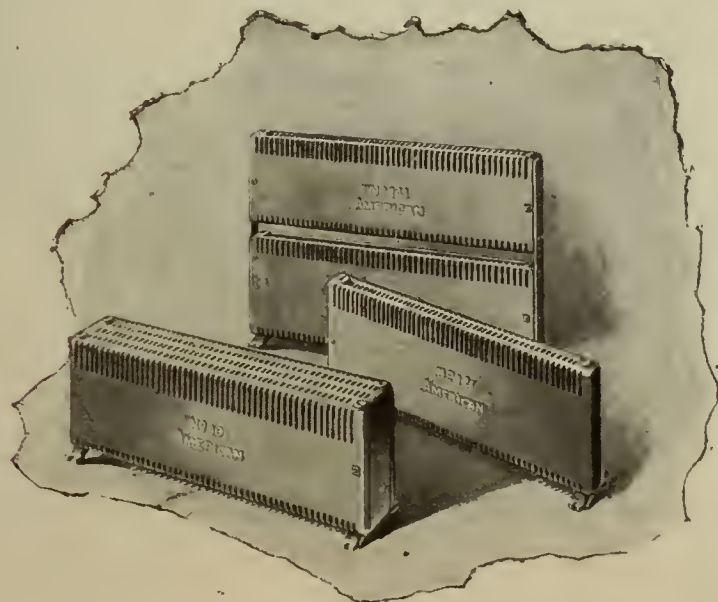


GRILL.

WATER URN.

nursery, living rooms or hospital wards and the kitchen, and are especially applicable to the ordinary forms of steam cookers, giving a steady, uniform temperature in the cooker and obviating all risk of either too violent boiling or of subsiding and cooling, to the detriment of the food being cooked.

The electric grills and broilers are ready in a few minutes after the current is applied, and the work is done without the food being singed, smoked, gas flavored or burned; the escaping juices are collected unspoiled in a pan beneath, so that the cook can baste the meat with its own juices, and thus all the elements of the food are saved. The broilers are so constructed that the working surface may be used wholly



ELECTRIC HEATER.

or in part, and are provided with a grease pan and a switch which can be operated to throw the heat on or off two or more of the sections.

In addition to cooking apparatus we illustrate some electric heaters, a sad iron and a glue pot; many other forms of apparatus are made, such as immersion heaters for melting pitch, curling tongs heater, etc.

There are days in the spring and fall when the usual services for heat are undesirable or unnecessary and recourse must be had to the ill-smelling gas or oil stoves or other auxiliary means of meeting the requirements. Often in hotels, apartment or dwelling houses, or in hospitals and on

steamships and yachts, certain rooms are in need of special warmth, while the remaining rooms do not require it. In such a contingency the electric heater meets the require-



GLUE POT.



TEA-POT AND STAND.

ments most satisfactorily. In warm climates, where the demand for heating is casual or spasmodic, the special advantages it presents are apparent.

The heaters, as will be seen from the cut, are compact in form and are finished in japan, bronze or white enamel to match surroundings. They are made in such a variety of shapes that they can be fitted into convenient places in rooms, and are so readily connected and disconnected that when the season for their use has passed they can be removed and stored until required again. They are all 26 inches long and vary in height from 10 inches to 22 inches and in width from 2 inches to 10 inches, according to the amount of heat required and the place where they are to be used.

New Book.

ECONOMY IN MATHEMATICS. New Calculation Tables for Multiplication and Division. Also a Table of Roots and Powers. By Levi W. Meech, A. M. Norwich, Conn.: The Henry Bill Publishing Company. 1894. 910 pages. Price, \$10.

This volume is primarily a multiplication table up to 999 times 999, and while there is nothing new in such a multiplication table, the present one is carried to a much greater length than usual.

The first multiplication table of which we have any knowledge was constructed by Pythagoras, and in the then state of arithmetical science in Greece, it must have been of the highest value in every-day affairs, as it is difficult for us in these modern times to conceive of any commerce being carried on, unless it be the rudest form of barter among savages, without some rudimentary form of arithmetical reckoning.

With the introduction into Europe by the Arabs of the Indian arithmetic (our present arithmetic), the necessity of the multiplication table, except the little corner which extends up to nine times nine, disappeared. Although up to nine times nine is all that it is strictly necessary to remember of the multiplication table, yet it is exceedingly convenient to be able to remember it much farther. It is very common, if not the usual practice, to teach up to twelve times twelve, and memorizing up to twenty times twenty or twenty-four times twenty-four is by no means rare.

It would accordingly seem that there is a very general opinion, although it may not be expressed in words, that it is well to memorize as much of the multiplication table as practicable without devoting an inordinate amount of time and study thereto. Moreover, the more expert one becomes in the use of figures, and consequently the better able to dispense with memorizing, the more able is he, as a rule, to retain the results of previous calculations in his memory.

Considered, therefore, as a Pythagorean table, pure and simple, the volume before us would be useful, and to any one having a large amount of multiplying to do, it would save much labor. It is, however, much more than a Pythagorean table, for by the use of certain auxiliary figures printed on each page, used according to a method described in the book, multiplication and division with any number of places of figures may be performed.

The labor involved in these operations to one who has mastered the methods is undoubtedly much less than by the ordinary arithmetical operations, but it will require some

study to become proficient in these operations, and it is unfortunate that the explanations are couched in language not at all clear or logical.

The auxiliary table of squares, cubes, square roots, cube roots and reciprocals, extends to 300. The roots are extended to seven places of decimals and the reciprocals to nine. There are projecting marginal indices at frequent intervals, so that the book may be opened almost instantly at any desired page. The binding is handsome and substantial, but the typography is not as good as could be wished, for, in a table of figures, above all other places, a clear and faultless imprint is important. The making of this book has involved an immense amount of patient labor, and considerable mathematical invention, and it belongs to a type recommended by no less an authority than the late Prof. De Morgan.

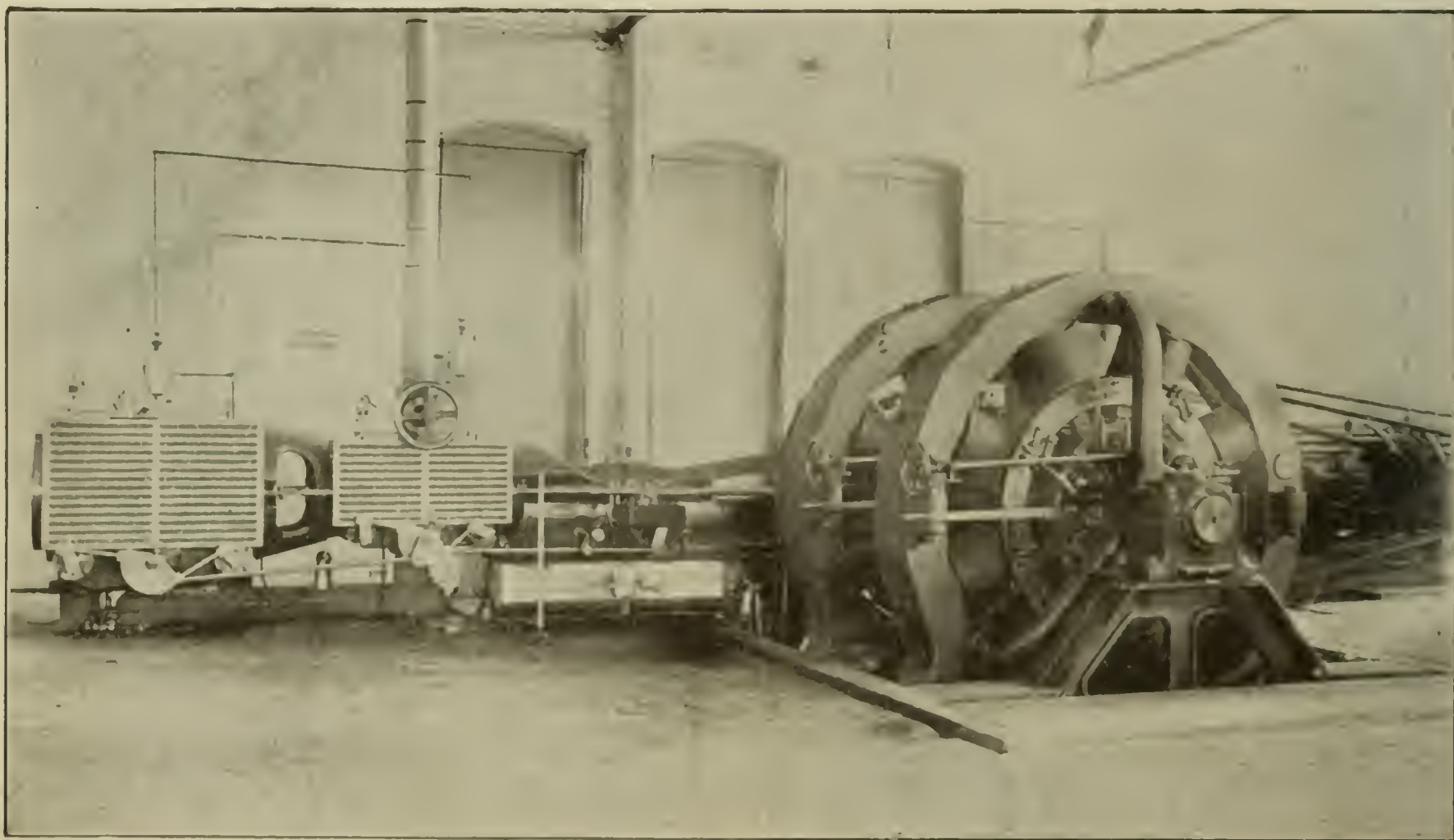
Direct Connected Engine and Dynamos.

The direct coupled dynamos and engine which we illustrate were recently installed in the station of the Edison Electric Light Company, at Grand Rapids, Mich., and consist of one four-valve compound condensing engine, 15 by 24 by 24, rated at 300 to 400 h. p., built by Russell & Co., of Massillon, O., and two 100-kw. generators made by the General Electric Company. The bed of the engine and the fields of the dynamos rest upon a common iron base. The main

New Wood Arc Light Apparatus.

It is but a few years ago that a 50-light arc dynamo was considered a practical limit, and the occasional machine designed for a larger number of lights was viewed with such suspicion that but little headway could be made with them. The extent of this prejudice was illustrated in the report against 100-arc machines by the advisory committee in the matter of the Detroit municipal plant, and Mr. Dow, the city electrical engineer, is to be commended for the firm stand he then took in favor of machines of larger power, and also congratulated that his views have been so soon corroborated by the general change in opinion on the subject. The strong tendency toward larger machines was made particularly apparent at the discussion on the subject at the Washington Convention of the National Electric Light Association, which dispelled the last doubts in the minds of station men as to the practicability of 100-light machines, and demonstrated that no inherent difficulties need be expected in even much larger capacities.

It is but natural that one of the leaders in this movement should be Mr. Wood, of the Fort Wayne company, who in the past has rendered such signal service to arc lighting, and we illustrate in Fig. 1 a new machine of his design, with a capacity of no less than 150 2,000-c. p. arcs, which is now being placed on the market by the Fort Wayne Electric Corporation. The new machine is there contrasted, using the



DIRECT CONNECTED ENGINE AND DYNAMOS.

shaft of the engine carries, in addition to the flywheel, the two armatures, and is supported in two pillow blocks mounted on detachable iron stands, so that the armatures may be moved without lifting the shaft out of place. The makers of the engines inform us that a test conducted by Mr. Frank A. Simonds, M. E., to determine the engine's economy in verification of guarantees, yielded the following results:

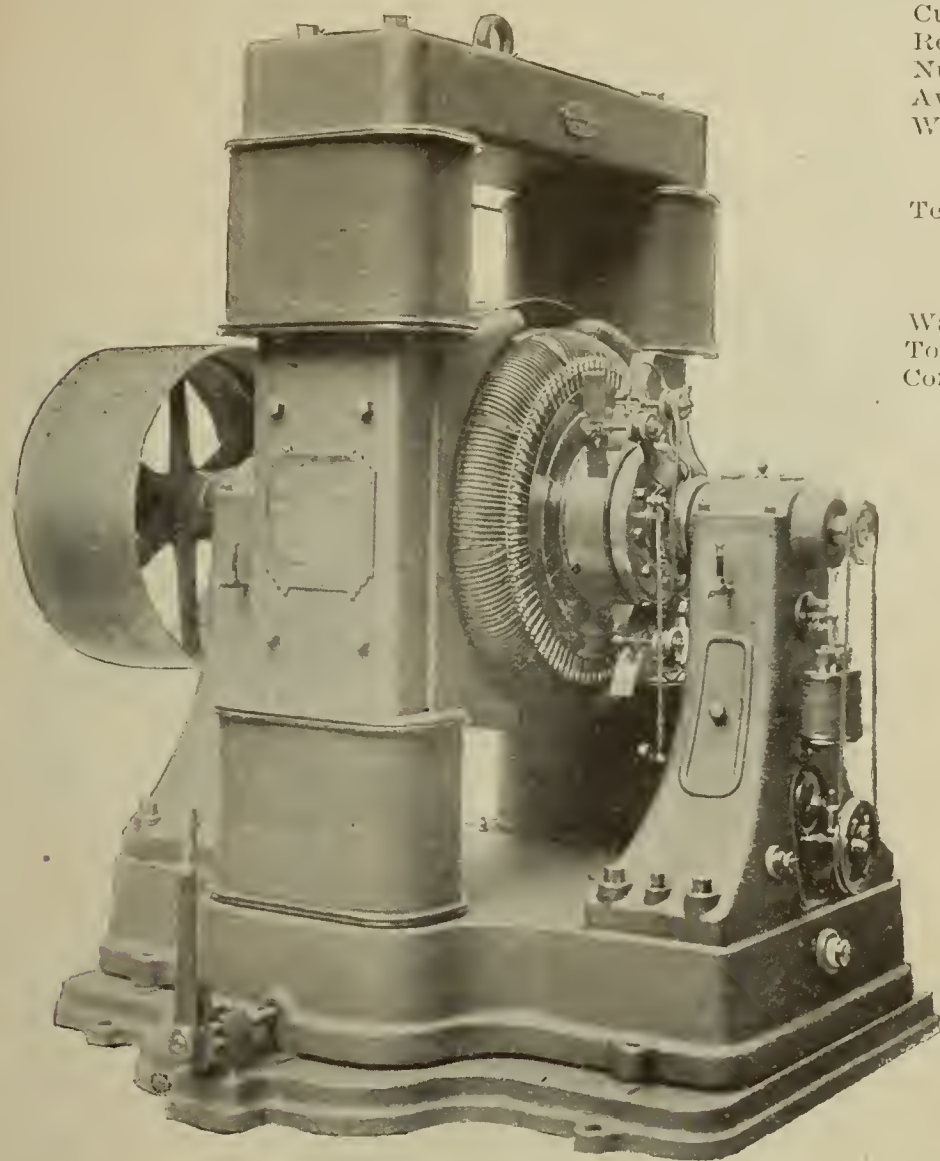
RUNNING NON-CONDENSING		RUNNING CONDENSING	
Duration trial, 6 hours.		Duration trial, 6 hours.	
Average steam pressure...	132.5	Average steam pressure...	130
" revs. per min....	162	" vacuum	25.75
" I. H. P. developed...	307.74	" revolutions.....	162
Water per I. H. P.....	18.15	" I. H. P.....	327.75
		Water per I. H. P.....	15.59

same scale, with the largest Fort Wayne machine previously built—an 80-arc machine (Fig. 2)—thus assisting to a clearer idea of the great advance implied.

It will be noted that in the new machine the field magnet frame has been placed in an upright position. The cores upon which the field coils are wound are massive wrought iron forgings, joined by a heavy cast iron yoke at the top and provided with cast iron pole pieces. The entire regulating mechanism is placed within the pillow block and is operated by a small round belt from a pulley at the end of the armature shaft. The regulation of the machine is effected after the manner of the Wood system, now well known and long tried. Sparking is almost entirely avoided by varying the

distance or the number of commutator segments, between the two positive and the two negative brushes. The regulation is such that the full number of lamps can be switched on or off without fear of endangering the machine.

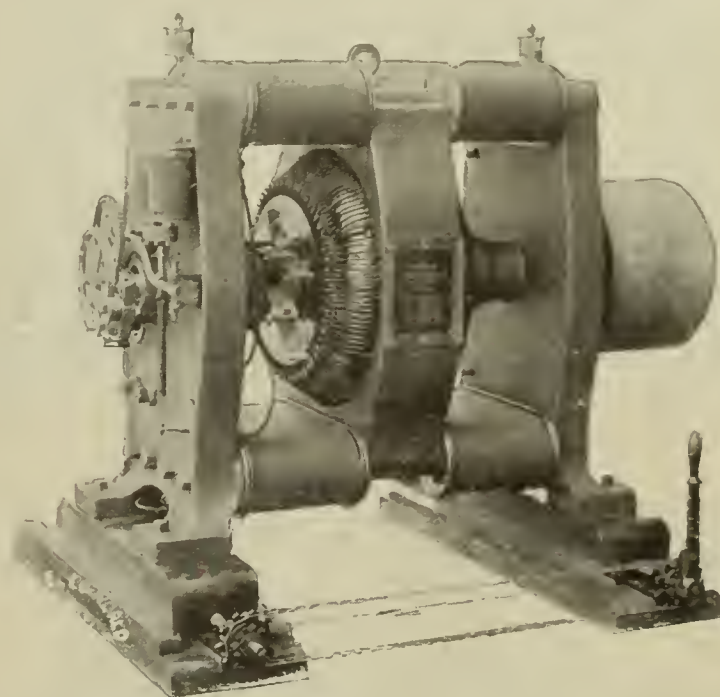
The circuits of the machine and its connections are



been previously operated for 30 hours, making in all a continuous run of 48 hours. The following data regarding the machine will prove of interest and particularly the remarkable showing as to efficiency:

E. M. F. at terminals.....	7,950
Current in amperes	9.6
Revolutions per minute	500
Number of lamps in circuit	150
Average volts per lamp	47
Weight of armature complete	2,288
" " dynamo	14,600
" " " with sub-base	15,800
Temperature of field magnets after 10 hours' run.....	68° C
" " armature core	95°
" " " wire	60°
" " room	27°
Watts output at full load, speed 500 r. p. m.....	67,680
Total watts generated	74,446
Commercial efficiency	90.91

During the test of the machine the potential at the ter-



FIGS. 1 AND 2.—NEW AND OLD TYPE WOOD DYNAMOS.

shown in Fig. 3. From these it will be seen that the machine is entirely self-contained. The wires leading to the circuits are taken from the binding posts at the base of the machine and carried below the floor to the switchboard, and thence through the lightning arresters to the outside circuits. This leaves the dynamo room entirely free from wires, which

minals was measured by means of two Weston voltmeters, specially designed for the purpose.

A combination gotten up to meet the requirements of the Detroit electric light plant is shown in Fig. 4, consisting of the new Wood machine coupled direct to a Willans high-speed engine.

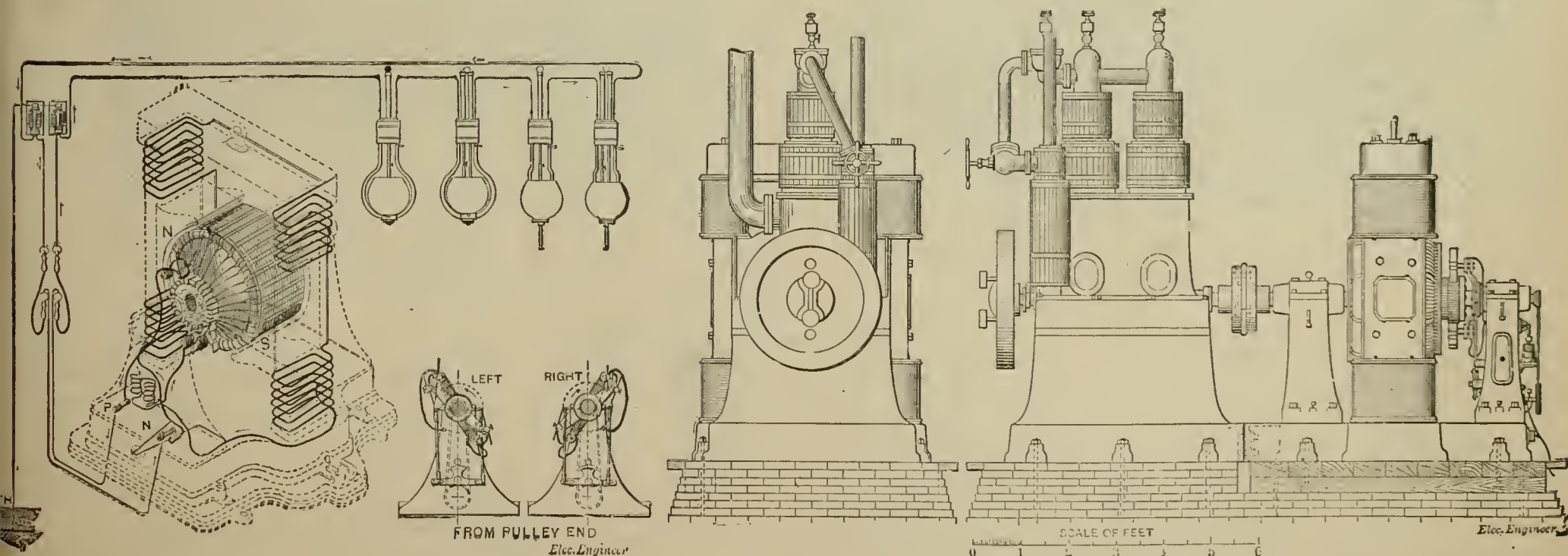


FIG. 3.—CONNECTIONS AND CIRCUITS.

FIG. 4.—WOOD DYNAMO DIRECT CONNECTED TO WILLANS ENGINE.

usually connect with the machine from overhead, thus giving the whole a substantial and neat appearance.

On a recent test a machine of the new type operated 153 full arc lamps on the 38-mile circuit of the local Fort Wayne electric light company, for a period of 18 hours, after having

Among the new auxiliary apparatus gotten up by the Fort Wayne company is the arc switchboard shown in Fig. 5. The plug sockets are mounted on marble bases, the line terminals above and the dynamo terminals on the lower board, with the voltmeter and ammeter and ground connec-

tions on the centre panel. This board embodies the ingenious devices of Mr. Wood, by which a circuit can be

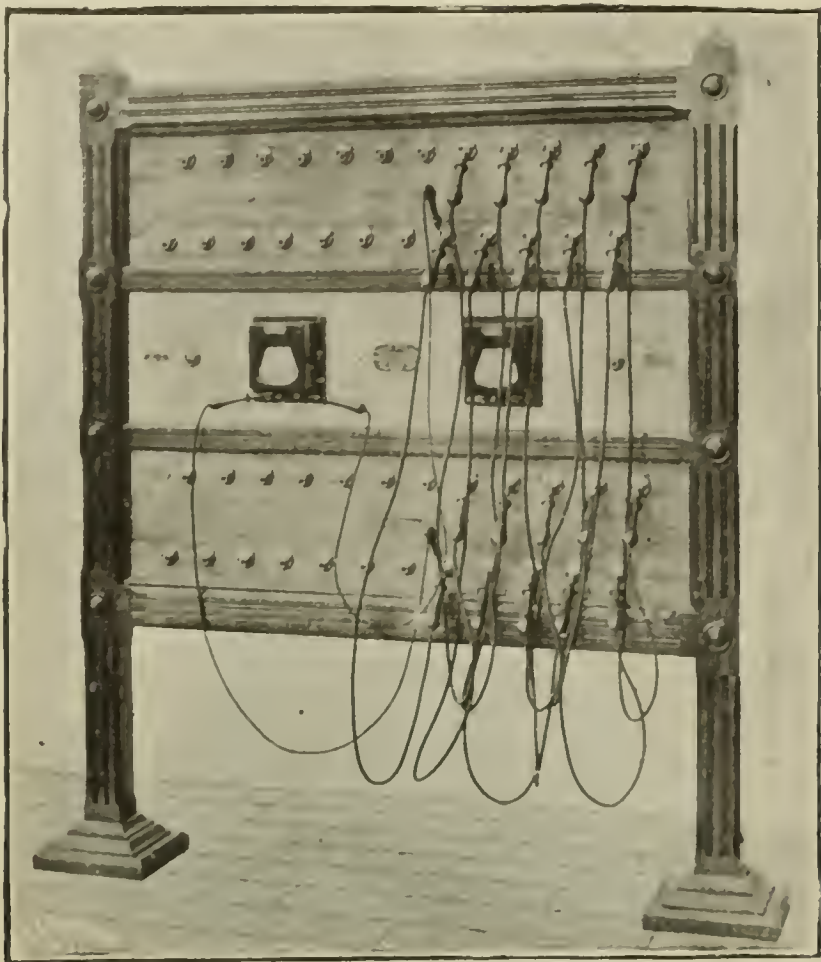


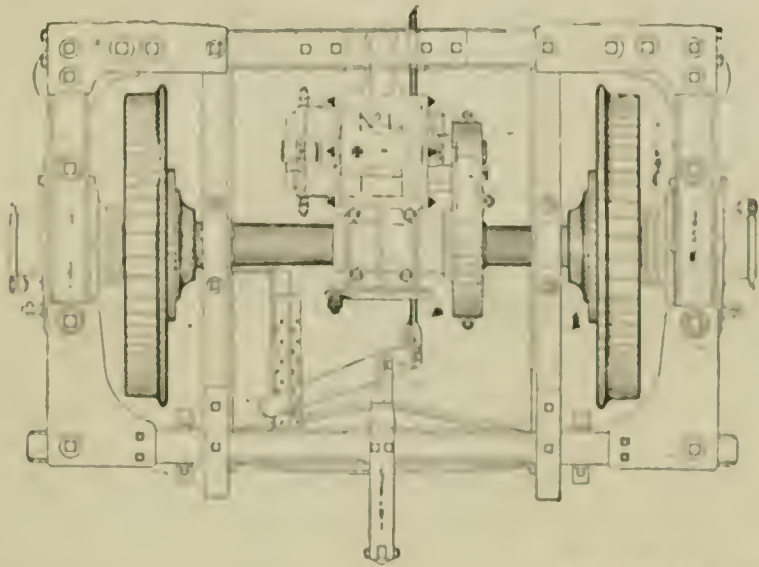
FIG. 5.—ARC SWITCHBOARD.

changed from one machine to the other without causing a break in the current.

Fig. 6 shows the Wood cut-out for arc work, which is so clearly represented as to require no further explanation.

Railway Car Electric Lighting.

For several years past efforts have been made to introduce electric lights for railway cars and many different devices have been brought forward. Simple storage batteries were first tried but failed to render satisfaction. The most ex-



RAILWAY CAR LIGHTING SYSTEM.

tensively developed method of electric car lighting heretofore introduced provided a steam motor in the baggage car, fed by steam from the locomotive, by which a dynamo was driven to generate an electric current carried through the train by wires extending from car to car. This plan required the constant presence of an attendant and has been found so expensive as to be impracticable. A method providing a sprocket wheel attachment with the car axle driving a dynamo in a closet within the car and still another making connection with the car axle by means of a spiral spring band have also been tried.

Another device has recently been perfected and introduced into practical use by the American Railway Electric Light Company, Vanderbilt Building, New York, which, it

is claimed, obviates the defects heretofore encountered. It provides a plain gear wheel attached to the car axle connecting by ordinary cogs with the shaft of the dynamo, which is securely placed on the car truck. By this means a constant and reliable electric current is generated, and by the utilization of a small storage battery the light is rendered uniform, both while the train is running and standing still.

Each car is thus independently provided with its generating and illuminating apparatus, so that cars may be detached from through trains when desirable and sent over connecting roads without limitation. All of the mechanism is securely placed beneath the floor of the car, completely incased to

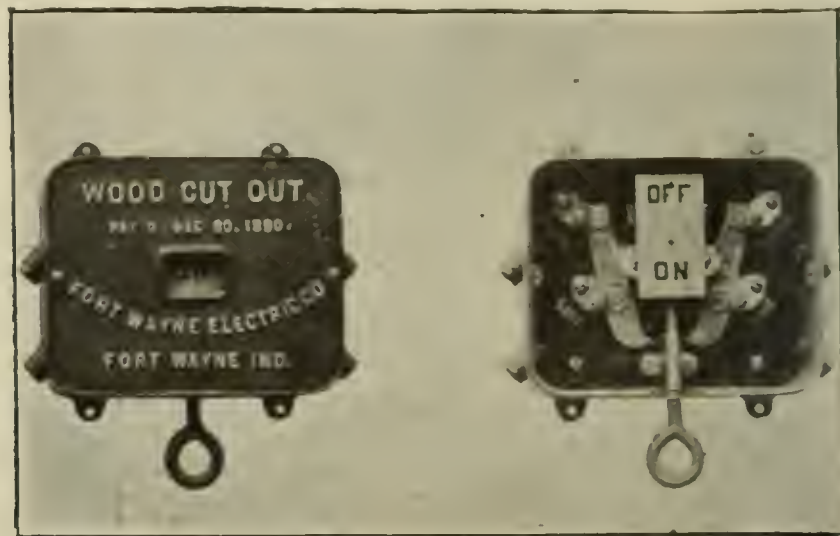
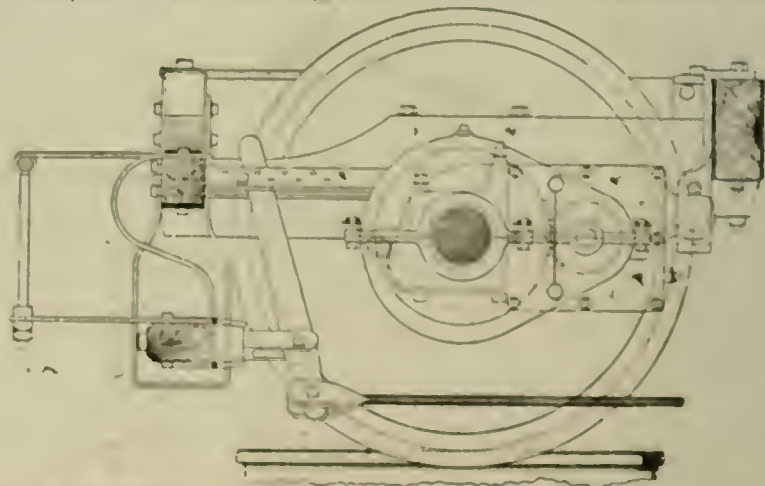


FIG. 6.—ARC CUT OUT.

avoid dust and dirt, so that no space is occupied within the car. The apparatus is automatic in operation, thus requiring no personal attention, except at long intervals of time, when it will be regularly inspected at terminal stations. The dynamo used for this purpose is compound wound, with the compound winding used in reverse to the shunt, which acts as a governor when the higher speeds are reached, and keeps the E. M. F. nearly constant, so that if the dynamo is wound to give 30 volts and 35 amperes at 25 miles per hour, it will not vary 5 per cent. at 60 miles per hour. The system is automatic in all its movements, the current being taken care of by an automatic cut-out and pole changer combined, the pole changer device taking care of the direction in which the



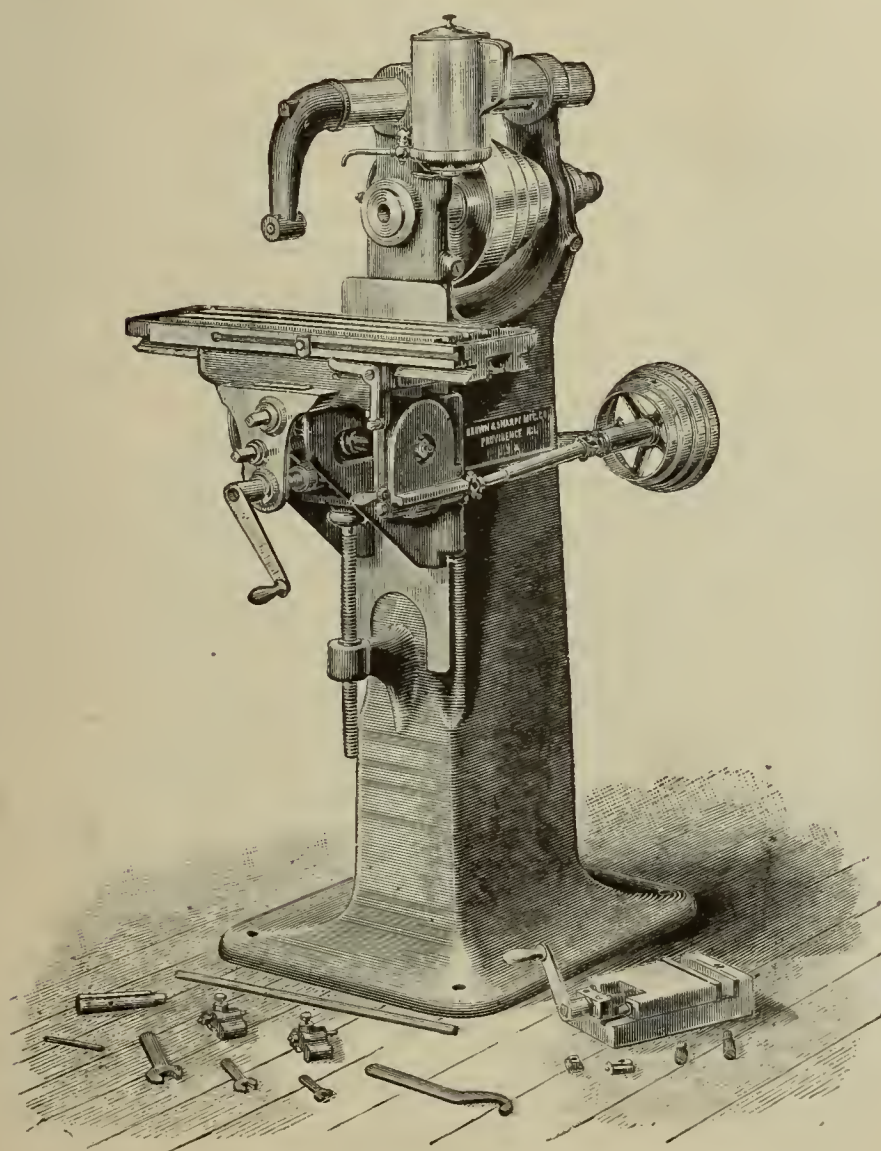
car is moving, and the cut-out taking care of circuits when the machine stops. A private car equipped with this apparatus recently completed a series of runs amounting to 4,332 miles, with, it is claimed, absolutely no cost for maintenance.

Plain Milling Machine.

The machine we illustrate has just been placed upon the market by the Brown & Sharpe Manufacturing Company, Providence, R. I., and presents a number of new features, chiefly in connection with the feed. The straight bearings are scraped to surface plates, and the cylindrical bearings are ground and fitted to standards. The feed and elevating

screws are accurately cut, and the alignments are correct. The spindle has a hole its entire length and runs in bronze boxes provided with means of compensation for wear. The front end is threaded and has a hole fitted for arbors with taper 1-2 inch per foot and .9 inch diameter at the small end. The cone has four steps, the largest being 10 inches in diameter and for a 2 1-4-inch belt. The overhanging arm can be easily reversed to receive an attachment, turned out of the way, or removed. The distance from the centre of the spindle to the arm is 4 3-4 inches, and the greatest distance from the end of the spindle to centre of arm, 10 1-2 inches.

The table, including oil pans and channels, is 25 inches long, 8 inches wide and has a working surface 20 inches by 6 inches. It has also three T slots 1-2 inch wide, a transverse movement of 4 1-4 inches and can be lowered 12 inches from centre of spindle. The feed of table, 16 inches, is automatic in either direction, and there are eight changes of feed varying from .005 inch to .1 inch to one revolution of spindle. Adjustable dials graduated to read to thousandths of an inch indicate the transverse and vertical movements of table, and these dials may be adjusted without the aid of wrench or screwdriver. The frame is hollow and fitted as a closet to



PLAIN MILLING MACHINE.

hold the small parts that accompany the machine. On the left side there is a pan for holding small tools, etc., and on the front of this there is a rack for wrenches. The countershaft has tight and loose pulleys, and should run about 180 revolutions per minute. The weight of machine ready for shipment is about 1,085 pounds and the net weight about 770 pounds. The floor space occupied is 41 by 35 inches.

The Kennelly Combination Galvanic and Faradic Adaptor.

One of the most urgent inquiries of the physician of to-day is for an instrument which he can use with the Edison 110 or 120 volt direct current for all the varied forms of electro-therapeutic treatment with absolute safety to the patient, and at the same time be able to graduate and control it

within the finest limits, and also accurately measure the strength of the current he is employing.

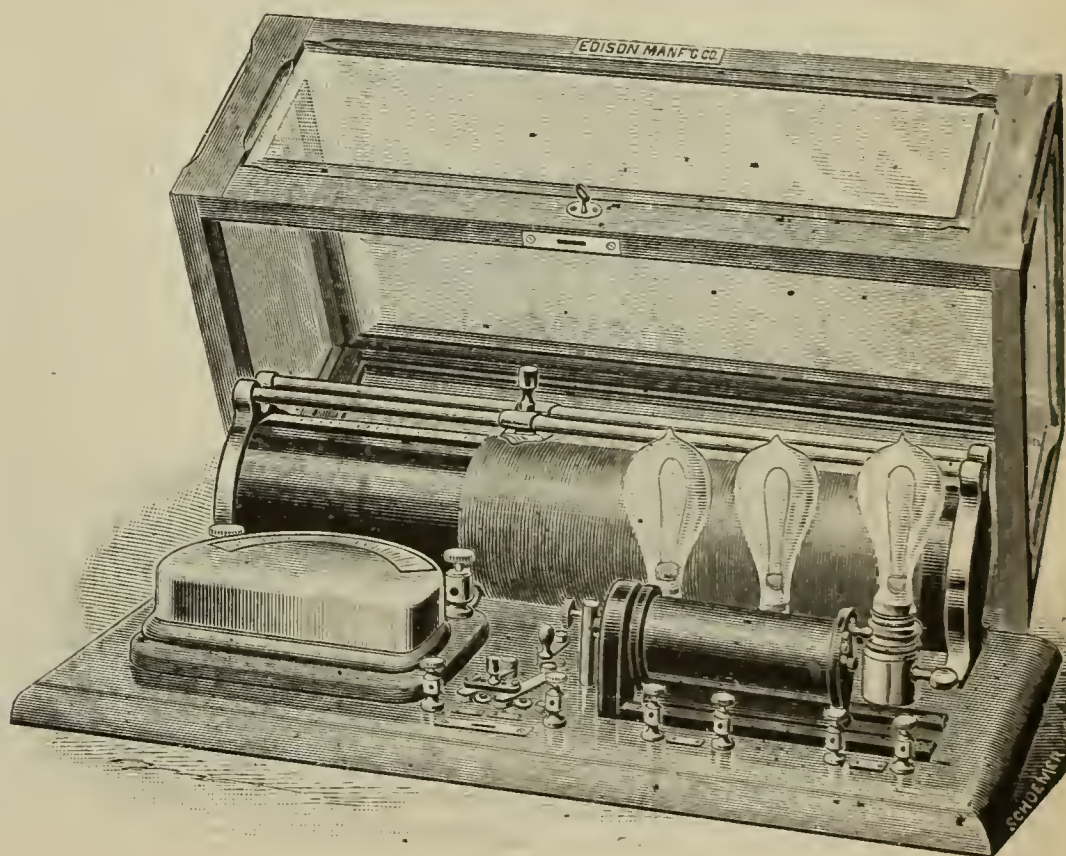
Such an apparatus is illustrated above, and has been designed by Mr. A. E. Kennelly (late chief electrician of the Edison laboratory), with a special view to fulfilling all these requirements, and is manufactured by the Edison Manufacturing Company, 110 East 23d street, New York.

It consists of a hard rubber cylinder, upon which is wound in suitable grooves, cut on the face of same, several hundred feet of German silver wire, having a very high resistance.

Near the end of the cylinder on the left, very high resistance carbon blocks are introduced into the circuit, making the total resistance about 33,000 ohms. This rheostat is regulated by the sliding contact, which travels along the two rods above and parallel with the cylinder.

A 16-c. p. lamp is placed in circuit with each of the leading-in wires to effectually protect the patient and apparatus should a short circuit occur on any part of the electric light circuit.

A third lamp, shown on the extreme right, provided with a key, is arranged in shunt with the rheostat. When the key is turned on, the voltage of the galvanic current is reduced to 60 volts. With this shunt in operation, and all the resistance of the rheostat thrown into the circuit by moving the sliding contact to the extreme left, a current of one milliamperere is obtained when the binding posts are connected together by a short piece of wire, i. e., short circuited. On moving the sliding contact to the right, the resistance is very gradually diminished, and the current correspondingly increased. This finely graduated current is required in some cases, where a



GALVANIC AND FARADIC ADAPTOR.

very slight irregularity in the current would produce a shock to the patient.

When a stronger current is required, the lamp is cut out by turning off the key and the current is used unshunted.

The well-known Kennelly milliammeter is mounted on the base on the left, the pole changing switch is placed in the middle of the board, while on the right is shown the faradic coil, which is also operated by the street current.

This is of the Du Bois Raymond type, the secondary being wound upon a separate spool, removable at will. This secondary winding consists of 18 layers of No. 34 wire, having a total length of about 1,800 yards. The winding is tapped in six places, so as to divide the coil into six sections, each section consisting of three layers of wire, the whole being connected in series.

By this arrangement 3, 6, 9, 12, 15 or 18 layers of secondary winding can be used as required, by moving the switch shown on the end of the coil.

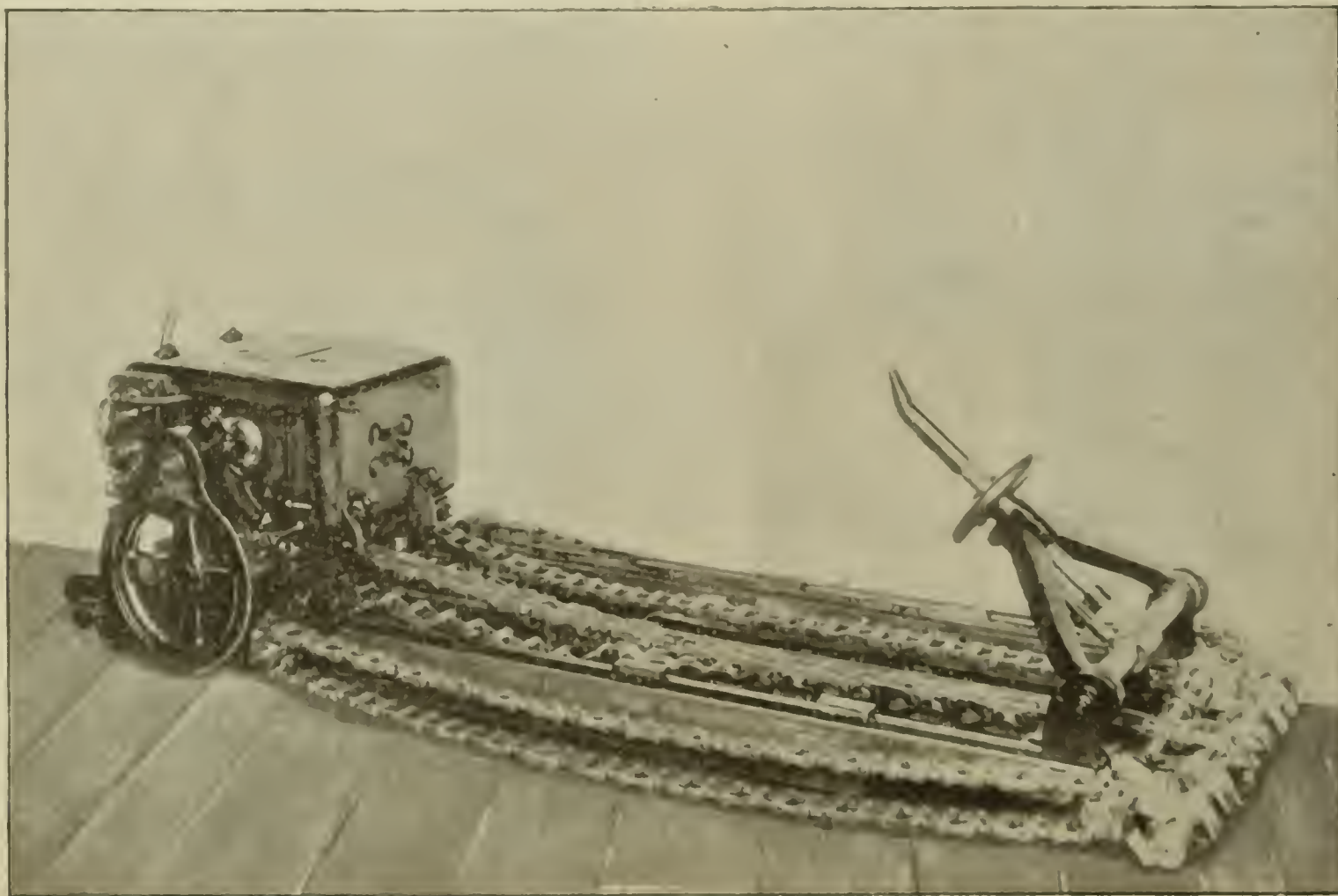
Each section produces an entirely different sensory effect, the current in the first section being very stimulating, whereas the current in the sixth section is of a very pleasing character and produces a sedative effect; the character of the currents in the other sections being intermediate between the two extremes. When first put into operation, the secondary coil should always be moved to the extreme right, so as to leave the primary uncovered, the strength of the current being increased by slowly moving it toward the left, so as to finally cover the primary coil.

The current in the primary, on the contrary, is at a minimum when it is entirely covered up by the secondary coil, which in this case must be short circuited by a switch provided for that purpose, and it is increased by sliding back the secondary coil to the right.

When the switch at the back of the pole changing switch is turned on and the vibrator set in motion, the current from the galvanic binding posts is of a pulsating character, as the primary of the faradic coil is superposed on the straight galvanic current, thereby producing the pulsating current as described by Dr. De Watteville. The strength of these two combined currents is controlled by the rheostat in the ordi-

is of the rotating bar type. It consists principally of a bed frame of two steel channel bars firmly braced. Mounted upon and engaging with this bed frame is a sliding frame similarly braced, consisting of two steel bars, at the rear end of which is mounted an ironclad multipolar electric motor communicating power to the feed and driving mechanism. The front end of this sliding frame carries the cutter bar, in which the cutters or bits of tool steel are held by set screws. When the cutter bar is revolved, these cutters or bits cover its entire face. The bar is driven by an endless chain, and as it is revolved is advanced by the feed mechanism into the coal or other material to be cut, to the desired depth, and the cuttings are brought out to the face of the coal by means of cleaning chains.

This machine is operated by two men, one in charge of the machine and the other as a helper. A carriage is furnished with the machine, which enables it to be handled with ease. The machine is taken into the mine on this carriage and run into the room to be under-cut. It is then placed on two skid boards in front of the coal at one side of the room or entry to be under-cut, and it is fastened firmly by means of the front and rear jacks, which are braced against the face and roof of the coal. These prevent the machine from moving when in operation. The power is then turned on by the attendant, and the machine proceeds to do its work.



ELECTRIC COAL CUTTER.

nary way. It is thus possible to obtain from this instrument: First, the direct galvanic current of 120 volts; second, the direct galvanic current of 60 volts; third, the primary faradic current capable of six variations of strength, depending upon the number of sections of the secondary coil that are short circuited; fourth, the six secondary faradic currents, all of which manifest distinct characteristics; fifth, the primary faradic current superposed on the 120-volt galvanic current; sixth, the primary faradic current superposed on the 60-volt galvanic current.

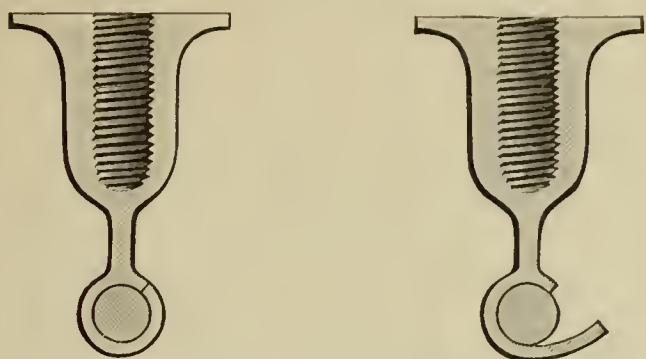
Electric Coal Cutter.

The illustration shows a new and improved device for cutting coal, which has just been designed and perfected by the General Electric Company. It is known as R. B. 40, and

The cutter bar, which is revolved by an endless chain, is fed forward to a depth of five or six feet, according to the size of the machine. The usual length of the cutter bar is 30 inches, but 42 or 48 inch bars can be used where the cutting is not too hard. When the full depth is reached the feed is thrown off, and by means of a reverse lever the cutter bar is withdrawn to its starting point and automatically stopped. This completes the cut, and the machine is moved over the length of the cutter bar used and another cut made in the same manner. This is continued until the entire width of the run or entry is under-cut, after which the machine is again loaded on the carriage and taken into another room.

The cuts are made in the short space of time of from four to six minutes. The amount of coal under-cut, or the lineal feet face for each machine, depends upon the quality of the

coal and the skill of the man handling it. The construction of this machine is extremely simple, and any person of ordinary intelligence can understand and handle it with a few



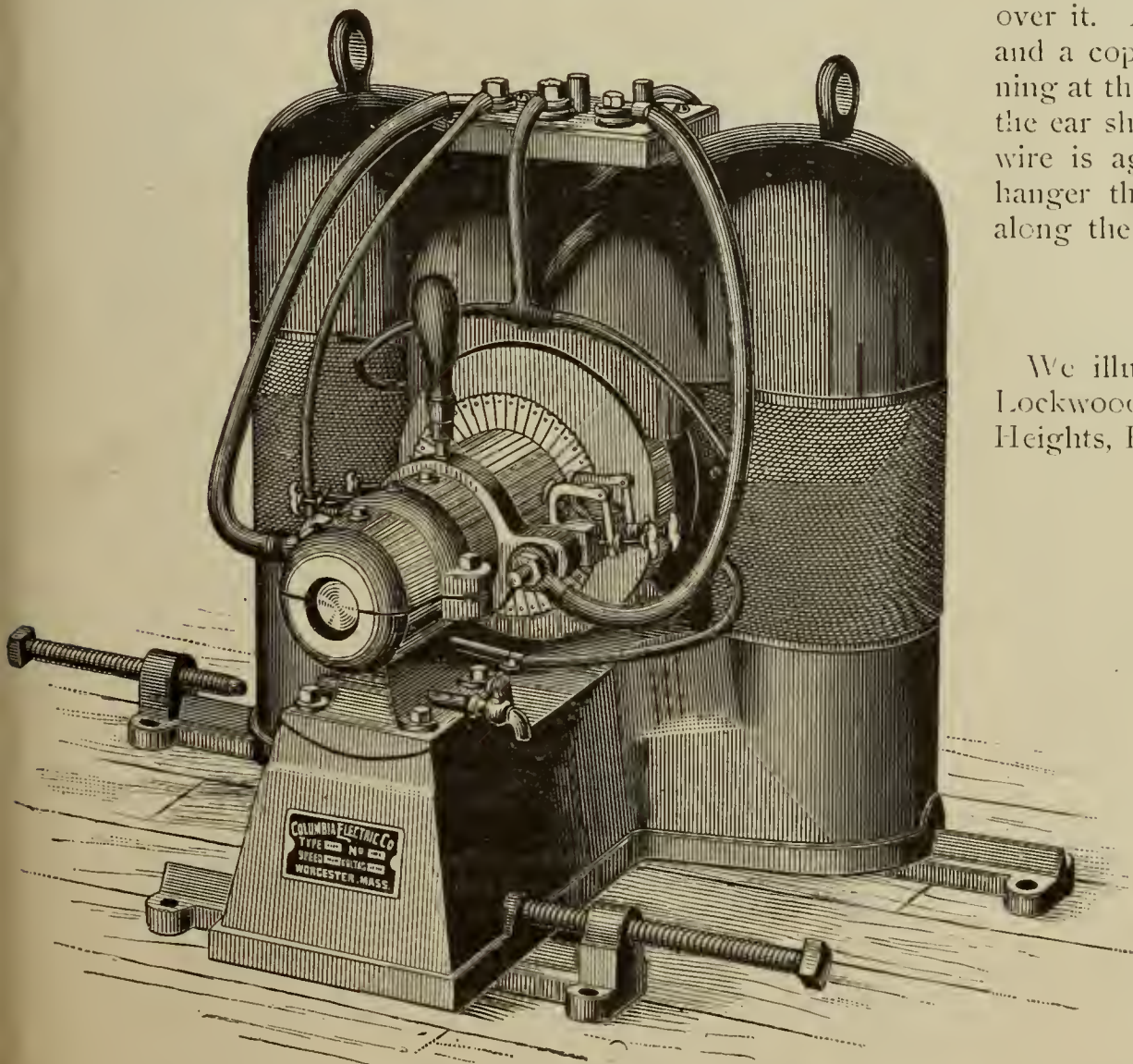
THE SPILLMAN TROLLEY EAR:

days' instruction. All parts are made in duplicate and are interchangeable.

The Columbia Dynamo.

We illustrate herewith the new type dynamo which the Columbia Electric Company, Worcester, Mass., is placing on the market.

The dynamo has consequent poles, with massive cast iron fields and wrought iron cores. The armature is of the Gramme ring type. The commutator is built of tempered copper and is very large. The brush holders are so arranged that carbon or woven wire brushes may be used. The fields are compound wound, and so proportioned that the potential between the brushes remains practically constant through all variations of load. The bearings are of



COLUMBIA DYNAMO.

the spherical type, so that they are self-aligning and self-adjusting, and are lubricated by means of ring oilers.

As will be seen from the cut, the dynamo is very compact and substantially built, with well proportioned fields. The company is at work developing some cast steel magnets for the same type. It has also on the market a dynamo whose fields are composed of wrought iron forgings.

The Spillman Trolley Ear.

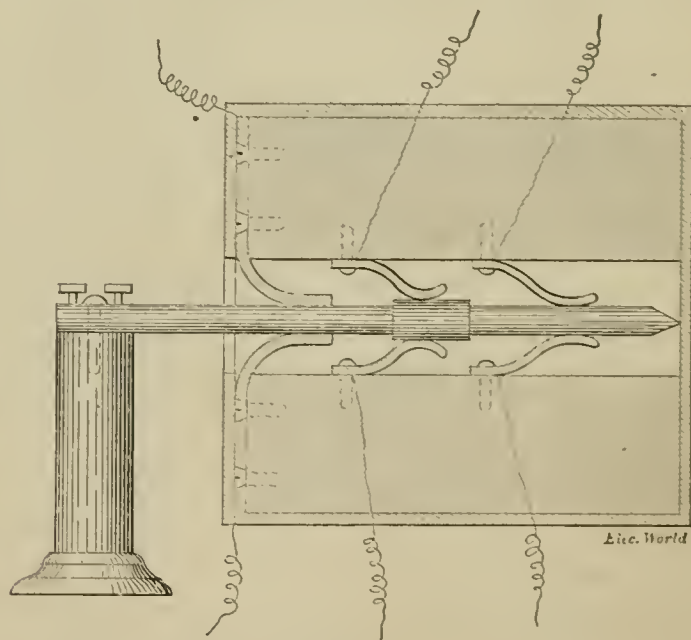
The accompanying cuts show different views of the Spillman trolley ear, which the Ohio Brass Company, of Mansfield, O., has recently made extensive arrangements to



manufacture and is now offering to the trade. The ear has several features peculiar to itself which commend it to the users of similar devices. It is safe to say that the Ohio Brass Company will find a large sale for them. The great objection raised to the use of soldered ears, namely, that of burning the trolley wire, the time and material consumed in soldering, the difficulty of adjusting the hanger after once in place, as well as the objection to many clamps, that of sparking when the trolley wheel passes over it, have all been overcome in the design and construction of this ear. It has been given a practical test both on straight line and curve work for over a year past on one of the largest roads in the West, and its utility thoroughly demonstrated. The ear is screwed on to the hanger body and the trolley wire placed in the concave lip. The trolley wire is then pulled to the necessary tautness and the lip of the ear is compressed over it. A metal block is held on the back side of the ear and a copper hammer used to do the forming with, beginning at the centre and working toward the ends. On curves the ear should be hung so that the side strain of the trolley wire is against the web. If it is necessary to adjust the hanger the lips can be opened sufficiently to slip the ear along the trolley wire.

Telephone Switch.

We illustrate herewith a telephone switch made by the Lockwood Electric Telephone Company, 18 Columbia Heights, Brooklyn. Secured to the receiver is a rod of hard



TELEPHONE SWITCH.

rubber with a metal sleeve about midway of its length. When the receiver is not in use, the rod is in the opening shown. the transmitter and receiver circuits, connected with the extreme contacts, are open and the central or call circuit is closed by the metal sleeve. When the telephone is in use, the central or call circuit is open and the two others closed.

New Incorporations.

NEW YORK, June 16, 1894.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked
Brush Ill., New York.....	50	10	30
Western Union Telegraph.....		84½	85
American Bell Telephone.....		196½	190
Detroit Electrical Works.....	10	3	4
Cleveland General Electric Co.....		85	90
East River Electric Light.....	100		65
Electric Con. & Supply Co., pref.....	15	15	10
" " " com.....	15	15	17
Edison Electric Ill., New York.....	100	93½	100½
" " " Ints.....		100½	107
Edison Electric Ill., Brooklyn.....	100	101	102
" " " Boston.....	100	117	118
" " " Chicago.....	100	125	130
" " " Philadelphia.....	100	130	132
Edison Electric Light of Europe.....	—		2
" Bonds.....		80	85
" Ore Milling.....	—	10	13
Fort Wayne Electric.....	—	1	2
General Electric Company.....	100	36½	36½
" " " deb. 5's.....	—	86	86½
Interior Conduit and Ins. Co.....	100	45	65
Mount Morris Electric.....	—	—	55
Westinghouse Consolidated.....	50	80½	87
" " " pref.....	50	81½	82

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, New York, June 18, 1894

MR. AVERY P. ECKERT has been appointed travelling representative of the Safety Electric Wire Company, of this city, and will shortly make a trip in the interest of their excellent wire and cable.

Mr. Eckert is well known among electrical supply houses, architects, etc. He is the son of Mr. W. H. Eckert and nephew of Gen. Thomas T. Eckert.

A GOOD START has been made toward laying the foundations for the power station of the Nassau Electric Railway Company, of Brooklyn, and the track and overhead construction are progressing rapidly. The company has already received several large shipments of trolley line insulators from the H. W. Johns Manufacturing Company, of New York.

N. M. GARLAND, of 120 Liberty street, this city, the general Eastern representative of the Emerson Electric Manufacturing Company, reports that despite the backward season, the sale of the "Meston" fan motors has been very large. The '94 model of this motor has many improvements, and has added considerably to the reputation of this popular fan.

MR. IRA W. HENRY, the electrician of the Bishop Gutta Percha Company, was married on June 6, 1894, in St. Agnes' Chapel, to Miss Frances Scrivener. A large gathering of friends witnessed the ceremony and expressed their hearty congratulations. The couple immediately started on a Southern trip. Capt. W. Walcott Marks, superintendent of the Bishop company, officiated as the best man, and Mr. Harry D. Reed acted as usher.

ERASTUS WIMAN, who was last week found guilty of forgery in the second degree, has for some years been identified with telegraphic and other electrical interests, notably in connection with an extensive system of electric lighting on Staten Island. At one time he occupied an important position in the direction of the Western Union, from which he was retired on account of his equivocal methods of obtaining information relating to a rival company.

THE CLEVELAND GENERAL ELECTRIC COMPANY has passed into the hands of a New York electric syndicate, all its obligations being assumed, and its stock, it is said, being taken up at par, minus brokers' commissions. Extensive improvements will be made in the local plant involving an immediate outlay of between \$400,000 and \$500,000. The local company will be known as the Cleveland Electric Illuminating Company, and James Parmalee will be president.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., June 16, 1894.

THE NEW YORK INSULATED WIRE COMPANY has removed its New England Department to 134 Congress street, Boston, of which Mr. Walter S. Barker is in charge.

MESSRS. LINTON & SOUTHWICK, of Worcester, Mass., report the demand for their switches as being so great just now as to require them to run their factory on 15 hours' time per day.

MR. C. J. H. WOODBURY has resigned the vice presidency of the Boston Manufacturers' Mutual Fire Insurance Company, to take effect Sept. 1, on which date he will enter the service of the American Bell Telephone Company.

BOSTON INCANDESCENT LAMP COMPANY.—Judge Colt, of the United States Circuit Court, at Boston, rendered last Monday an opinion restraining this company from manufacturing incandescent lamps, and in favor of the Edison Electric Light Company.

THE AUTOMATIC SWITCH COMPANY, Baltimore, Md., has appointed the following agents: Boston Electric Company, 548 Washington street, Boston, Mass.; Michigan Electric Company, 47 State street, Detroit, Mich.; Duquesne Electric Supply and Construction Company, 709 Lewis Block, Pittsburgh, Pa.

THE BILL relative to the inspection of electric light meters has been reconsidered by the Massachusetts Legislature, notice being given that an amendment would be substituted, requesting the gas and electric light commissioners to investigate the working of meters and report their findings to the next general court.

ANDOVER, MASS.—Alvin T. Morrill, of this city, has been appointed receiver for the Craighead & Kintz Company, in the Supreme Court, by Judge Barker. The company was organized with a capital of \$250,000, and engaged in the manufacture and sale of electric and kerosene lighting apparatus and fancy metal goods, with a factory at Andover. The assets are inventoried at \$300,000, and the liabilities are less than \$70,000.

MR. GEORGE NICHOLS SARGENT, of Melrose, Mass., and junior member of the firm of Almon & Sargent, electrical engineers and contractors, of Boston and New York, was married on the 11th inst. at the Cathedral rectory, in Boston, to Miss Alice Adelaide Proctor Poor, daughter of John A. Poor, Esq., the well known coffee broker of Albany, N. Y. We join in congratulations with Mr. Sargent's numerous friends, and wish for the happy couple a life of uninterrupted happiness and prosperity.

THE ELECTRIC POTENTIAL.—Boston's new electric club met at Young's Hotel last Wednesday evening for the purpose of enjoying another dinner and listening to an instructive address on "Electrolysis of Pipes and Cables," by Mr. I. H. Farnham, of the American Bell Telephone Company. Fifteen new names were added to its membership, and 25 members attended this meeting—facts which argue future prosperity for this new organization. Mr. Farnham's address commanded the close attention of all present, and while in great measure it was a repetition of his utter-

ances recently before the American Institute of Electrical Engineers, he introduced several new ideas and observations. Mr. Farnham presented about 50 stereopticon views, showing cables, gas and water pipes destroyed by the action of electrolysis, and diagrams showing the proposed methods of remedying the evils and the danger districts around Boston before and after improvements had been effected. The most interesting part of his address was a model showing the action of electrolysis. President C. W. Holtzer presided over the meeting.

Canadian Notes.

OTTAWA, Ont., June 16, 1894.

MONTREAL.—The street railway company has placed a number of new open cars on the streets. There are 15 similar ones being made. The cars were constructed by the Ottawa Car Company. The making of these cars outside the city, it is held, is tantamount to the annulment of the company's contract.

OTTAWA, ONT.—The Bell Telephone Company's underground cable will be laid in a few days. Eighteen thousand feet of underground cable and 19,000 feet of aerial cable will be laid and strung. The underground cables are heavily encased in lead. Each of these cables contain 100 pairs of wires. The cables are 2 5-16 inches in diameter, and weight five pounds per foot.

OTTAWA, ONT.—Thos. Todd, president of the Galt and Preston Street Railway Company, stated at a recent meeting of the directors that the contract for dynamos, motor cars, overhead work, bolting rails, etc., had been awarded to Messrs. Ahearn & Soper, of Ottawa, at the sum of \$15,925, and the contract for engines and boilers to the Goldie & McCulloch Company, of Galt, at \$6,000.

MONTREAL.—The Montreal Street Railway is said to have a great scheme on foot, which, if carried into effect, will necessitate an enormous outlay of money. Owing to the rapid growth of the city the company has for some time contemplated the erection of a large power house and yards in a central part of the city. The only site which is said to be desirable for the project is the large square bounded by St. George, Vallee, Philip and Dorchester streets. Some of the proprietors have been waited on, and offers made for their properties. If the scheme is carried out, an immense power house will be built on a portion of the ground. The remaining sections will be utilized for tracks and running sheds for the electric cars.

News of the Week.

Telegraph and Telephone.

WHEELOCK, TEX.—Mitchell Bros. & Decherd will construct a telephone line to Franklin.

AUGUSTA, GA.—Jacob Edmunds is reported to be organizing a \$10,000 telephone company.

DANVILLE, VA.—Address W. A. Taylor concerning a \$10,000 stock company organizing to construct a telephone system.

PALESTINE, TEX.—L. C. Ketchum has been granted a 15-year franchise for a telephone system, and will construct it immediately.

SALISBURY, MD.—The Salisbury Telephone Company will purchase 10 miles of telephone wires, 50 instruments, etc. A. J. Benjamin is president.

SCRANTON, VA.—Address Clemmer & Hogshead concerning a company organizing with a capital stock of \$5,000, to establish a telephone line to Middlebrook.

WHITE RIVER JUNCTION, VT.—A new telephone exchange is to be located at White River Junction by the New England Company, and will include all the surrounding towns. It will be equipped with long distance phones.

LEXINGTON, VA.—A company has been organized to erect a telephone line between Staunton and Middlebrook. J. H. Bowman is president. This company will possibly, in the future, extend its line to Greenville, Moffett's Creek and Lexington.

HUNTSVILLE, TENN.—James E. Caldwell, president, and Leland Hume, general manager, of the Cumberland Telephone Company, of Nashville, were in the city looking into the building of a long distance line from this city to Nashville.

Electric Light and Power.

FLEMINGTON, N. J.—Flemington will establish an electric light plant.

GENESEO, N. Y.—Ground has been broken for the electric light plant in this village.

EAST TROY, WIS.—East Troy is considering the cost of an electric lighting plant.

MORRISTOWN, N. J.—Bound Brook has a newly organized electric light company.

NANTUCKET, MASS.—The Nantucket Electric Light Company is advertised to be sold under foreclosure.

QUITMAN, GA.—The town will issue \$20,000 in 6 per cent. bonds for putting in electric light and waterworks.

NIAGARA FALLS, N. Y.—The Niagara Falls Electric Light and Power Company has increased its capital stock from \$40,000 to \$75,000.

BROOKLYN, N. Y.—The Brooklyn Common Council has granted franchises to the State and Kings County Electric Light and Power companies.

GENESEO, N. Y.—The electric lighting company of Geneseo will soon build its power house on the company's lot, north of the gas house.

LAFAYETTE, IND.—The Thiemes-Wagner Company will erect new buildings at its brewery plant, and an electric lighting machine will be put in.

WASHINGTON, D. C.—Address S. Wike, acting secretary of the treasury, until July 9 concerning bids for combination gas and electric light fixtures for public buildings at Duluth, Minn.; Galesburg, Ill.; Jackson, Mich. and Paris, Tex.

MILWAUKEE, WIS.—City Clerk Anderson sent a circular letter to 122 cities in the United States in which the electric lighting plant is owned by the municipality. He inquires as to the cost and other particulars regarding the operation of the plants.

PENSACOLA, FLA.—The Citizens' Electric Light and Power Company has organized with a capital stock of \$20,000, and will at once begin the erection of a plant. T. E. Welles is president, C. J. Heinberg, secretary and treasurer, and W. B. Crossand, general manager.

ROCHESTER, N. Y.—Acting on a recent resolution of the Common Council, the lamp and electric committee of the Council has decided to advertise for bids for the lighting of State street in a similar manner to that employed on East Main street, where lamps are now being placed.

ALBANY, N. Y.—The United Electric Light and Power Company, of New York, certifies that it has increased its capital stock from \$5,500,000 to \$6,000,000. The amount of capital actually paid in is \$2,049,600, and the amount of the company's debts and liabilities is \$2,946,570.

THE FRANKLIN ELECTRIC LIGHT COMPANY, Franklin, Ohio, will soon be in the market for some slow speed motors of about 40 h. p. capacity each, to be used for the operation of some power pumps, and will furnish specifications of the requirements necessary to be fulfilled.

PITTSBURGH, PA.—The Alleghany sub-committee on public lighting met June 6, and recommended to councils that the bid of R. C. Tannehill, for the erection of an additional electric light plant on Braddock street, be cut \$4,500 that it may come within the limits of the appropriation.

LEWISTOWN, PA.—The Logan Iron Works, situated in Millin County, Pa., about one and a half miles northeast of Lewistown, has commenced the erection of its new buildings recently destroyed by fire. It is the intention to equip the new mill with an electric crane and all the latest labor-saving appliances.

CHAPPAQUA, N. Y.—A franchise has been granted to G. H. Selleck & Co., electrical contractors, 66 West 122d street, New York, to erect and maintain an electric light and power station in the villages of Unionville, Sherman Park, Pleasantville, Chappaqua and Mount Kisco. The plants will be constructed and operated by the firm named.

HOPKINSVILLE, KY.—The city clerk of Hopkinsville, Ky., will receive sealed bids for lighting the city by electricity with not less than 35 arc lights of 2,000 c. p. each, all night and every night lighting, for a period of not less than one nor more than five years from Aug. 22, 1894. Said bids to be filed with W. H. Tibbs, city clerk, on or before July 3, 1894.

ST. BERNARD, OHIO.—Sealed proposals will be received until July 7 for the furnishing and erection of boilers, engine, counter-shaft, belts, etc., for an electric light plant, the furnishing and erecting of dynamos and apparatus for the production of and operation of arc and incandescent lights. Herman J. White, John A. Larkin and Henry Inwalle are the board of trustees. George Hornung, 30 East Fourth street, Cincinnati, Ohio, is consulting engineer.

UNION, MO.—The electric lights were successfully started on the evening of June 6, the event being made the occasion of a great celebration. This plant, which was designed by William H. Bryan, consulting engineer, of St. Louis, presents some novel features. The lights are operated from Mr. A. A. Tibbs's Weather-house station at Washington, Mo., 10 miles distant. The current used on the primaries in Washington and Union is 1,000 volts alternating. At Washington a step-up transformer is used, raising the voltage to 4,000, and the current is then transmitted over a pair of No. 3 wires, a step-down transformer being located at the entrance to the town of Union. The service in Union consists at present of 250 16-c. p. commercial lights, and five 50-c. p. and 16 32-c. p. street lamps. Although Union is a town of less than 1,000 inhabitants, and the consumption of light there is necessarily limited, the recent advancement in transformer construction and the low cost of copper have made it possible to handle this service profitably from the Washington plant. It is estimated that with the average load, the losses due to transformation and transmission will not exceed 5 per cent.

The Electric Railway.

WATERLOO, N. Y.—The Canandaigua street railway is being converted into an electric road.

CHEVY CHASE, MD.—The Chevy Chase Electric Railroad is to be extended to Kensington, Ky.

BUFFALO, N. Y.—An electric railway between Randolph and East Randolph is being talked of.

BOSTON, MASS.—An electric railway connecting Hartford and Rockville is to be built this summer.

EAST WEYMOUTH, MASS.—The new electric railway from North to East Weymouth has been opened for operation.

SUSQUEHANNA, PA.—A charter has been granted the Honesdale Electric Railway Company, with a capital of \$50,000.

STAUNTON, VA.—Address secretary of Chamber of Commerce concerning proposed electrical railroad from Staunton to Monterey.

LYNCHBURG, VA.—C. S. Hutter may be addressed concerning the proposed electric railroad from Lynchburg to Bedford City, Va.

WASHINGTON, D. C.—Address the Columbia Railway Company concerning an underground cable for the propulsion of its cars.

VELASCO, TEX.—Address W. A. Rowan concerning proposed electric railroad to connect the Sante Fe and Velasco Terminal railways.

NIAGARA FALLS, N. Y.—The contract for the new electric railroad at the north end of the city has been let to J. W. Hoffman & Co., of Philadelphia.

ROCHESTER, N. Y.—A certificate of lease of the Cayuga Lake Electric Railway to the Ithaca Street Railway Company has been filed with the Secretary of State.

TERRE HAUTE, IND.—The Terre Haute Electric Railway Company has been organized with a capital of \$500,000. The directors are P. P. Thomas, J. G. McNutt and M. F. Burke.

BALTIMORE, MD.—The Hall's Spring electric line of the Baltimore City Passenger Railway Company will be extended to Clifton as soon as the rights of way are secured from the city.

ALBANY, N. Y.—It is said that about \$350,000 will be required to build and equip the proposed electric road between Amsterdam and Gloversville. If Amsterdam will take \$50,000 of the stock the road will be built.

HOUTZDALE, PA.—Messrs. Seeley & Barret, of Hackett, Pa., will build a new railroad from Phillipsburg to Ramsey immediately, making Houtzdale the main point, and eventually it will be built to Clearfield and Curwensville.

POUGHKEEPSIE, N. Y.—The contract for trolley line insulators has been awarded to the H. W. Johns Manufacturing Company, New York, by the Poughkeepsie and Wappinger Falls Railway Company, shipments to begin immediately.

BOSTON, MASS.—The South Side Street Railway Company, which proposed to build a route from Lowell to Lawrence, has withdrawn its petition for a location there, owing to the refusal of the Lowell aldermen to grant right of way in that city.

CINCINNATI, OHIO.—The commissioners of Butler County granted a 50-year franchise to the Hamilton, Leesonsville and Middleton Electric Railway Company for a road between Hamilton and Middleton. Eastern capitalists are behind the movement.

ST. LOUIS, MO.—The Lindell Railway Company has been granted permission to build a one-story brick power house, costing \$16,000, on the north side of Park avenue, between Vandeventer avenue and Lawrence street. The office is at 2330 Chateau avenue.

PHILADELPHIA, PA.—An ordinance has been passed authorizing the Union Passenger Railway Company and its lessee to make further extensions, and to use electric motors, to be supplied from overhead wires, and to erect and maintain poles to support the same.

BRADFORD, PA.—A charter was issued June 7 by the State department to the Bradford Electric Street Railway Company, of Bradford, capitalized at \$100,000, to run through the principal streets of the city of Bradford. The president is Lewis Emery, Jr., of Bradford.

DANBURY, CONN.—The Danbury and Bethel Horse Railway Company has filed with the selectmen a plan showing the highways in and through which it proposes to lay its tracks for the proposed electric railway.

COUNCIL BLUFFS, IOWA.—The Council Bluffs and Lake Manawa Electric Railway Company will build, equip and operate an electric railway from a point on South Sixth street, in the vicinity of the Rock Island depot, to the town of Manawa.

ST. JOSEPH, MICH.—We are informed by the St. Joseph and Benton Harbor Electric Railway and Light Company that its plant has not been destroyed by fire, as reported recently in these columns. We regret the error, which led to a deluge of communication from electrical firms.

LOWELL, MASS.—The work of constructing the connecting link of the Lowell, Lawrence and Haverhill Street Railway between Lowell and Lawrence has begun, and when completed the entire line from Lowell to the end will be 42 miles continuous street railway, one of the longest in the country.

UTICA, N. Y.—The Rome City Street Railway Company has for

some time had under consideration a proposition to substitute electricity for horse power. W. P. Rayland, secretary and treasurer of the company, is now engaged in securing the consent of real estate owners along the old line to the proposed change.

PHILADELPHIA, PA.—On June 15 the Philadelphia and Trenton Street Railway Company, to extend from Calhoun street bridge to Frankfort, 25 miles long, was chartered with a capital of \$150,000. The incorporators are Lewis Calvin Mans, president; Theo. F. Hansen, Philadelphia; J. Bethell, Lansdowne; Jos. H. Real, Bloomfield, N. J., and J. Henry Durrall, Trenton.

OPELIKA, ALA.—The Opelika and Auburn Electric Railway Company has been organized with M. E. Gray, of Columbus, president; J. L. Cowan, Opelika, vice president and general manager; A. H. Slaughter, treasurer, and C. I. Dougherty, secretary. Preliminary surveys have been made, and the company is now in the market for the necessary construction equipment.

ELYRIA, OHIO.—Tom L. Johnson has applied to the City Council for permission to construct and operate a street railroad in this city. Mr. Johnson not only does not ask a bonus for constructing the proposed road, but proposes to pay one-third, not to exceed \$3,500, toward the construction of a stone arch across the west branch of the Black River, on Lodi street.

WHITE PLAINS, N. Y.—The committee appointed by the Board of Trustees of White Plains to make a final report relative to the conditions to be imposed by the board for the granting of franchises to the New York, Elmsford and White Plains, and the New York, Mamaroneck and White Plains electric companies (railway) held a final meeting June 8, and will soon make a report.

LYNCHBURG, VA.—Owing to the sickness of members, there was no meeting of the electric road promoters in Lynchburg. The "Advance" says: "It developed, however, that if the people of the county can raise \$25,000 and the right of way, the road will be built. It is understood that an effort will be made to get a vote of the county of Bedford on a subscription of \$25,000."

TAMPA, FLA.—Mayor R. W. Easley and W. H. Kendrick have petitioned for the privilege of right of way for the street railway, which they are organizing a corporation to operate. They were granted the privilege of laying tracks from some point on Livingston avenue, thence south to the line of the city of Tampa, and thence along said avenue to Palm Beach and Hocker's Point.

NASHVILLE, TENN.—The Nashville Traction Company will purchase the overland Railroad Company's properties and Glendale Park from Rudolph M. Hunter, who purchased them at the recent sale. The company intends to push the improvements on the property, rebuilding the road with 60-pound steel rails, part of which have already arrived. It is expected that the road will be running within 60 days.

PITTSBURGH, PA.—A charter has been issued to a company to build an electric road from Castle Shannon to Pittsburgh. Among those interested are J. F. Grimes, of Knoxville, and W. W. Murray. The Knoxville Land Improvement Company and the Fair Haven Land Improvement Company are behind the scheme. The name of the company is the Knoxville, Fair Haven and Lebanon Railway Company, and the capital stock is \$100,000.

PHILADELPHIA, PA.—A charter has been granted to the Market Street, Richmond and Frankford Street Railway Company, which has a capital of \$180,000. An elevated structure will be erected, if possible, and if that cannot be done, a surface electric road will be laid, provided the necessary permission is obtained from the Council. Walter N. Boyer, treasurer of the United States Railway Supply Company, 1213 Filbert street, is president.

CHICAGO, ILL.—The Cicero and Proviso Railway Company presented a petition to the Board of Trustees of the village of Harlem, asking for permission to construct and operate a single track street railway on Harlem avenue, between the north line of the village and the centre line of West Madison street in said village. The petition was referred to a committee of the Board, and will be brought up at the next meeting of the Board, on June 23.

COHOES, N. Y.—The joint committee having charge of the arrangements for the proposed belt line electric road has met and appointed Messrs. Fruchting, Simmons, Neary, Houlihan, O'Day, Weldon, Baere and Wilcox to solicit signatures of taxpayers along the route of the proposed line for permission to operate electric cars through the streets. It was decided to name the proposed road the Cohoes City Railroad, and to make the capital stock \$50,000.

SOUTH MILWAUKEE, WIS.—The residents of South Milwaukee are considering the raising of a bonus to induce the Milwaukee Street Railway to extend its line to that village. The company has already secured a franchise to extend its lines to St. Francis and Cudahy. The cost to extend it from Cudahy to South Milwaukee will be \$12,000, which some residents of South Milwaukee favor raising. Work on the St. Francis and Cudahy extensions will begin shortly.

NORFOLK, CONN.—At a meeting of the Norfolk City Railway Company and the Suburban and City Railway Company, the two companies were consolidated under the name of the Norfolk Street Railroad Company, the consolidation to take effect as soon as reported to the board of public works. The following officers were elected: Murray A. Verner, of Pittsburgh, president; Thos. Clyde, of New York, vice president, and H. C. Whitehead, of Norfolk, secretary and treasurer.

TRENTON, N. J.—The North Jersey Street Railway Company, capitalized at \$5,000,000, of which \$40,000 is paid in, filed its certificates of incorporation with the Secretary of State on June 14. The incorporators are James K. Corbiere, of Caldwell; Daniel V. Harrison and William H. Power, of Montclair; James C. Beach and Halsey M. Barrett, of Bloomfield; William J. Davis, Harrison; Henry M. Doremus, of Newark, and John L. Johnson, of Verona. The company will operate in Newark.

NIAGARA FALLS, N. Y.—A franchise for the Niagara Falls, Whirlpool and Northern Electric Railroad, running from the northern part of the city down Main street to the Devil's Hole, was secured from the Common Council two or three months ago, and now the contract for the construction of the road has been let to J. W. Hoffman & Co., of Philadelphia. The ties have begun to arrive, and the work will begin at once. It is expected that the road will be in operation by Aug. 1. The power will be obtained of the Niagara Falls and Suspension Bridge Street Railroad Company, with which company traffic arrangements will probably be made.

MORRISTOWN, N. J.—A communication signed by Aug. W. Cutler, attorney, representing some citizens of Morristown, states that they are about to perfect the incorporation of a street railway in Morristown, to be run by horse, steam or electricity, and that they are at work securing the consent of the property owners before petitioning the Council for the franchise. The communication further states that the company would be willing to pay the city for the franchise, say 2 per cent. of the gross or 5 per cent. of the net earnings of the road. Referred to committee on streets.

Miscellaneous Notes.

THE WESTERN UNIVERSITY OF PENNSYLVANIA, Allegheny, Pa., reports that with its large faculty and thoroughly equipped laboratories it is now as well prepared to meet the requirements of those seeking an education, especially in engineering, as almost any other college in the country.

THE NEW YORK ELECTRIC CLUB.—A proposition has been made by a number of the former members of the New York Electric Club to have an annual dinner in memory of the club. The first dinner will be held at the Imperial Hotel on June 21. Those desiring to attend should communicate with Mr. George F. Porter, 136 Liberty street, not later than June 18.

THE AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION will hold its fourth annual meeting at the New York Academy of Medicine, 17, 19 and 21 West 43d street, New York City, on Tuesday, Wednesday and Thursday, Sept. 25, 26 and 27, 1894. The sessions are to be held in the main hall on the ground floor, and the room immediately adjoining has been secured for the exhibition of electro-medical apparatus.

THE POSTAL TELEGRAPH BUILDING, 253 Broadway, was, on the invitation of President Chandler, visited on Monday night of this week by representatives of the electrical manufacturing and supply industries of New York and vicinity; on Tuesday evening by the members, in a body, of the New York Electrical Society, and later in the week by the members of the American Institute of Electrical Engineers, and many other distinguished guests, who examined with much interest the electrical plant and other features of the handsome building. The offices of *The Electrical World* were kept open on each of the evenings for the benefit of the visitors, many of whom honored it with a call.

LONG ISLAND ELECTRIC RAILWAYS.—A new railroad syndicate has been formed to construct an extensive system of electric railways on Long Island, which, it is thought, will compete with Corbin's Long Island Railroad for a greater part of the lucrative traffic now enjoyed by the latter. The first line will soon be constructed from the Brooklyn city boundary to Jamaica, whence a spur will run to Far Rockaway and along the beach to Rockaway. The main line will run parallel with the tracks of the Long Island Railroad through a half-score towns to Babylon. From Rockville Centre branches will run north and south, the former to Mineola and the latter to Long Beach. It is the intention to eventually build to Patchogue.

Trade and Industrial Notes.

THE ST. LOUIS ELECTRICAL SUPPLY COMPANY has secured the contract for the 500-light incandescent plant at New Athens.

THE GENERAL ELECTRIC COMPANY'S Washington office will be transferred to 227 East German street, Baltimore, Md., on the 21st inst.

THE BLAIR LAMP ADJUSTER COMPANY, of Omaha, Neb., reports good success with its adjuster, and at present is working day and night in order to keep its stock up to the demand.

THE GENERAL ELECTRIC LAUNCH COMPANY has sold Mr. Henry W. Parsell a new and handsome electric launch for use on Schroom Lake during the coming summer. The launch is equipped with batteries of the Consolidated Electric Storage Company.

THE H. W. JOHNS COMPANY, 87 Malden lane, New York, has the contract from the Bridgeport (Conn.) Traction Company for furnishing all trolley line insulators, and a similar contract with the Poughkeepsie (N. Y.) and Wappinger Falls Railway Company.

THE NATIONAL WATER-TUBE BOILER COMPANY, New Brunswick, N. J., gives a concise resume, in a small pamphlet, of the advantages of water-tube boilers over those of the fire-flue or fire-tube type, and calls attention to the superior rating received by its boilers at the World's Fair over other water-tube types there used.

MASON'S ELECTRIC EXCHANGE, 943 Fulton street, Brooklyn, has issued an illustrated circular describing the Mason perfected phonograph battery. All of the phonographs (nearly 100 in number) at Coney Island, Manhattan Beach and Eldorado last summer were successfully operated the entire season by this battery.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., will build the roof of the new electric light station for the Flatbush Gas Company, at Flatbush, N. Y., which will be 60 feet wide and 73 feet long, divided into a dynamo room and a boiler house. The roof will be covered with its patent anti-condensation corrugated iron roof covering.

MR. ALTON D. ADAMS, Worcester, Mass., has entered the field as consulting electrical engineer in addition to his other connections, and will make the design of electric machinery, power transmission and street railway plants a specialty. Mr. Adams' success as a designer of electric machinery and wide experience in general electrical engineering indicate his fitness for this work.

THE SIMPLEX ELECTRICAL COMPANY, 1137 and 1138 Monadnock Block, Chicago, announces that the relations heretofore existing, by which Mr. George Cutter has been acting as its Western sales agent, have been dissolved. Its Chicago office will hereafter be located at 1137 and 1138 Monadnock Block, and Mr. H. R. Illxson, who has for some time been identified with its interests in Chicago, will be in charge.

THE COLUMBIA ELECTRIC COMPANY, Worcester, Mass., has recently bought out the stock and trade of the Worcester Electrical Engineering Construction Company, and is carrying on, together with the manufacturing of dynamos, a construction and supply trade. Its offices are located in the Burnside Building, 339 Main street, Worcester, and the factory at 180 Union street.

THE JOHNS-PRATT COMPANY, for whom the H. W. Johns Manufacturing Company, 87 Malden lane, New York, is the selling agent, is pushing the delivery of trolley line insulating materials for 43 miles of road recently contracted for by the Hartford Street Railway Company. The Johns-Pratt Company also manufactures vulcanite, "Monarch" and other insulating materials.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., describes in a small pamphlet its 1894 model fan motors, which are adapted for both direct and alternating currents. These new models embody all the improvements which three years' of manufacture and service have suggested, and are guaranteed to run three months without any repairs whatever. The pamphlet also illustrates the transformers manufactured by this same firm.

THE CLONBROCK STEAM BOILER WORKS, Brooklyn, N. Y., closed the following contracts for Climax boilers last week: United Electric Light and Power Company, New York City, 10,000 h. p.; Thomson-Houston Electric Company, New York City, 1,000 h. p.; New Electric Light and Power Company, Newark, N. J., 2,000 h. p.; Central Railway and Electric Company, New Britain, Conn., 1,000 h. p.; Edison Electric Illuminating Company, Brooklyn, 4,000 h. p.

THE NATIONAL TELEPHONE MANUFACTURING COMPANY, 620 Atlantic avenue, Boston, Mass., received its patent on its telephone on May 29. As the application was filed on March 24, this is remarkably quick work on the part of the patent office. This telephone which was illustrated and described in The Electrical World of Jan. 27 and April 14, 1894, has already attracted much attention. The company also manufactures an improved transmitter. A modern magneto bell will soon be placed on the market by the company.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., on account of the demand for the Packard "Mogul" lamp for outside work, has made arrangements for a special street hood for the Mogul lamp, and will place it on the market shortly. The company has also made arrangements with the principal supply dealers throughout the country for handling the Alyn soldering stick; a single day's shipment last week ran up to over 5,000 sticks, and was made up chiefly of small orders.

THE COMMERCIAL ELECTRIC COMPANY, Indianapolis, Ind., sends us a folder containing a large number of testimonials to the efficiency of the Commercial dynamos and motors. One from the well known Chas. E. Gregory Company, of Chicago, states that a 15-kw. Commercial dynamo it installed ran 22 hours daily from May 1 to Nov. 3, 1893, without any shut down or interruption whatever, and with a wear on the commutator during that period which did not exceed 1-64th of an inch.

THE INDEPENDENT ELECTRIC COMPANY, 39th street and Stewart avenue, Chicago, Ill., has issued a neat 21-page pamphlet relating to the exhaustive line of tested fuse wire and links made by it. An excellent technical article on fuse links, by its electrical engineer, Chas. A. Pratt, is included, which is the best treatise on the subject that we know of, both from a practical and theoretical standpoint, and should be read by every electric light and power station superintendent.

BURTON L. WHITE, electrician for the McCullough-White Electrical Supply Company, of Wichita, Kan., has severed his connection with that firm, and has opened up an office for himself at 1423 North Lawrence avenue, in the same city, where he will be pleased to furnish estimates on fire alarm, telephone, lighting and annunciator systems free. Mr. White was in the employ of the Electric Launch and Navigation Company as charging electrician during the World's Fair. We wish him success in his new venture.

MESSRS. CHAS. SCHIEREN & CO. shipped to the Bangkok Tramway Company, Ltd., Bangkok, Siam, last fall, two 14-inch perforated leather belts. Upon arrival they were immediately placed on Brush generators. In a letter from the manager of the road to the Brush company in January last, the following statement is made: "Belting is also running, and has so far given us extreme satisfaction; our chief engineer can, in fact, scarcely find terms to express his admiration for its fine appearance and smooth running."

MESSRS. STUCKY & HECK, 23 and 25 N. J. R. R. avenue, Newark, N. J., report their repair and supply business exceptionally good. The electrical apparatus of the steamers Carib Prince and Irrawaddy has been entirely overhauled by them, and is again ready for service. They have recently acquired the agency for the Fleming woven wire dynamo brush for Newark, Paterson, Jersey City and surrounding district, and many orders have already been taken. Messrs. Stucky & Heck pay particular attention to commutator repairs and rewinding of armatures.

THE SHULTZ BELTING COMPANY, St. Louis, Mo., has issued a neat circular calling attention to its patent grooved sable rawhide belting. This belting is tanned only on the surfaces, instead of all the way through, thus preserving an interior of rawhide of great strength and durability, and affording a soft driving surface. The grooves run lengthwise of the belt, thus offering channels for the escape of air, so as to avoid air cushions. The grooves are constantly kept clean by the currents of air. They can be run, it is claimed, very nearly as slack as link belting.

G. M. ANGLIER & CO., 116 Bedford street, Boston, Mass., who are exclusive contractors for apparatus manufactured by the Mather Electric Company in New England, have just closed a contract with the Gardner Electric Street Railway Company, of Gardner, Mass., for one 160-h. p. Mather multipolar generator. Messrs. Angier & Co. are devoting a great deal of attention to the equipment of street railway plants, and, as the Mather generator in its present form has all the latest improvements and a very high efficiency, we bespeak for them a good business during the present season.

THE MATHER ELECTRIC COMPANY, Manchester, Conn., has brought out a handsome catalogue, giving a short description of its improved ring type lighting dynamo, with dimensions of the different sizes now manufactured, and a partial list of plants in operation. This pamphlet is supplementary to the very complete one covering the Mather company's system of incandescent lighting and an addition to its special catalogues, of which it is the fourth, the others being on "Slow Speed Electric Motors," "Street Railway Generators and Equipments" and "Direct Connected Lighting and Power Generators."

QUEEN & CO., Philadelphia, report that their Acme testing set is meeting with a continually increasing success. Its compactness and lightness are much greater than the sets previously designed by this firm, it being contained in a box 8 inches by 6 inches by 5 inches, and weighing but 6 pounds. The quickness with which resistance measurements can be made with it renders it especially popular with electric light and railway companies, dynamo and motor manufacturers, inspectors, etc. A specially valuable feature is the ability to use it anywhere, even in the closest proximity to large dynamos.

THE ROYAL ELECTRIC COMPANY, Peoria, Ill., has issued a pamphlet giving short, concise descriptions of the apparatus manufactured by it, accompanied by tables of full electrical and other data. The well known alternating dynamo of this firm, we learn, is manufactured in capacities from 500 to 2,000 lights, the speed varying from 1,100 to 700 revolutions. With alternating machines a slate switchboard is furnished, equipped with all necessary apparatus, which is a commendable feature. The Royal direct current machines and Royal transformers are also illustrated, and tables of data relating to them given.

THE MICA INSULATOR COMPANY, 218 Water street, New York, in a 24-page catalogue just issued, describes and illustrates the various mica products made by it, and includes some 10 pages of unusually cordial testimonials as to their merits. As an example, we reprint the following from the United Columbian Electric Company: "We have given your mica and mica cloth a severe trial, and are satisfied it comes as near to being a perfect insulator as anything can. The mica troughs, for slotted armatures, are far superior to anything we have yet seen. We have seen an armature, built for 500-volt railway circuit, insulated throughout with mica, stand a 2,000-volt current without breaking down."

THE UNITED STATES HEAD-LIGHT COMPANY, Utica, N. Y., of which J. Kirby, Jr., is president and A. J. Williams secretary, has purchased of M. M. Buck & Co., the Dayton Manufacturing Company, the Kelly Lamp Company, I. A. Williams & Co., and the Adams & Westlake Company the machinery, tools, patterns, etc., constituting their head-light business, together with 32 letters patent and a number of applications for patents, covering standard

devices for illuminated numbers and signals in head-lights and other desirable improvements therein. It is the intention of the United States Head-Light Company to unite with the patents and facilities thus acquired the result of over forty years' experience in manufacturing head-lights, for the purpose of embodying in them the latest improved devices which will add to their design, convenience and durability; furnishing head-lights for all purposes superior to any heretofore supplied, at the lowest possible price consistent with first-class material and workmanship. Selling agents for this company will be conveniently located in the best distributing points of the country, who will carry in stock a full line of standard head-lights and parts thereof, for the purpose of filling all orders promptly.

THE STANDARD ELECTRIC COMPANY, Chicago, has just published a handsome catalogue of 88 7½ by 10½ inch pages, descriptive of the Standard system of dynamo-electric machinery. The book is bound in cardboard covers, and is well printed on a fine, heavy paper, with numerous exceptionally well executed half-tones. The great success which attended the introduction of the Standard series arc system encouraged the belief that the principles of construction therein involved would also be appreciated in further applications, and a year or more has been devoted to designing and perfecting a complete line of apparatus for all purposes, and the formal presentation of Standard apparatus for arc,

alternating and direct current work is made in this catalogue. In addition to dynamos and motors, the company has also perfected, on entirely new lines, a complete complement of accessories, such as instruments, switches, transformers, etc., which are also fully illustrated therein. The more important apparatus have been recently illustrated and described in our columns, but every central station manager and electrical contractor will find it to his interest to procure a copy of the catalogue in order to obtain a full presentation of a system which is complete in all of its details, and bears evidence of skillful design and thorough construction.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden Carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 DeKalb street, St. Louis, Mo.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED JUNE 5, 1894.

in charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

- 520,763. **MULTIPHASE CURRENT MOTOR**; L. Bell, Boston, Mass. Application filed Nov. 4, 1892. This comprises a field magnet having a row of poles in a continuous ring, a winding thereon by which continuous current is passed around the field magnet poles, an independent closed-circuited winding in grooves in the pole faces, and a switch adapted to open or close the closed circuited winding. (See illustration.)
- 520,764. **METHOD OF, AND MEANS FOR, STARTING ALTERNATING CURRENT MOTORS**; L. Bell, Boston, Mass. Application filed July 3, 1893. This consists in arranging the inducing coils of the motor in multiple at starting, and when the speed rises, throwing the coils into series.
- 520,772. **FUSE BOX**; A Ekstrom, Lynn, Mass. Application filed Nov. 29, 1892. This comprises a box, line terminal supports ranged on each side thereof, leaving a space between them, and a fuse supporting block adapted to slide in between the supports and fill the space between them.
- 520,773. **ARMATURE FOR DYNAMO ELECTRIC MACHINES**; H. F. T. Erben, Schenectady, N. Y. Application filed Feb. 9, 1894. The combination of a spider having arms adapted to engage core discs, the arms being provided with an opening, and conductors passing through such opening, and commutator segments connected to such conductors.
- 520,776. **LIGHTNING ARRESTER**; J. W. Gibboney, Lynn, Mass. Application filed Feb. 6, 1893. This comprises an electric generator and work circuit supplied therefrom, and a constantly maintained short circuit composed of liquid flowing from one main line conductor to the other.
- 520,780. **ELECTRIC MOTOR TRUCK**; J. C. Henry, Westfield, N. J. Application filed Aug. 27, 1892. This comprises an electromagnet, a receptacle surrounding the same, a pipe communicating at each end with the top and bottom of the receptacle, respectively, and forming a closed circuit therewith, and a fluid insulant filling the receptacle and pipe. (See illustration.)
- 520,781. **DYNAMO ELECTRIC MACHINE**; A. B. Herrick, Schenectady, N. Y. Application filed Jan. 25, 1894. This consists in rotating the armature in a composite field of force having some of its parts more highly magnetized than others.
- 520,782. **ELECTRIC MOTOR**; A. Hinman, Olympia, Wash. Application filed Dec. 14, 1893. A motor having its armature coils held within seatings by metallic washers, whereby one or more may be removed by loosening the screw of the washer.
- 520,784. **ELECTRIC MOTOR CONTROLLER**; W. J. Hopkins and T. Stebbins, Boston, Mass. Application filed Sept. 19, 1891. A controller having a movable contact arm, a removable actuator engaging therewith, and a detent adapted to lock the contact arm when the actuator is removed.
- 520,786. **EAR PAD FOR TELEPHONE RECEIVERS**; J. W. Kinniburgh, Wellington, New Zealand. Application filed Nov. 10, 1893. A pad formed of layers of material joined together in such manner that a clean surface is exposed when desired.
- 520,787. **ELECTRIC LOCOMOTIVE**; W. H. Knight, Lynn, Mass. Application filed Jan. 18, 1894. The combination of two or more trucks, each having a plurality of separately driven axles mechanically connected together, and means for simultaneously effecting the same change in the motive condition of each truck.
- 520,788. **STAND FOR CONTROLLING ELECTRIC CIRCUITS**; E. R. Knowles, Middletown, Conn., and E. H. Park, Millbury, Mass. Application filed March 31, 1893. The combination with a stationary insulating plate carrying spring pins, of a movable box containing the insulating plate carrying rigid pins.
- 520,789. **VOLTMETER**; E. R. Knowles, Middletown, Conn. Application filed Dec. 5, 1893. The combination with an armature,

of a spindle on which it is mounted, and a copper shell surrounding the spindle and having bearings in which the spindle is journaled.

- 520,795. **ELECTRO-PROTECTIVE SYSTEM FOR LOCKS**; M. Martin, Malden, Mass. Application filed Nov. 23, 1893. The combination with a lock provided with a removable cover, and a locking device for the cover under the control of the key for the lock.
- 520,800. **ALTERNATING CURRENT MOTOR**; O. Offrell, Middletown, Conn. Application filed Nov. 29, 1892. A motor comprising end frames having planes to fit against the field magnet core, and dished portions to inclose the field magnet coils.
- 520,809. **MEANS FOR PREVENTING ARCING IN ELECTRIC POWER STATIONS**; E. Thomson, Swampscott, Mass. Application filed Sept. 1, 1890. The combination with a circuit breaking apparatus of a wall on one side thereof, and provided with an opening in proximity thereto, and arc propelling means for forcing toward the opening any arc that may form at the circuit breaking apparatus.
- 520,810. **ELECTRIC RECIPROCATING MOTOR**; E. Thomson, Swampscott, Mass. Application filed July 10, 1891. The combination in a reciprocating electric motor, of a reciprocating rod, an armature sleeved thereon, stops on the rod, and buffers between the armatures and stops.
- 520,811. **ELECTRIC METER**; E. Thomson, Swampscott, Mass. Application filed Feb. 21, 1894. This comprises a series coil, an armature, a resistance in series with the armature, and a shunt coil arranged to furnish an initial or starting field sufficient to balance the friction of the moving parts, such coil being in series with a resistance.
- 520,820. **SIGNAL LIGHT FIXTURE**; W. Carter, J. W. Dawson and J. Meyrick, Jr., Louisville, Ky. Application filed April 5, 1893. This comprises a valve seat, a gravity valve therein, a channel between the seat and the valve, and an electromagnet supported with its poles in convenient proximity to the valve.
- 520,822. **SYSTEM OF CIRCUIT CONTROL FOR ELECTRIC MACHINES**; C. E. Davis, Chicago, Ill. Application filed Oct. 16, 1893. This consists in breaking the supply circuit, connecting the motors in series with each other and closing a short circuiting device around one of the motors.
- 520,852. **ELECTRIC SWITCH BOX**; E. R. Knowles, Middletown, Conn. Application filed Dec. 5, 1893. This comprises a double pole snap switch inclosed in a watertight box, and having an operating handle on the outside of the box.
- 520,855. **FEED WIRE INSULATOR**; C. A. Lieb, New York, N. Y. Application filed April 12, 1894. An insulator composed of a body of insulating material, and a metal cap therefor carrying a sleeve having a curved bottom for the feed wire.
- 520,895. **WOMB BATTERY**; J. C. Petit, Fort Worth, Tex. Application filed April 10, 1894. This comprises a body having a hollow shank, and a hollow stem connected to the shank, and made of electrically dissimilar material from the body, and an adjusting instrument having a hook at one end.
- 520,908. **ELECTRIC CIRCUIT REGULATOR**; H. F. Waite, New York, N. Y. Application filed Jan. 27, 1893. This comprises a motor, a circuit breaker, current connections, and a governing device controlling the circuit, whereby when the interruptions fall below a certain number, the circuit will be interrupted.
- 520,926. **LEVER CONTROLLING DEVICE**; A. H. Johnson, Rahway, N. J. Application filed Sept. 6, 1893. This comprises a lever and a movable dog for locking it, a current including a magnet for attracting the dog, a device for positively moving the magnet toward the dog when the latter is in locking position, and a weight for effecting this movement.
- 520,937. **TROLLEY WIRE SUPPORT**; L. McCarthy, Boston, Mass. Application filed March 3, 1894. This comprises a supporting arm, an insulator and jointed connectors extending upwardly

and in opposite directions from the insulator and suspending it below the points of attachment of the connectors.

520,938. CLOSED CONDUIT FOR ELECTRIC RAILWAYS; P. Plödeck, Sr., Cleveland, Ohio. Application filed Feb. 21, 1894. This consists of an underground conduit covered by a row of lids which are lifted by the passing of the trolley arm of the car.

520,940. DYNAMO ELECTRIC MACHINERY; C. Sellers, Philadelphia, Pa. Application filed Oct. 27, 1893. In a dynamo electric machine having a vertical shaft, a cylindrical frame provided with internal projections having bearings concentric with the axis of the rotation of the shaft. (See illustration.)

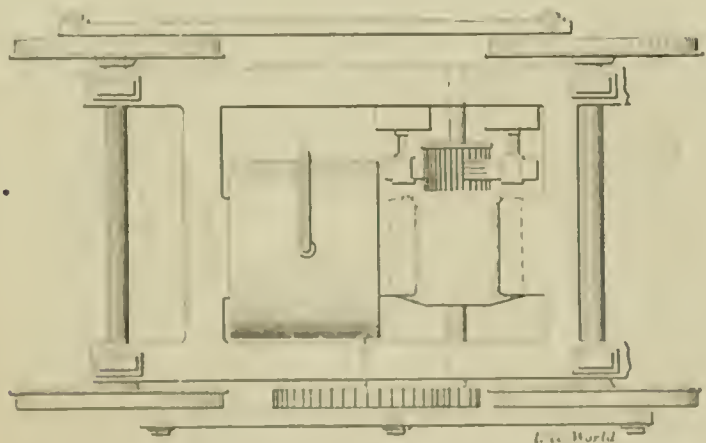
520,963. AMMETER; E. R. Knowles, Middletown, Conn. Application filed Dec. 9, 1892. An ammeter having its helix composed of a strip of metal containing two narrow and wider portions, one following the other.

520,964. VOLTMETER; E. R. Knowles, Middletown, Conn. Application filed Dec. 14, 1892. This comprises a core containing a narrow transverse socket, in combination with a flat frame removably inserted in the socket and containing bearings for the needle spindle.

520,965. SYSTEM OF ELECTRICAL DISTRIBUTION; B. G. Lamme, Pittsburgh, Pa. Application filed March 27, 1893. A constant current alternating generator, a series motor in the circuit thereof, a constant current series direct current generator, and translating devices in series with the direct current generator.

520,970. METHOD OF ECONOMIZING THE ENERGY OF ALTERNATING CURRENTS; C. F. Scott, Pittsburgh, Pa. Application filed Aug. 7, 1893. This comprises a feeding converter, translating devices in the secondary thereof, an auxiliary converter having its primary and secondary in series respectively with the primary and secondary of the main converter, and means whereby said auxiliary converter may be short circuited.

520,971. ELECTRIC RAILWAY OVERHEAD SWITCH; M. A. Smith, Brooklyn, and W. Clabaugh, New York, N. Y. Application filed Feb. 21, 1894. This comprises a rail having a horizontal contact portion, and inclined groove, and a split key clamp at the outer end of the groove.



NO. 520,780.—ELECTRIC MOTOR TRUCK.

520,975. CONVERTER SYSTEM FOR ELECTRIC RAILWAYS; G. Westinghouse, Jr., and C. F. Scott, Pittsburgh, Pa. Application filed July 31, 1893. This comprises a working conductor, an alternating current generator and main line fed therefrom; in combination with one or more converters, the primaries of which are fed by the main line, and the secondaries of which are connected to the working conductor, means for resisting flow of current in series with the primaries of the converters, and means actuated by the increase of current due to closing the secondary circuit through the car motors for short circuiting the current resisting means.

520,991. ELECTRIC ARC LAMP; L. E. Howard, Plainfield, N. J. Application filed Aug. 19, 1893. A lamp having its burner or source of light surrounded by a transparent envelope coated with a deposit of translucent metallic oxide.

520,996. ELECTRIC ARC LAMP; L. B. Marks, New York, N. Y., and C. Ransom, Passaic, N. J. Application filed Jan. 9, 1894. This consists in confining the arc within an inclosure, restricting all the drop of potential in the arc circuit to the arc, and continuously maintaining the drop at a point which prevents an excessive flow of current.

521,010. CONDUIT ELECTRIC RAILWAY SYSTEM; J. B. Brand, Milwaukee, Wis. Application filed March 19, 1894. This comprises a closed conduit pipe, a plurality of contact devices movably engaged within bearings in the wall of the pipe, a conductor extending through the pipe adapted to make contact with the contact devices, and a service rail comprising a plurality of sections flexibly engaged with and insulated from each other at the joint and pivotally connected at the joint with the contact devices.

521,018. CONNECTION FOR ELECTRIC WIRES; J. Y. De Mott, Newark, N. J. Application filed Jan. 6, 1894. This comprises a plate of conductive material bent at the centre to form a raised rib and having its opposite edges turned on to the rib and forming a joint thereat.

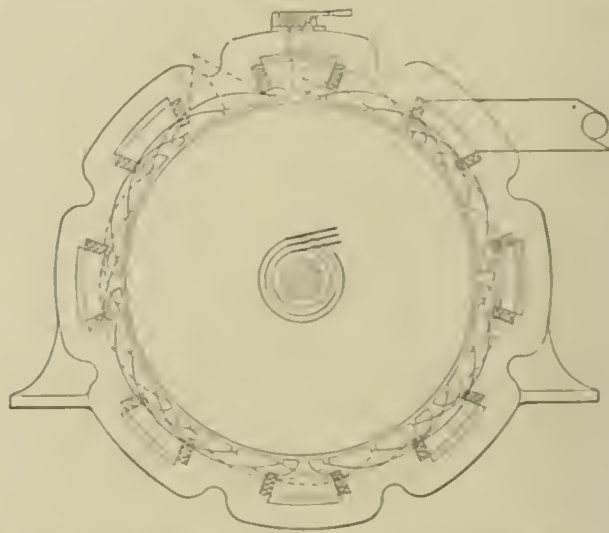
521,046. ELECTRICAL ANNUNCIATOR; E. W. Ross, Boston, Mass. Application filed Jan. 12, 1894. This comprises a single helix having a sliding armature core, a device for holding the core normally beyond the helix, an unequally balanced lever adapted

to be tripped by the core, a sleeve outside of the helix, and an index finger carried on the end of the spindle.

521,051. SYSTEM OF ELECTRICAL DISTRIBUTION BY ALTERNATING CURRENTS; C. F. Scott, Pittsburgh, Pa. Application filed Feb. 26, 1894. This consists in transmitting three-phase alternating currents to a distance, transforming the same into two-phase alternating currents, and utilizing the transformer currents.

521,089. ELECTRIC METER; W. B. Reed, New Orleans, La. Application filed Feb. 13, 1894. In a three-wire system of electric lighting, the combination with an electric meter, of an electric motor having a rotating armature and field coils, the latter being supplied from the positive and negative sides of the system, respectively, and an armature circuit fed normally from the neutral wire which enters the meter.

521,099. ELECTRIC HEATING APPARATUS; G. D. Burton, Boston, Mass. Application filed Aug. 11, 1893. This comprises a converter attached to one terminal of a converter and provided with means for receiving one end of the rod to be heated, and an arc shaped conductor attached to the other terminal of the



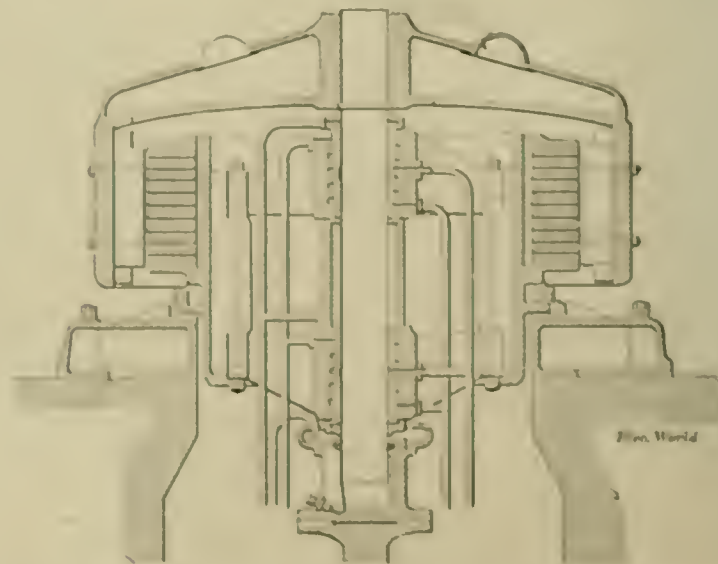
NO. 520,763.—MULTIPHASE CURRENT MOTOR.

converter and adapted to swing away from and toward the central hub, the conductor being provided with a series of undercut tapering jaws.

521,124. SECTION INSULATOR; H. B. Nichols and F. H. Lincoln, Philadelphia, Pa. Application filed Jan. 25, 1894. This comprises an insulating block or strip of fibre, contact arms engaging the ends thereof, and a bridge wire connecting the arms.

521,125. ELECTRIC SUBWAY; J. J. E. Phillips, Brooklyn, N. Y. Application filed Aug. 29, 1893. A carriage for laying a cable in a conduit, consisting of a series of cars, trolleys, detachable connections uniting them, and laterally slotted supports carried thereby.

521,131. INCANDESCENT LAMP; D. C. Voss, Boston, Mass. Application filed Nov. 23, 1893. An insulating cement free of silica, potash, soda and lime, and composed of the oxides of lead, manganese and alumina of highest oxidation combined by fusion with each other.



NO. 520,940.—DYNAMO ELECTRIC MACHINERY.

521,138. ELECTRIC MOTOR FOR DENTAL ENGINES; W. A. Crowder, Chicago, Ill. Application filed Oct. 22, 1892. The combination of an electric motor, and a brake located within the magnetic influence of the motor and actuated thereby.

521,144. ANNUNCIATOR; T. J. Thompson, Chicago, Ill. Application filed Sept. 30, 1891. This comprises a single spool of a core provided with projecting ends forming pole pieces, adjustable screws inserted in the under faces of the poles, an armature loosely mounted thereon and provided with a notch, a latch rigidly mounted upon the same shaft with the pointer, and a stud forming the bearing of the shaft, the shaft being cut away to permit the latch and permit the rotation thereof.

The Electrical World.

Vol. XXIII.

NEW YORK, JUNE 30, 1894.

No. 26.

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THE W. J. JOHNSTON COMPANY, Limited,
253 BROADWAY, NEW YORK.
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New England Office, 620 Atlantic Ave., Boston.
Western Office, 936 Monadnock Block, Chicago.
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In the growth of the paper in circulation, size and general improvement, the value of its columns for reaching those engaged in electrical pursuits has not failed to be appreciated by advertisers. The following table shows its steady onward march in this department of business. The first issue of

1880 contained 25 different adv'ts.	1887 contained 154 different adv'ts
1881 " 28 " "	1888 " 175 " "
1882 " 45 " "	1889 " 234 " "
1883 " 63 " "	1890 " 289 " "
1884 " 82 " "	1891 " 325 " "
1885 " 100 " "	1892 " 316 " "
1886 " 138 " "	1893 " 317 " "

The first issue of 1894 contained 320 different Advertisements.

No announcements of the publisher are included in this list.

"WANT" AND "FOR SALE" ADVERTISEMENTS

are a special feature of THE ELECTRICAL WORLD. Position Wanted small advertisements cost but \$1 an insertion; Help Wanted and For Sale small advertisements cost but \$1.50 an insertion. Remit in advance for the number of insertions desired.

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253 Broadway, New York.

VOL. XXIII. NEW YORK, JUNE 30, 1894. NO. 26

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THE BATE REFRIGERATOR CASE.

We are informed by the clerk of the United States Supreme Court that the Bate refrigerator case has been advanced and assigned for hearing on Nov. 5, 1894. It will probably be two or three days after that date before it is actually argued, and at least two weeks, and perhaps several months, before the opinion will be delivered. As a consequence of this, the Edison lamp patent may expire under existing law before a decision is reached, but if the law is reversed in the Bate case this expiration will be nullified and the life of the patent extended to 1897.

STORAGE BATTERIES FOR POWER STATIONS.

In another column will be found an interesting account of a storage battery plant installed in the power station of the street railway in Zurich, Switzerland, which is of timely interest in view of the attention recently given to that subject in this country. The line is a comparatively small one, but it is with such lines that the use of storage batteries offers the most benefit on account of great fluctuations in the load. In the present case the considerable grades make these fluctuations greater than usual, so that we are not surprised to learn that the size of the generating plant is only half as large as would otherwise be necessary. In addition, the possibility of working the machinery somewhere near its point of maximum efficiency entails a saving in operating expenses which should also be no small matter. Our correspondent lays stress, and with reason, upon the care which the battery receives and the automatic arrangements for securing its most efficient working. To attempt to use storage batteries without the most minute care and attention to every detail would almost undoubtedly result in failure. It does not follow that this would entail a corresponding expense, but rather implies a most carefully thought out routine to begin with and then rigidly carried out. It would be the part of wisdom for a manufacturer in this country to refuse pioneer orders for storage batteries for central or power stations unless he is thoroughly convinced that they will be operated under proper conditions, as failures at the beginning would result in greatly retarding the general adoption of this useful auxiliary.

THE GOVERNMENT BRIEF IN THE BERLINER TELEPHONE SUIT

The brief of the counsel of the Government in the suit, now before the United States Circuit Court at Boston, for the annulment of the Berliner microphone patent, is quite breezy in tone and does not mince matters in its references to the Patent Office and its employees. It opens with the statements that the application for the Berliner patent dragged for years in the office for no apparent reason except an alleged probability of interference with some other application or applications, which, however, never materialized; that the application during its progress through the office disclosed remarkable transformations, and exhibited a process of evolution closely following the development of the art outside the Patent Office; and that the Commissioner of Patents, with the knowledge and acquiescence of the Bell company had finally proceeded illegally in the issue of the patent. Definite charges are made of "fraud, concealment, misrepresentation or deceit practiced by the applicant upon the Commissioner or the public," and of malfeasance and excess of power on the part of the Commissioner. It speaks of the innumerable delays in the Patent Office as a farce—"a farce in its ab-

surdity, but a Chinese tragedy in duration"—and the following indictment is not pleasant reading to those who have at heart the integrity of administration of our patent system: "No explanation can be given of these shameful proceedings in the Patent Office that will acquit the Commissioner from an imputation of corruption, or an indifference to the rights of the public which would be scarcely less criminal, except that he did not realize what was going on. The application was not before him personally, and it is only charitable to suppose that its existence, the character and scope of its claims, their relation to the art of telephony, and the effect which the delay in the grant of the patent would have in prolonging the monopoly of that art, were never present before his mind together, so as to give him a realizing sense of the gravity of the situation. As for the examiners, that excuse cannot be offered, or any other, unless it be that they had become so much the slaves of routine that they had no conception of duty, except to keep the applications in their hands rolling down ruts which had been worn by custom, and had become oblivious of all considerations of justice and right which exist apart from precedents and rules. * * The attitude of the Bell company toward these unwarranted and illegal delays was not only one of consent, but more, it was an attitude of interested consent, of assisting acquiescence, of guilty connivance. It knew that the Commissioner was betraying his trust—knew the practical effect of what he was doing far better than he did; it knew that it was its duty to stir him to action, but studiously refrained from doing so. Of all that was wrong in the business it was more guilty than the Commissioner. Can it hold beyond the reach of the law the fruit of that wrongdoing?" In addition to the charges of fraud and connivance, it is claimed that the patent is also void on the ground that the Berliner patent of 1880 describes the whole invention of the microphone exactly as it is described in the patent of 1891, the latter adding nothing to the description or claim except to broaden the scope of the latter. Further, it is contended that the transmitter of the patent is identical with the Reis transmitter of thirty years ago in its mechanical construction, being merely a make-and-break sound-transmitting telephone. The brief ridicules the statements of three ex-employees of the Patent Office, which are, respectively, that the Bell company was "urgent," "urgent and persistent" and "persistent in urging" that the patent be advanced; moreover, during the three and a half years prior to the issue of the patent and subsequent to the period referred to by these employees, it could have been issued at any time upon the demand of the Bell company. Referring to the issue of the two Edison microphone patents and the Berliner patent, the brief states: "The issue of this group of three patents in 1891 and 1892 upon applications filed in 1877, one covering broadly the mode of operation of the microphone, another covering broadly the only material known from which commercially operative and useful microphone contacts can be made, and the third a combination of material and mode of operation, is a circumstance fit to excite attention, and suggests irresistibly the presence of a premeditated design to postpone the issue of the patents in order to make them more valuable. Not one of them would have earned a cent for the Bell company at any time prior to March 7, 1893. It was foreseeable ten years ago that they might earn millions of dollars after that date." The conclusion of the counsel is, finally, that "the Bell company is seeking to perpetuate its monopoly of the art of telephony by means of a patent which not only ought not to have been issued as and when it was issued, but which has never been used and never will be." From the points of the brief we have quoted, it will be seen that the matter at issue goes beyond the Berliner patent, and is in effect largely an indictment of the Patent Office itself. The various charges made against the latter are so serious as to demand nothing less

than an immediate and thorough investigation by Congress into its methods. The need of this is urgent, whether the delay of issue of the several telephone patents was secured by direct fraud, or through a lack of proper safeguards against the misuse of the machinery of the Patent Office by a great monopoly, or through an extraordinary system of circumlocution in itself responsible for the delay. No branch of public administration, not even that of justice, should be more above suspicion than the one relating to the granting of patents. The great publicity given to these charges against the Patent Office through the widespread interest in the Berliner suit, united to the fact that they are made by counsel for the United States Government itself, have already doubtless created a distrust in the integrity of our patent system, which is the more serious because by tending to discourage inventors it tends to blight what has been one of the most fruitful factors in our industrial growth.

An Entirely Unsolicited Opinion.

A gentleman whose views on electrical journalism and particularly on the subject of advertising are always welcomed, was moved by the spirit to write *The Electrical World* a personal letter on receipt of last week's issue, in which he said:

"Upon looking over the pages of *The Electrical World* of this week, its appearance, make up and especially the size of the advertisements, gave to my mind a better idea of what an ideal trade paper should be than any other publication of its kind I have ever seen. Having made it my business for over five years to watch and scrutinize the pages of all the electrical papers, the changes for the better, especially in *The Electrical World*, never struck me so forcibly as now. May be the reason was that I happened to look over an old copy of *The Electrical World* of 1884 when this week's issue was handed to me. The difference is remarkable. Then a great blanket sheet, clumsy in appearance and hard to handle. A few advertisements (very few, indeed), and most of them covering a whole page, while now a convenient sized publication, replete with interesting matter on the reading pages, arranged and systematized so as to appeal at once to every reader by the beauty of its make up. There seems to be a method exercised in the arrangement of *The Electrical World* of to-day, indicating that every item and every article or department has been placed in its position with the motive of making the whole an harmonious combination of the interesting events of the week in addition to the electrical field of the globe. But being more interested in the advertising pages than in the other portion, I must say that especial congratulations are due you on their account, not only for their large number but also for their arrangement."

An Ancient Dynamo.

Sir Frederick Bramwell, in a recent lecture, stated that the Holmes dynamo, with permanent magnets, which was tried experimentally as early as 1857, was still being used at last accounts, some three or four years ago, for generating electricity for the light in the South Foreland Lighthouse.

English Journalism.

The fact that Goebel claimed to have anticipated Edison in the invention of the incandescent lamp seems to have only quite recently reached a well-known English engineering journal, as the "news" is published in the issue of June 1 of this year. The news that Goebel died some time ago may be looked for in that journal some time in 1895 or 1896.

Molecular Energy.

According to G. F. Fitzgerald, a hydrogen molecule moving with the velocity of light has an energy of less than half a millionth of an erg.

SWITZERLAND AS THE PRESENT ELECTRICAL CENTRE OF EUROPE

BY FREDERICK BATHURST.

THE ZURICH-HIRSlanden ELECTRIC RAILWAY.

Whilst there are already installed in different parts of Switzerland isolated examples of overhead electric railway systems, intended mainly for the transportation of a summer tourist traffic, there are none, the writer believes, either in Europe or the United States that present the points of interest contained in the one it is now proposed to describe. This road, running from the centre of the town of Zurich to an outlying suburb, Hirslanden, was opened to the public in the beginning of the year, and is, it is thought, the precursor of the development that may now be expected in many other Continental towns.

Zurich has, of late years, vied with an ordinary American town in the rate at which its population is increasing and the way in which new residential suburbs have sprung into existence. Formerly a long, straggling city, built upon both sides of the River Limmat, starting from the point where the lake outflows, the town now covers all the surrounding hills, so that it has become nearly circular in form.

This growth has necessitated a reconsideration of the "rapid transit" facilities and resulted in the projection of another addition to the modern Juggernaut of electric street railways. To prejudge from its present operation, this road will form a practical proof of the question long mooted in the United States as to the desirability of the use of accumulators in the power house.

As before referred to in this series of articles, the cost and difficulty of obtaining an adequate coal supply is the incentive driving Swiss engineers to the consideration of the best electrical practice, and without the inducement and promise of economy to be effected in coal consumption by the use of accumulators, it would have been impossible to show a prospective profit for this road and present the scheme to business men as a lucrative investment. Receiving, however (from the makers of a secondary battery of established reputation), a guarantee by which the cost of maintenance became a definite quantity, the road has been equipped and put into successful operation.

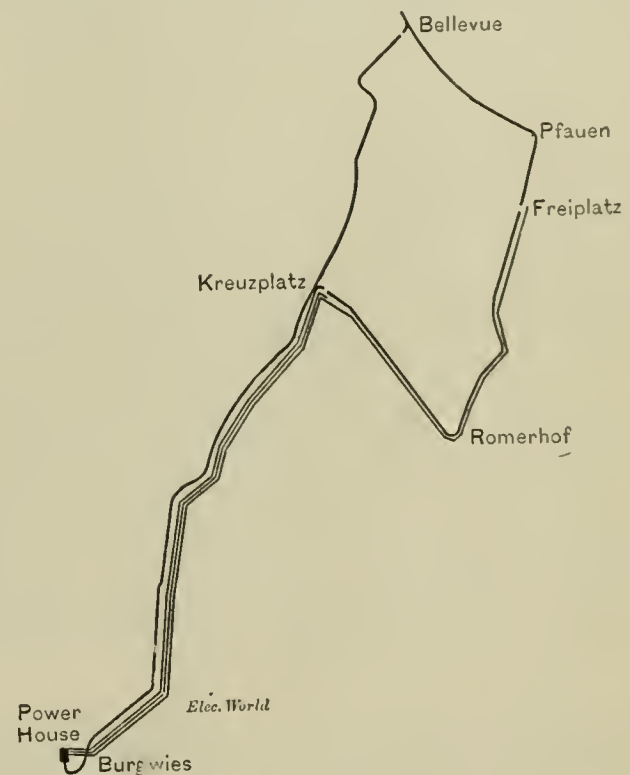
The ground plan of the road (see cut) resembles in form a reversed nine, consisting of a tolerably straight length of

have immediate access to what may eventually be the complete town system.

The power house is situated outside the town at the Hill of Burguris, two miles distant, in the suburb of Hirslanden.

The profile plan, giving percentage of grades and their length in meters, will show that the road is a continual ascent from Bellevue to the power house end. The power house was located here on account of the cheapness of real estate and the accessibility of a water supply for condensing purposes.

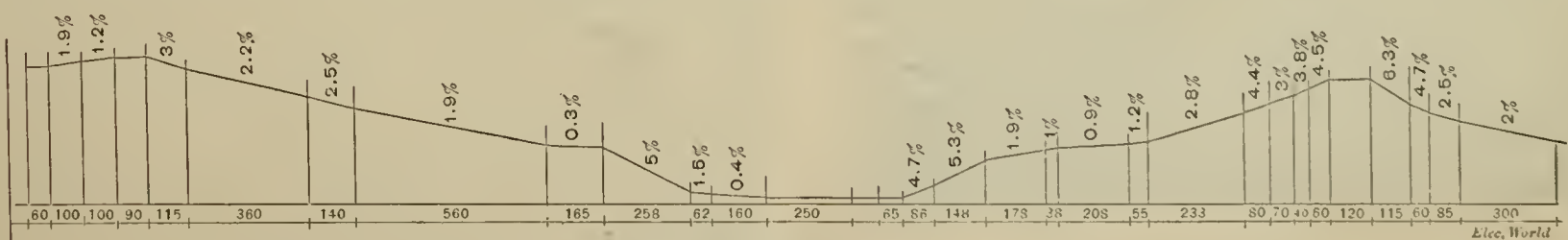
The plan and general view of this building are shown in the illustrations. It will be noted that it is a combination



MAP OF ROAD.

construction of engine room and car barn under the same roof. Provision is made for the ultimate equipment of the road—18 cars.

The accumulator house is also included, being situated at the back of the engine room; in fact, the division is such that the cars take up about one-half of the total space available, the division wall being laid longitudinally, and the re-



PROFILE OF ROAD.

track from Bellevue to the power house with a detour branch by Pfauen and Romerhof, returning to the main line at Kreuzplatz.

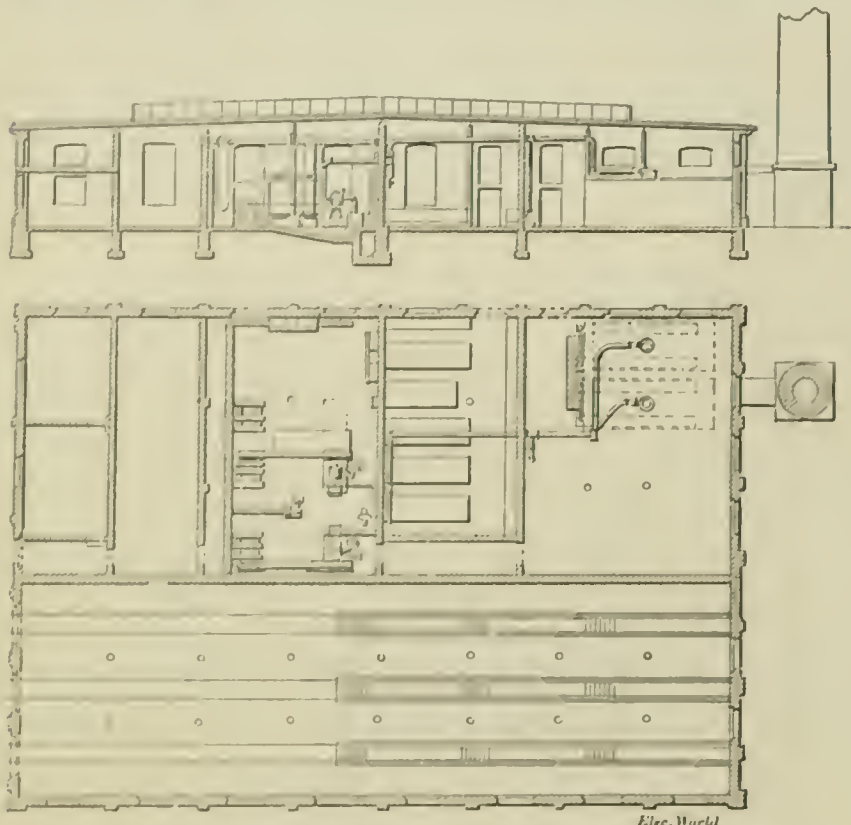
From the map of Zurich it will be seen that Bellevue is in the centre of the town, upon the lake front and at the end of the magnificent Uto promenade by the Quai Bridge, so that passengers landing from the lake steamers can at this point

maintain half nearly equally divided among offices, engine room, accumulators and boilers. Everything is on the ground floor, the lighting being very effectively achieved by glazing the roof. The graceful chimney stack forms a landmark for miles around, and stands as an index of the substantial construction of the whole plant.

An idea of the interior of the engine room can be obtained

from the cut. There are three vertical type compound condensing engines (Oerlikon type), two of 100 indicated horse power each and a smaller one capable of indicating 45 h. p.

The crank shaft of the two larger engines sets very low in the foundations, and each has a wheel pit, so that the fly-wheels on them can be belted directly on to the generator



PLAN AND ELEVATION OF POWER HOUSE.

pulleys. These engines run at 240 revolutions per minute, the generators at 450 revolutions per minute.

The generators, also by the Oerlikon works, are four-pole ironclad machines, have external field frame Gramme ring armatures and a capacity of 66 kw. They are specially designed as shunt machines for running in connection with the accumulators, but are provided with additional series field windings, so that they can, if necessary, be run upon the line as an ordinary compound wound generator. This provision adds to the certainty of operating the road, even supposing it was requisite to cut-out the accumulators. Under ordinary running conditions the output at 450 revolutions is 120 amperes at 550 volts, only one generator at a time being run and the other held as reserve.

The small engine is coupled direct to an auxiliary four-pole generator, this set being used for charging the "extra"



EXTERIOR OF POWER HOUSE.

cells of the battery. Space is left for additional engines when the equipment is extended to 18 cars.

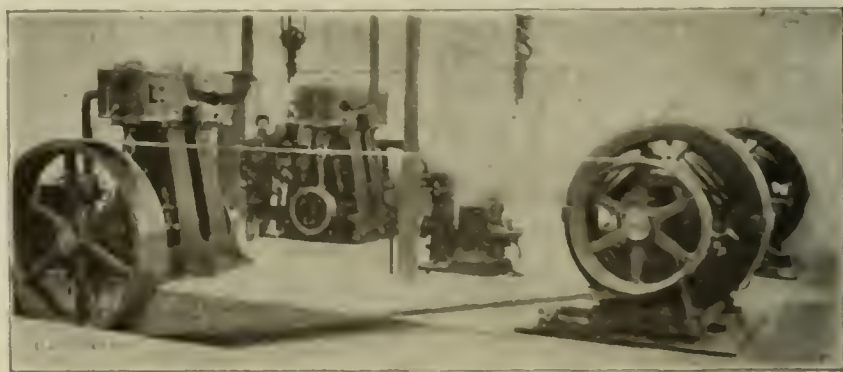
The boilers are of the Galloway type, installed upon the Escher Wyss system.

Every attention has been given to convenience of operation, so that one attendant can satisfactorily take charge of the engine room.

Among details of equipment one notices the provision of overhead travelling cranes. The neatness of the station and absence of unsightly electric cables are also remarked, and there is a point in European practice which might well be copied more often than it is—all the cables are taken downward by the side of their machines into troughs or channels provided in the floor. They then pass into a common conduit, and, supported upon porcelain insulators, find their way toward the switchboard. The conduits have removable iron covers, constructed in convenient lengths, so that any part of the wiring can be inspected at a moment's notice.

At one end of the engine room two switchboards are placed, one being of the usual street railway type, containing main switches, feeder cut-outs, lightning arresters, etc., the other being specially designed to suit the peculiarity of this station.

On this—the accumulator switchboard—are arranged the "high" and "low" voltage relays, ammeters and discharging switches for the battery which forms the direct source of power to the line. All the regulation on this board is automatic. The most conspicuous apparatus (see cut) is the circular switch, which cuts in and out the cells to suit any variation of the line voltage. It is very interesting to watch the operation of this "cell regulator switch," the contact arm of which, actuated from behind by two solenoid magnets acting by reverse pawls upon toothed wheels, swings around the contact plates in either direction with continued and unerring accuracy. The switch was designed and made by the Oerlikon works. The board also contains a "minimum cut-out," operating to disconnect the generators whenever the charging current from the generators falls below 10 am-



A VIEW IN THE ENGINE ROOM.

peres. A polarized cut-out and a 2-volt voltmeter for the additional cells are referred to later.

In the battery room, supported to wooden frame tiers upon insulators, there are 300 Tudor type secondary cells, made by the Hagen company, of Germany. They have been installed upon a 10 years' contract agreement by which the makers become entirely responsible for their operation and maintenance. Of the 300 cells, connected in series, 240 constitute the battery proper, and are always in parallel circuit to the generators; the remaining 60 cells are used for regulating purposes, and through the circular switch are put in and out of the line circuit, as required. Each cell has a normal capacity of 245 ampere hours with an 80-ampere discharge, although 160 amperes can be taken momentarily without damage. The battery, as a whole, is rated as capable of giving 120 amperes at 550 volts, and is estimated as being able to run the line with nine cars upon it for 1 1-2 to 2 hours independently of the generators.

The function of the 60 additional cells being of the utmost importance, very complete arrangements have been made for their preservation. For at least one hour every day, generally at the time when least load is on the line, the small direct connected generating set is started up and charges the regulating cells independently of the remainder of the battery. The generator is specially wound, so that its output is 20 amperes at 150 volts and 30 amperes at 100 volts. The state of each individual regulating cell can be determined at any time from its indication on the 2-volt voltmeter.

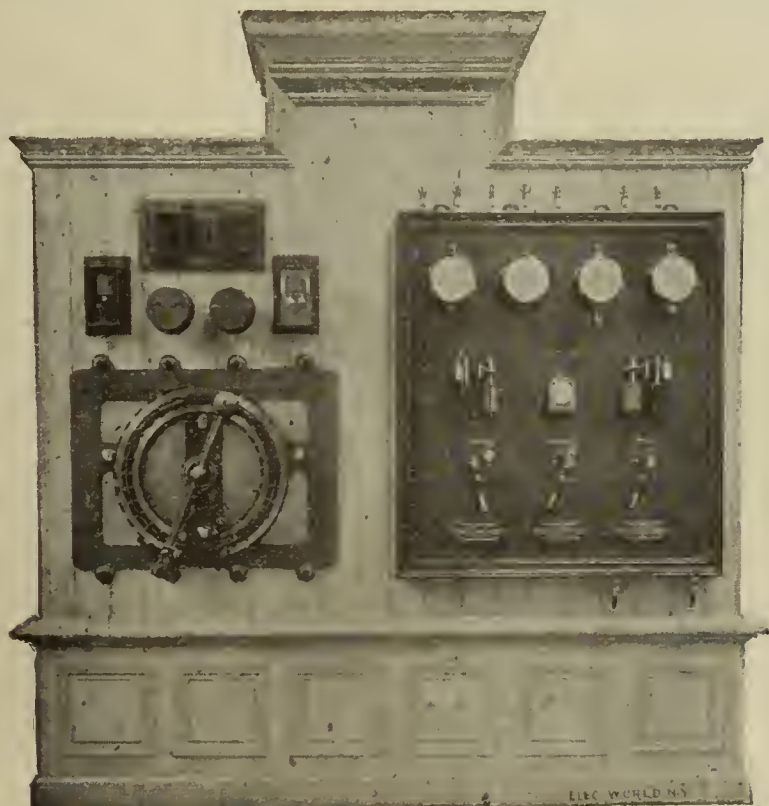
As a rule, at the end of the day's run, the extra cells are found to be "run down" and the attendant determines how long it is necessary to run the small generator so as to bring them back again into good condition, this machine providing that as their voltage rises its charging current decreases.

It is found that the average current output from the station, with nine cars on the track, is 90 amperes, although the momentary fluctuations may vary from 0 to 200 amperes.

With the former condition, the whole of the current output from the generator passes into the battery for storage, while in the latter condition the generator supplies the line with 120 amperes and the battery makes up the deficiency of 80 amperes.

Load variations may cause variations in the speed of the engine, amounting to 2 per cent. or 3 per cent., and the question as to the source of supply at a certain moment of overload depends upon whether the cell regulation or that of the generator responded the quicker.

The function of the cells is to take this peak of the load, so that an economy can be effected in the size and first cost of the engine, generators and steam equipment. It will be ap-



ACCUMULATOR SWITCHBOARD.

parent that the use of accumulators in this particular case makes it possible to run on half the size plant otherwise necessary. Only one generator set need run continuously, so that the steam required, even for running the other one light, is saved perpetually, and there is the additional gain where at such times both generating sets would have to be running uneconomically on small loads.

Coal in this plant costs 30 francs per ton and has usually to come from Germany.

The road is a severe one, the up grade being practically continuous from the lake front to the power station, and presenting stretches of 2 1-2 per cent., 3 per cent. and 5 per cent. grades, 500, 300 and 140 metres long, respectively. The steepest grade is 6.3 per cent., 1.5 metres long, on the detour branch upon the return to Kreuzplatz. The track, laid on a one metre gauge, has a total length, not including turnouts and lengths of double track, of 4.6 kilometres. The curves, with the exception of the sharp one at Romerhof, are ordinary.

A rail of the girder type, weighing 70 pounds per yard, is employed throughout. The dimensions are:

Width of web at foot.....	125 millimetres	=	about 5	inches
Height from web to tread.....	140	"	"	5 1/2 "
Width of wheel tread.....	40	"	"	1 3/8 "
Width of flange opening.....	30	"	"	1 1/4 "

The rails are laid directly upon the ground, mostly macadam or hard limestone roadbed, with tie spacing pieces every 10 feet.

The jointing is effected with the ordinary fish-plates on either side of the girder, but cement blocks are placed under the break in the web.

Every joint is bonded electrically with copper bonding wire, having riveted ends. A copper earth wire 7 millimetres diameter (No. 1 B. & S.) is laid throughout the track and connected to each bonding wire.

Iron and wood poles are used for supporting the trolley



CENTRE POLE CONSTRUCTION IN THE TOWN.

and feeder wires, the former being used in the town as centre poles, the later being used on the outskirts and mainly for cross suspension. The iron poles are made from three lengths of steel tube 3, 4 and 5 inches diameter, shrunk together, whilst the bracket, or cross-arms, are made from 1 1-2-inch pipe. Stranded steel wire suspension and straining cable 8 millimetres diameter (No. 0 B. & S.) is used throughout.

Above is shown a portion of the track construction in the town near the lake front.

The trolley wire, 7 millimetres diameter (No. 1 B. & S.), is of hard drawn copper and supported by insulators of the American type; in fact, "Aetna" insulation blocks and bolts have been obtained from the "Hub of the Universe." Boston type trolley switches are also employed.



THE CAR.

The line is divided into four sections, the town portion having three separate feeders (see map), whilst the outlying section is fed direct from the trolley. Total length of feeder wire is four miles. Greater care is taken in the insulation of the trolley and feeders than usual, as many as three distinct insulating blocks being placed between line and earth.

Each car truck is equipped with one 15-kw. single reduction street car motor very similar to the present G. E. No. 800 motor. The armature runs at 450 revolutions, the ratio of reduction is 1:4.9. The soft steel gear has a 4-inch face and the pinion is hardened steel. The weight of the motor complete is 950 kilogrammes (2,100 pounds), the weight of the car equipped ready for service is 3.8 tons.

Twenty-six passengers form a normal load. The average running speed attained on the line, inclusive of stoppages, is 12 kilometres (7 1-2 miles) per hour, but a speed of 20 kilometres is obtained on those level stretches where it is necessary to make up time.

The handsome car is shown in a view which also gives an idea of the truck arrangement and the safety netting and fenders by which the wheels are completely surrounded. The inside of the car is finely finished in American bent wood, and if an attractive looking, clean and well lighted interior is the inducement to increased patronage, the success of this line must have already been secured.

The controller, as seen below, is the same in effect, though rather different in form, as that usually employed. The handle is operated by a forward or backward horizontal motion instead of a rotary one. Current is "off" when the handle stands in a vertically upright position. It is claimed that this movement is easier for the motorman. The form is



CAR CONTROLLER.

compact and allows a convenient arrangement of the blow-out magnet. The control is effected by means of a resistance in series with the armature and an extra shunt or loop coil on the motor field.

It may be useful to note that the Continental practice in respect to the street car gong or alarm is to place a bell on the brake handle, so that the driver can operate brake and bell at the same time, and when on this road the car-piercing foot gong, so familiar in American practice, was first introduced, it was the subject of long and bitter complaint from the quiet loving inhabitants of the town. Even now it is only on probation.

This road, so recently opened as the 1st of March, has followed the regular precedent and attracted to it during the first three weeks of its opening an enormous traffic of pleasure riders, enough to insure a dividend for the first six months' operation, and so far elate the shareholders that they have held meetings to consider the advisability of obtaining extensions to their franchises in the town.

Much credit is due to Messrs. Huber and Kolben, of the Oerlikon works, who, working upon the experience of American street railways, have been the first to put into successful operation this accumulator plant, and although it is too soon at present to offer reliable data as to the efficiency

of its operation, undoubtedly many of those interested in this extensive branch of industry will await with lively concern the publication of the experience and figures gained by the engineers of this road.

Leaving it to those better fitted to pass judgment as to whether Switzerland may or may not be designated the present electrical centre of Europe, the writer would now apologize for having, at such length, endeavored to present descriptions of plants which to him appear typically illustrative of the advanced state of Swiss electrical practice.

Reactance.*

BY CHARLES PROTEUS STEINMETZ AND FREDERICK BEDFORD.

The term "reactance," which has been used and advocated by writers and others and which has been officially adopted at our suggestion by the American Institute of Electrical Engineers at its Philadelphia meeting, is one which assumes particular importance now that the term "inductance" is defined as synonymous with the "coefficient of self-induction," usually symbolized by the letter "L." Reactance is a quantity similar in many respects to resistance, but the electromotive force used in overcoming reactance consumes no power, for it is at right angles to the current.

The impressed electromotive force in an alternating current circuit may be divided into two components: First, the *power electromotive force* in the direction of the current, and, second, the *reactive electromotive force* in quadrature with the current to overcome the reactance. The reactive electromotive force is the product of the current and the reactance. *The reactance is, accordingly, equal to the component of the impressed electromotive force at right angles to the current, divided by the current.* Reactance is measured in ohms.

The reactive electromotive force in the circuit may be due to self or mutual induction, to capacity or to some outside counter electromotive force produced by a motor or other device. In general, in any alternating current circuit,

Impressed E. M. F.

$$= \sqrt{\text{Power E. M. F.}^2 + \text{Reactive E. M. F.}^2};$$

that is, the impressed electromotive force is the vector sum of the electromotive force which transmits power and the reactive electromotive force.

Reactance tends to cause a phase difference between current and electromotive force. If θ represents this angle of phase, we have the relation,

$$\tan \theta = \frac{\text{reactance}}{\text{resistance}}.$$

When θ is negative, the current lags behind the electromotive force; when θ is positive, the current is in advance of the electromotive force. The expression for the instantaneous value of the current may be written,

$$i = I \sin (\omega t + \theta).$$

or

$$i = \frac{\text{Impressed E. M. F.}}{\text{Impedance}} \sin \left\{ \omega t - \arctan \frac{\text{reactance}}{\text{resistance}} \right\}.$$

A few illustrations of particular cases will make the use of the term reactance more clear.

Circuits Containing Resistance and Inductance.—In a simple circuit containing resistance and inductance, the reactance is equal to $L \omega$; that is, it is 2π times the product of the inductance and frequency. The impedance being the vector sum of the resistance and reactance, is

$$\text{Impedance} = \sqrt{R^2 + L^2 \omega^2},$$

where $\omega = 2 \pi \times \text{frequency}$. In this case all the power is used in overcoming resistance, and the power electro-

* A paper presented at the close of the Philadelphia meeting of the American Institute of Electrical Engineers, May 1st 1894.

motive force is equal to the ohmic electromotive force RI . The reactive electromotive force is equal to the inductive electromotive force $L\omega I$; hence
Impressed E. M. F.

$$= \sqrt{\text{Power E. M. F.}^2 + \text{Reactive E. M. F.}^2};$$

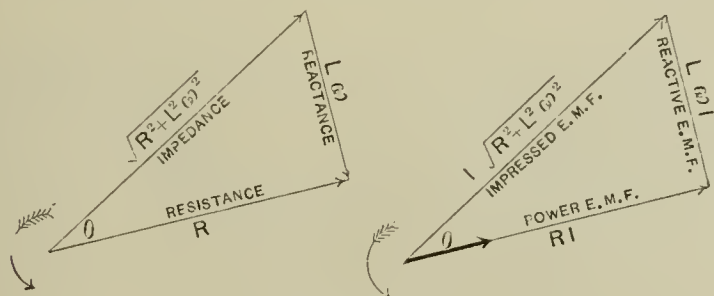
or

Impressed E. M. F.

$$= \sqrt{\text{Ohmic E. M. F.}^2 + \text{Inductive E. M. F.}^2}.$$

The impressed electromotive force in this case is the vector sum of the electromotive forces necessary to overcome resistance and inductance.

A consideration of Figs. 1 and 2 (in which positive direction is counter clockwise) will show that the reactance and



FIGS. 1 AND 2.

reactive electromotive force are *positive* in the case of a circuit containing inductance. The impressed electromotive force, which is the sum of the two, is therefore in advance of the current, which is in the same direction as the power or ohmic electromotive force. The current is indicated by a closed arrow in the figures. The same, however, may be otherwise expressed if we take the impressed electromotive force as our direction of reference, by saying that the *current lags behind* the electromotive force by the angle θ , which angle is negative, therefore, for circuits with inductance according to the relation

$$\tan \theta = -\frac{\text{reactance}}{\text{resistance}} = -\frac{L\omega}{R}.$$

The value of the current at any instant is given by the equation

$$i = \frac{E}{\sqrt{R^2 + L^2\omega^2}} \sin \left(\omega t - \arctan \frac{L\omega}{R} \right).$$

Circuits Containing Resistance and Capacity.—In such circuits the reactance is equal to $-\frac{1}{C\omega}$, where C , capacity, and $\omega = 2\pi \times$ frequency, that is, it is negative. The reactive electromotive force is also negative, being equal to $-\frac{I}{C\omega}$. This negative reactance gives a positive value to the angle θ , and the current is accordingly in advance of the electromotive force. We have then

$$\text{Impedance} = \sqrt{R^2 + \frac{1}{C^2\omega^2}},$$

and

$$\tan \theta = -\frac{\text{reactance}}{\text{resistance}} = +\frac{1}{CR\omega},$$

similar to the corresponding equations above. The instantaneous value of the current is given by the equation

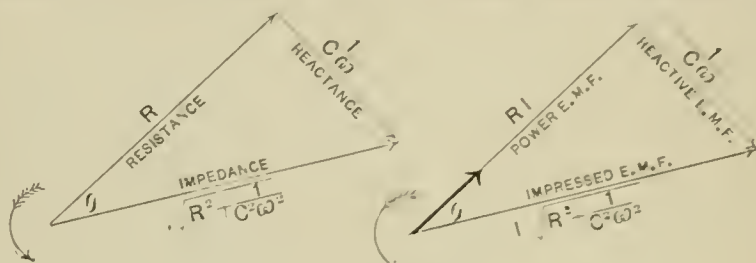
$$i = \frac{E}{\sqrt{R^2 + \frac{1}{C^2\omega^2}}} \sin \left(\omega t + \arctan \frac{1}{CR\omega} \right).$$

These relations are shown in Figs. 3 and 4.

Circuits Containing Resistance, Inductance and Capacity.—In a circuit containing inductance and capacity the reactive electromotive force is the sum of the inductive electromotive force and the condenser electromotive force; that is,

$$\omega I - \frac{I}{C\omega}. \text{ The reactance is similarly the sum of two}$$

terms, $L\omega - \frac{1}{C\omega}$; thus, the reactance is positive or negative, according to whether the inductive electromotive force is greater or less than the condenser electromotive force.



FIGS. 3 AND 4.

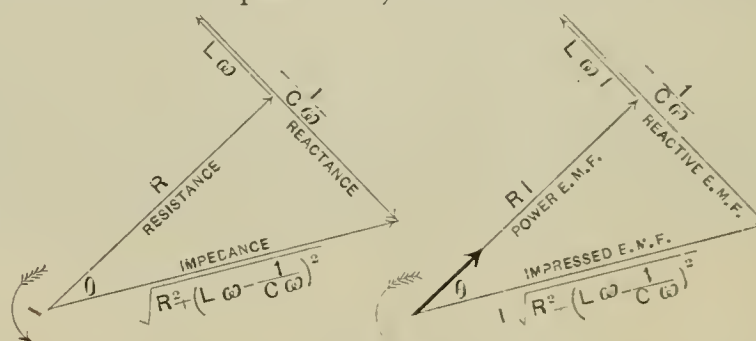
Whether the current is behind or ahead of the impressed electromotive force depends upon the same condition, for

$$\tan \theta = -\frac{\text{reactance}}{\text{resistance}} = \frac{1}{CR\omega} - \frac{L\omega}{R}.$$

The value of the current at any instant is

$$i = \frac{E}{\sqrt{R^2 + \left(L\omega - \frac{1}{C\omega} \right)^2}} \sin \left\{ \omega t + \arctan \left(\frac{1}{CR\omega} - \frac{L\omega}{R} \right) \right\}$$

The diagrams in Figs. 5 and 6 illustrate the case of a single circuit containing resistance, inductance and capacity. In the case here represented, the condenser electromotive



FIGS. 5 AND 6.

force is greater than the inductive electromotive force, and the current is therefore in advance.

Circuits Containing Mutual Induction.—To further exemplify the use of the term reactance, let us consider a circuit containing a transformer. Besides the electromotive forces already discussed, we must consider the back electromotive force due to the influence of the secondary upon the primary circuit. This may be resolved into two components, one in the same direction as the current, and the other in quadrature with it, which will form part of the power electromotive and reactive electromotive forces, respectively. The electromotive force introduced by a motor is treated in the same way.

These illustrations will suffice to show the method by which any electromotive force in a circuit is resolved into two components, one in the direction of the current, which therefore transmits power, and the other at right angles to the current, which represents no power but simply overcomes the reactance.

It is to be borne in mind that the terms here given may be used in all alternating current circuits, whether the current is harmonic or not; for, when the current is not strictly harmonic, we may consider it equivalent to an harmonic current. The *equivalent* harmonic current and equivalent harmonic electromotive force have the same square root of mean square values as the actual current and electromotive force, and have such relative phase positions that the same power is transmitted.

Reducing the Size of the Earth.

The results of the recent races at Derby were received by cable in New York City only a few seconds later than in London.

Western University of Pennsylvania's Electrical Engineering Course.

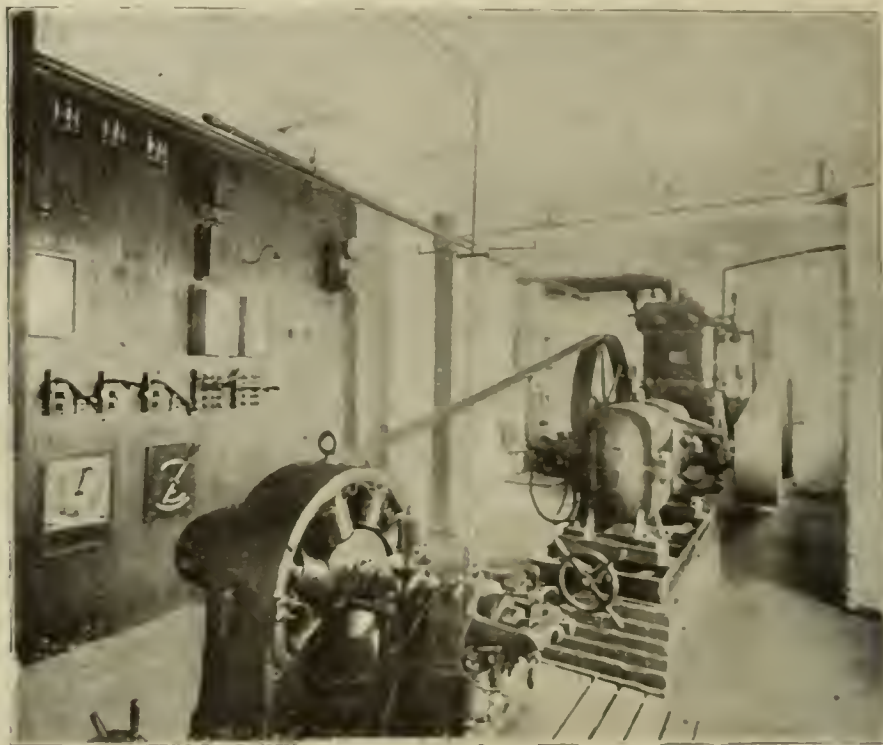
The Western University of Pennsylvania is probably best known through its observatory, commonly known as the Allegheny Observatory, where Prof. Langley made his celebrated researches on radial heat, and on aero-dynamics. It was here that the bolometer was invented and the infra-red spectra of the sun and other sources of radiant energy were first mapped out. Although the university is comparatively an old institution, having been incorporated in 1819, it was not until quite recent years that any attention was given to the engineering branches, and this, in spite of the fact that it is situated at one of the largest manufacturing centres in the world. In 1882 a chair of civil engineering was founded, and filled by Prof. Carhart, the author of several well-known text-books. In 1892 a chair of mechanical engineering was created, which was filled by Prof. Stewart, and in 1893 one of electrical engineering, which was filled by Prof. Fessenden, formerly professor of electrical engineering at Purdue University.

The accompanying illustrations show views of the main building of the university, of the temporary dynamo-room, and of the temporary electrical laboratory.

Although, as mentioned above, the electrical laboratory is only a temporary one, it is well equipped, especially in the direction of exact electrical measurements. Four thousand dollars was invested in electrical instruments of the highest class last fall, bought from the Weston Instrument Co., White & Co., Nalder Bros., and Queen & Co. In addition to the amount mentioned above as invested in the finer instruments, a quantity of rougher apparatus was bought, or constructed in the university shops, and the laboratory furnished with two dynamos and a number of motors.

Among the finer apparatus may be mentioned ten Weston instruments, including one laboratory standard voltmeter;

for Allegheny, this enabling accurate measurements of mass to be made), dividing engine and comparator from the Societe Genevoise, Ayrton-Sumpner, Ryan and Kelvin electrometers: ballistic, D'Arsonval and other galvanometers:



DYNAMO ROOM.

portable testing sets, dynamometers, storage batteries, instantaneous contact apparatus, etc.

The course is, as usual, a four year one, the first two years being about the same as most technical colleges. The shop work includes woodworking, blacksmithing, pattern-making, founding and machine shop work. One foreign language is required from engineering students. In the junior year, the electrical engineers take up the electric,



MAIN BUILDING, WESTERN UNIVERSITY OF PENNSYLVANIA.

Kelvin balances, reading from a few centiamperes to eight hundred amperes; a Kelvin wattmeter, two Carhart-Clark cells, three standard ohm coils, in platinoid and constantin; specially designed Carey-Foster commutator and conductivity bridge, Ayrton-Perry secohmmeter and standard of self-induction, other standards of self-induction and capacity, Anthony bridge (from exhibit of Queen & Co. at the World's Fair), range from 1-1,000,000 ohm to 111,000,000 ohms; Lummer-Brodhun photometer; Sartorius balance with weights compared with Berlin bureau of weights and measures (as was determined very accurately by the U. S. surveys

magnetic and dielectric circuits: electro-chemistry, with special reference to thermo-chemistry, and practical testing work in the laboratory with Weston instruments, such as localization of faults, insulation tests, standardizing instruments, etc. In the second half of the year, the course comprises dynamo-machinery, dynamo design, differential equations, and testing work on dynamos and motors.

In the first half of the senior year Bedell and Crehore's "Alternating Currents," and Emtage's "Mathematical Theory of Electricity" are completed, with advanced laboratory work and absolute measurements and experiments on A. C.

circuits. In the second half of the year, the second volume of Fleming's "Alternating Current Transformer," transformer and station design, estimates on electrical construction, polyphase currents, a short practical course on modern vector methods, and similar subjects. During the senior year each pair of students is required to make the principal working drawings of two of the following: direct-current dynamo or motor, A. C. dynamo or motor, transformer—from original designs.

Thermodynamics, steam-engine design, mechanics of materials, graphical statics, engine and boiler tests and other engineering subjects are taken up during the junior and senior years.

It will be seen that the university has many advantages for the performance of high-class research work, and the neighborhood of the Westinghouse Electric Company, the Car-

of which (moulds and furnace) the air has been rarefied as far as practicable through exhaustion by air pumps or other mechanical means.

The apparatus includes a long, air-tight smelting channel or chamber, the hearth of which inclines to a central orifice, through which the fused metal passes into the moulds. This chamber is filled with the metal to be smelted, and heat is generated by passing an adequate current of electricity through the mass without the use of any kind of fuel, or the employment of carbon electrodes. In this latter respect, the inventor of this process claims that it is entirely original and distinct from all other electrical smelting systems now in use in this country.

The furnace is lined with glazed fire-bricks, which are so



VIEWS IN THE ELECTRICAL LABORATORY.

negie Steel Works and other large engineering works renders it particularly suitable for the location of a university where engineering studies are to be carried on.

The attention of the citizens of Pittsburgh having at last, through the efforts of Dr. Holland and some of the trustees, been called to the advantages of having a technical school of high standing in the neighborhood, it is now proposed to build and equip suitable engineering laboratories and shops. The sum of \$500,000 is now being raised for this purpose, and \$160,000 has already been secured. An electrical laboratory will be built and equipped with the most approved apparatus and machinery, at an estimated cost of \$150,000.

Electrical Smelting in Germany.*

BY FRANK H. MASON.

Among the recent German inventions in metallurgy, one of the most interesting, by reason of its simplicity and its probable value in practical application, is a process invented by Mr. Edward Taussig, of Bahrenfeld, for the smelting and casting of metals by electrical heat, under the influence of rarefied air.** The operation consists in fusing ores or metals in a closed furnace or chamber, the hearth of which is connected with moulds into which the fused metal flows by gravitation, and is cast into any desired form, and in both

efficient a non-conductor as to insulate quite perfectly the contents of the chamber, so that the heat is developed where it is required evenly throughout the mass, and very little, if any, loss of current is experienced. From the testimony of experts who have examined this process in operation, it appears that a degree of heat sufficient to smelt pig iron in 15 minutes can be generated and maintained without unduly heating the other parts of the circuit, and this is equally true of the smelting of easily fused metals like lead and zinc, and of Siemens-Martin steel of Swedish origin, which is known to be one of the most refractory of all the useful metals.

The entire absence of coke, coal, or carbon electrodes secures to the fused metal nearly absolute purity, and the continued exhaustion of air and the gases generated by smelting increases the fluidity of the molten material and wholly prevents oxidation and blistering and produces castings of a dense, smooth quality, which have shown, under elaborate tests made by unimpeachable authority, the highest mechanical qualities of which cast iron is capable.

Without attempting to estimate the practical value of this process or its future range of application, it is fairly within the province of the present report to consider what may be reasonably inferred as to the limitations by which the industrial process will be restricted, and its probable economic efficiency for smelting and casting. For smelting raw ores, the most obvious advantage claimed for it is that it can be worked wholly by water power and without fuel in mountainous and remote districts which produce ores and have abundant water, but no coal.

For fusing iron, steel, or other metals for casting purposes, the advantages claimed are rapidity of operation, improved quality in the castings, susceptibility of continuous working, and—even where steam power is used to generate the current—an economy of fuel which is estimated at from

*Report of U. S. Consul-General at Frankfort.

** In transmitting his report, Consul-General Mason says: "It is believed that this process, which is not yet patented in the United States, may have a practical interest for many foundry men and producers of iron and steel in our country. In this connection, it may be of interest to know that the American patents for the Otto-Hoffman system of coke manufacture, with saving of the by-products, have recently been purchased by a syndicate organized at Pittsburgh and Cleveland, which is preparing to establish extensive works under that system at several localities in the United States."

30 to 50 per cent. of the coal used in smelting by the ordinary method. From what has been already stated, it would appear that the practical limit of capacity will be a furnace or fusion channel from 36 to 40 feet in length, and capable of containing at one charge about one and one-half tons of metal. By working such a furnace with a current of 30,000 amperes and 50 volts—which would represent a force of about 2,000 h. p., or somewhat less than the energy employed in the reduction of aluminium at Neuhausen—the entire charge of 3,000 pounds can be fused and run into castings within a quarter of an hour. By repeating the operation as rapidly as the charge can be replaced and smelted, a single furnace of this capacity can be made to turn out in a working day a large quantity of castings, and when motive power for generating the current is supplied by water, or even by steam made with a low, cheap quality of coal, the economy of the process over present methods would seem to be obvious.

Comparisons have been made with the well-known results of making iron and steel castings by smelting in a Siemens-Martin regenerative furnace, where from 1,000 to 1,400 pounds of coal are burned to smelt 2,000 pounds of iron. Assuming that water power for the Taussig process is not available, and that the dynamo and air pumps must be worked by steam, it is claimed that the same result, viz., the smelting of 2,000 pounds of iron or steel, can be effected by the consumption of from 720 to 800 pounds of steam coal—an economy of 50 per cent. in the use of fuel. This economy is still greater, if, instead of the foregoing comparison with smelting in a Siemens regenerator, we consider the treatment of steel in crucibles, where 1,200 pounds of the best coal is consumed for each 1,000 pounds of steel, and this proportion is increased to 1,500 or even 1,600 pounds when the coal used is of inferior quality and yields a large percentage of ash. It is, therefore, confidently asserted by experts who have examined this new electrical (vacuum) smelting process that it will secure a saving of more than half the fuel that is now required for the fusion of steel in crucibles, and that the saving would be proportionately greater under conditions which would enable the current to be generated by water power.

While the preliminary experiments—which have been conducted with a current of 18 to 20 h. p.—have been brilliantly successful, with resulting products of high and uniform quality, the practical application of this new process on an industrial scale has yet to be made. Works have been built at Copenhagen, where it will soon be put into practical operation, and a syndicate has been organized for a similar purpose in southern France. The first use of the system will be in the production of small castings of iron and steel, in which high quality, smoothness of surface and freedom from flaws and air holes are especially important. In the earlier experiments, four-bladed propellers of a size suitable for electrical or steam launches were cast with such excellent results that the ultimate success of the process for fine castings up to a certain size would seem to be assured.

In the production of pig iron and other metals direct from the ores, greater difficulties will no doubt be encountered, for the reasons, among others, that the charge to be smelted will be necessarily small, and the furnace must be so constructed as to provide for the elimination of the scoriae. The experiments in this direction have been made thus far on only a small scale, but the produced iron, owing to the absence of coal or coke and the prompt withdrawal of the air and gases generated by smelting, is very pure; and since it contains a much lower percentage of carbon (2.00 per cent.) than ordinary iron, it would seem to be well adapted to the manufacture of steel.

It is estimated that with a plant equipped with a motive force of 500 to 600 h. p. and supplied with good, ordinary 48 per cent. ore, the cost of producing a ton of pig iron—

allowing \$2.40 per ton as the price of the ore—would not exceed \$9.65, and this, in the opinion of the inventor, could be easily reduced to \$8 per ton if a motive power of 1,000 h. p. were employed. In a report on this process, which has been published in "L'Electricite," a leading electrical journal of France, the statement is made that—

The uniform distribution of the heat by the electric current through the mass to be melted adds to the advantages of the process that of perfect equality in the product, and, in fact, everything leads to the belief that the application of this system will afford a vast field for remunerative working. The cost of a new installation of this kind on a large scale would very slightly exceed that of an ordinary installation of the same importance. In reality, it would cost less, as the new system would be free from the expense of furnace repairs and replacement of crucibles, which is so large an item under the old one. In both systems the manual labor is about the same. In the new one it is, perhaps, rather less, as the work of charging the furnace is done away with, and the direct method of casting from the apparatus is more simple and economical, in addition to the fact that much less fuel is employed.

Putting aside, therefore, all mere conjectures and theorizing, and adhering strictly to what has been thus far accomplished, the record of actual results would seem to be:

(1) It has been shown that by this process a degree of heat sufficient to smelt a ton or more of iron within 15 minutes may be generated, sustained and applied at will without the use of carbon electrodes and without excessive heating or injury to other portions of the circuit. This, alone, is a fact of dominant and far-reaching importance.

(2) Castings of iron and steel, up to a weight of 200 pounds or more, have been made, which have shown all the desirable qualities—smoothness of surface, fineness of texture and freedom from much of the impurities which are always more or less incident to smelting by ordinary methods.

(3) Pig iron of excellent quality has been produced in small quantities by direct smelting from Swedish ores. The tests of this iron, as made by the Royal School of Mines at Berlin, have been published in several technical journals. These tables are too abstruse and complicated to be of general interest, but the net results may be summarized in the statement that the tractile strength of a round rod 10 millimetres in diameter was 3,410 pounds, and the resistance to compression of a rod 301 millimetres in length and 30 millimetres in diameter was 57,850 kilograms, or 127,270 pounds.

The Hatchet Planimeter.

In our issue of April 14, page 491, we described briefly a simple form of planimeter for measuring the areas of curves, such as indicator diagrams. The London "Electrician," June 1, reprints from another journal a simple exposition of the geometry of this little instrument, to which those of our readers who are interested are referred. It appears that it is the invention of Mr. H. Corn Kundsén, of Copenhagen. From this brief theory of the instrument it does not appear that it is essential to start at the centre of mass of the figure. For indicator diagrams it seems to be best to place the instrument on a line through the middle of the diagram and perpendicular to the atmospheric line. It is stated that it is preferable to trace the diagrams in the directions in which they are drawn by the indicator: 8 inches is suggested as a suitable length. The starting position of the instrument need not be exactly perpendicular to the atmospheric line. Some engineers who have used the instrument say it is very suitable and very accurate for indicator diagrams.

Water an Insulator.

Prof. Kohlrausch, who has made experiments with the purest water which can possibly be produced, finds that a column of one inch has a resistance equal to a copper wire of the same cross-section passing twenty-five thousand times around the earth.

A Reliable Method of Recording Variable Current Curves.*

BY A. C. CREHORE.

The apparatus described in the paper is for the purpose of obtaining a continuous record of an alternating current flowing in a conductor, which record will not also include the effects of inertia on the parts of the apparatus. This is accomplished by a photographic record made by a beam of light influenced directly by the electric current without the intervention of any moving material.

Faraday discovered that if a beam of polarized light is passed through some substance in the direction of the lines of magnetization within that substance, there is a rotation of the plane of polarization in a direction which is the same as the direction of the current required to produce such a field.

The arrangement of the apparatus, by means of which this principle is applied, is made plain by the accompanying illustration. The quartz prism is added that small currents may be recorded, the resultant polarization being then the sum of the magnetic and quartz polarizations; without this prism the record would become faint when the current approaches zero, but since quartz also naturally rotates a beam of polarized light this difficulty is thus obviated. The tube upon which the coil carrying the current is wound is a glass tube of 1.4 centimetres internal and 1.8 centimetres external diameter, and 70.15 centimetres long. The tube is filled with carbon bisulphide, which is confined by means of two plane parallel plates of glass, each 1.3 centimetres thick,

that the time of exposure of any part of the plate is extremely short. To meet this demand the most sensitive plates that can be made should be used. The width of the band with any given plate depends largely upon the time of exposure. Then, too, a plate is to be desired that will photograph toward the red end of the spectrum as well as in the blue. The band does not possess very sharp outlines, but gradually shades off from dark to light.

These objections do not have so much weight, however, in cases where the general direction of the variation of the current is what is wanted more than any exact measurement of its amount, and in the majority of cases this is really what is wanted.

Another objection of a different nature that seems difficult to avoid is the fact that the coil, which is wound upon the tube, must necessarily possess a small amount of self-induction. It may be said, however, that even though we are prohibited from measuring certain currents on account of this self-induction, we are always sure that we are measuring the exact current which is flowing through the coil.

Relative Cost of Alternating and Continuous Current Machines.

According to a recent statement of Prof. Forbes an alternating current dynamo can be obtained about 40 per cent. cheaper than a direct current machine for the same capacity when dealing with large powers.

Practical Notes on Dynamo Calculation.—VII.

BY ALFRED E. WIENER.

b.—Energy Dissipated by Hysteresis.

The iron of the armature core is subjected to successive magnetizations and demagnetizations. Owing to the molecular friction in the iron, a lag, in phase, is caused of the effected magnetization behind the magnetizing force that produces it, and energy is dissipated during every reversal of the magnetization. The name of "*Hysteresis*" (from the Greek *ὑστερέω*, to lag behind) was given by Ewing, in 1881, to this property of paramagnetic materials, by virtue of which the magnetizing and demagnetizing effects lag behind the causes that produce them.

Although Warburg,¹ Ewing,² Hopkinson³ and others have made numerous researches about the nature of this property of paramagnetic substances, it was not until recently that a definite Law of Hysteresis was established. In an elaborate paper presented to the American Institute of Electrical Engineers, on Jan. 19, 1892, Charles Proteus Steinmetz⁴ gave the results of his experiments, showing that the energy dissipated by hysteresis is proportional to the 1.6th power of the magnetic density, directly proportional to the number of magnetic reversals and directly proportional to the mass of the iron. This law he expressed by the empirical formula:

$$H_1 = \eta_1 \times B^{1.6} \times N_1 \times M_1,$$

where H_1 = energy consumed by hysteresis, in ergs;

η_1 = constant depending upon magnetic hardness of material ("Hysteretic Resistance");

B = density of lines per cm^2 of iron;

N_1 = frequency, or number of complete cycles of 2 reversals, per second;

M_1 = mass of iron, in cm^3 .

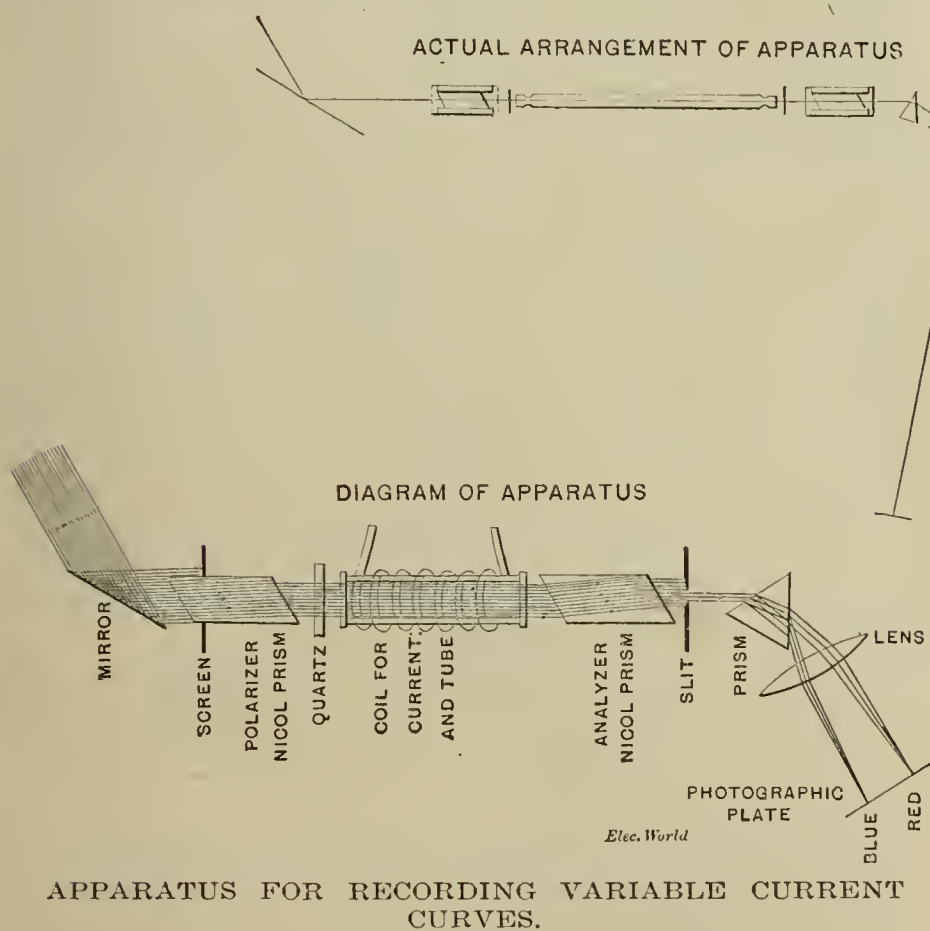
The values of the hysteretic resistance found by Steinmetz for various kinds of iron are given in the following table:

¹Warburg, Wiedem. Ann., XIII., page 141 (1881); Warburg & Hoenig, Wiedem. Ann., XX., page 814 (1884).

²Ewing, Proceed. Royal Soc. XXXIV., page 39 (1882); Philos. Trans., Part II., page 526 (1885).

³J. Hopkinson, Philos. Trans. Royal Soc., Part II., page 455 (1885).

⁴Steinmetz, Trans., A. I. E. E., volume IX., page 3; The Electrical World, XIX., pages 73, 89 (1892); XX., page 285 (1892.)



fitted tightly upon the ground ends of the tube. Upon this tube are wound six layers of No. 18 double cotton copper magnet wire, occupying a length upon the tube of 61.5 centimetres. The wire was wound so that 100 turns occupied 12.7 centimetres, thus giving 2,900 turns in all, is very large considering the size of wire. The light used was sunlight reflected from the mirror of a heliostat.

The ordinates of the record are not directly proportional to the magnetizing force, though nearly so; the displacements of the beam of light due to the current will be actually proportional to the ordinates of a parabola, but in this case the portion that applies will be so nearly a straight line that the displacement will be nearly proportional to the current.

The objections which most naturally suggest themselves against this method of taking current curves are perhaps the following: The photographic plate must move so quickly

* Abstract of a paper read at the Philadelphia meeting of the American Institute of Electrical Engineers.

TABLE XXIII.—HYSTERETIC RESISTANCE FOR VARIOUS KINDS OF IRON.

Kind of Iron.	Hysteretic Resistance, η_1
Sheet Iron, magnetized lengthwise.....	.0025 to .005
“ “ .0165" thick.....	.0035
“ “ .015" “.....	.004
“ “ .006" “.....	.005
“ “ magnetized across Lamination.....	.007
Iron Wire, length-magnetization.....	.0035
“ “ cross- “.....	.040
Wrought Iron, Norway Iron.....	.0023
“ “ ordinary, mean.....	.0033
Cast Iron, ordinary, mean.....	.013
“ “ containing $\frac{1}{8}\%$ Aluminium.....	.0137
“ “ “ $\frac{1}{2}\%$ “.....	.0146
Mitis Metal.....	.0043
Tool Steel, glass hard.....	.070
“ “ oil hardened.....	.027
“ “ annealed.....	.0165
Cast Steel, hardened.....	.012 to .028
“ “ annealed.....	.003 “ .009

For the materials employed in building up the armature core, according to this table, we can take the following average values of the hysteretic resistance:

Sheet iron : $\eta_1 = .0035$,

Iron wire : $\eta_1 = .040$.

Inserting these values in Steinmetz's equation, and reducing the latter to our practical units, we obtain for the energy loss by hysteresis in any armature having core built of discs or ribbon:

$$w_h = 10^{-7} \times .0035 \times \left(\frac{\mathfrak{B}_a}{6.45} \right)^{1.6} \times N_1 \times 28,317 \times M$$

$$= 5 \times 10^{-7} \times \mathfrak{B}_a^{1.6} \times N_1 \times M, \quad (36)$$

and in any armature with core of iron wire:

$$w_h = 5.7 \times 10^{-6} \times \mathfrak{B}_a^{1.6} \times N_1 \times M, \quad (37)$$

where w_h = energy absorbed by hysteresis, in watts;
1 watt = 10^7 ergs;

$\mathfrak{B}_a$ = density of lines in armature body, per square inch of core section;

N_1 = frequency, in cycles per second, $= \frac{N}{60} \times P$;

N = number of revs. per min., P = number of pairs of poles;

M = mass of iron in armature core, in cubic feet;
1 cu. ft. = $28,317 \text{ cm}^3$.

The mass, in cubic feet, for both drum and ring armatures

is

$$M = \frac{d_a'^3 \times \pi \times l_a \times b_a \times k_1}{1728}, \quad (38)$$

d_a' = mean diameter of armature core, in inches;

l_a = length of armature core, in inches;

b_a = radial depth of armature core, in inches;

k_1 = ratio of net iron section to total cross section, see

Table XVIII., Chap. 12;

1728 = multiplier to convert cubic feet into cubic inches.

Formulae (36) and (37) can be rendered more convenient for practical use by uniting the terms $5 \times 10^{-7} \times \mathfrak{B}_a^{1.6}$, and $5.7 \times 10^{-6} \times \mathfrak{B}_a^{1.6}$, respectively, into one factor, η , the *factor of hysteresis*, that is the energy absorbed by hysteresis in one cubic foot of iron, when subjected to magnetization and demagnetization at the rate of one complete cycle (two reversals) per second.

For convenience, the author, in Table XXIV., has calculated the numerical values of these hysteresis factors, η , for all core densities from 10,000 to 125,000 lines per square inch, thus simplifying the equation for the hysteresis loss into the formula:

$$w_h = \eta \times N_1 \times M. \quad (39)$$

In Table XXIV., columns headed $\eta \div 480$ are added for the case the hysteresis loss is to be calculated for an arma-

ture, of which the weight, in pounds, of the iron core is known.

TABLE XXIV.—HYSTERESIS FACTORS FOR DIFFERENT CORE DENSITIES.

Magnetic Density in Armature Core. Lines of Force per sq. in.	Watts dissipated at a frequency of one complete magnetic cycle per second.				Magnetic density in Armature Core. Lines of Force per sq. in.	Watts dissipated at a frequency of one complete magnetic cycle per second.			
	Sheet iron.		Iron wire.			Sheet Iron.		Iron wire.	
	p. cu. ft.	per lb.	p. cu. ft.	per lb.		p. cu. ft.	per lb.	p. cu. ft.	per lb.
	η	$\eta \div 480$	η	$\eta \div 480$		η	$\eta \div 480$	η	$\eta \div 480$
10000	1.25	.0026	14.3	.030	66000	25.72	.0537	294.0	.613
15000	2.40	.0050	27.4	.057	67000	26.34	.0550	301.0	.628
20000	3.79	.0079	43.3	.090	68000	26.97	.0563	308.2	.643
25000	5.42	.0113	62.0	.129	69000	27.61	.0576	315.5	.658
30000	7.30	.0152	83.5	.174	70000	28.26	.0589	322.8	.673
31000	7.70	.0160	88.0	.183	71000	28.91	.0603	330.1	.688
32000	8.10	.0168	92.6	.192	72000	29.56	.0617	337.6	.704
33000	8.50	.0177	97.2	.202	73000	30.22	.0631	345.1	.720
34000	8.91	.0186	101.8	.212	74000	30.89	.0645	352.9	.736
35000	9.33	.0195	106.5	.222	75000	31.56	.0659	360.7	.752
36000	9.76	.0204	111.5	.232	76000	32.23	.0673	368.5	.768
37000	10.20	.0213	116.5	.242	77000	32.91	.0687	376.3	.784
38000	10.65	.0222	121.6	.253	78000	33.60	.0701	384.2	.800
39000	11.10	.0231	126.8	.264	79000	34.29	.0715	392.1	.817
40000	11.55	.0240	132.0	.275	80000	34.99	.0730	400.0	.834
41000	12.01	.0250	137.2	.286	81000	35.69	.0745	408.0	.851
42000	12.48	.0260	142.5	.297	82000	36.40	.0760	416.0	.868
43000	12.96	.0270	148.0	.308	83000	37.11	.0775	424.0	.885
44000	13.45	.0280	153.7	.320	84000	37.82	.0790	432.4	.902
45000	13.95	.0290	159.4	.332	85000	38.54	.0805	440.8	.919
46000	14.45	.0300	165.1	.344	86000	39.27	.0820	449.2	.936
47000	14.95	.0311	170.8	.356	87000	40.01	.0835	457.6	.954
48000	15.45	.0322	176.6	.368	88000	40.75	.0850	466.0	.972
49000	15.96	.0333	182.4	.380	89000	41.50	.0865	474.5	.990
50000	16.48	.0344	188.3	.392	90000	42.25	.0881	483.0	1.008
51000	17.01	.0355	194.3	.405	91000	43.00	.0897	491.5	1.023
52000	17.55	.0366	200.6	.418	92000	43.76	.0913	500.0	1.042
53000	18.10	.0377	206.9	.431	93000	44.53	.0929	509.0	1.064
54000	18.65	.0388	213.2	.444	94000	45.30	.0945	518.0	1.080
55000	19.21	.0400	219.5	.457	95000	46.07	.0961	527.0	1.098
56000	19.78	.0412	226.0	.470	96000	46.85	.0977	536.0	1.116
57000	20.35	.0424	232.6	.484	97000	47.63	.0993	545.0	1.135
58000	20.92	.0436	239.2	.498	98000	48.41	.1009	554.0	1.154
59000	21.50	.0448	245.8	.512	99000	49.20	.1025	563.0	1.173
60000	22.09	.0460	252.5	.526	100000	50.00	.1041	572.0	1.192
61000	22.69	.0472	259.4	.530	105000	54.06	.1127	618.0	1.290
62000	23.29	.0485	266.3	.554	110000	58.23	.1215	666.0	1.388
63000	23.89	.0498	273.0	.568	115000	62.53	.1305	715.0	1.490
64000	24.50	.0511	280.0	.583	120000	66.95	.1400	765.0	1.595
65000	25.11	.0524	287.0	.598	125000	71.50	.1500	817.5	1.705

The values of η contained in this table are graphically represented in Fig. 14, two different scales being used in plotting the curves, as designated.

With regard to the exponent of $\mathfrak{B}_a$, in formulae (36) and (37), which Steinmetz found to be approximately = 1.6 over the whole range of magnetization, Ewing,¹ by very re-

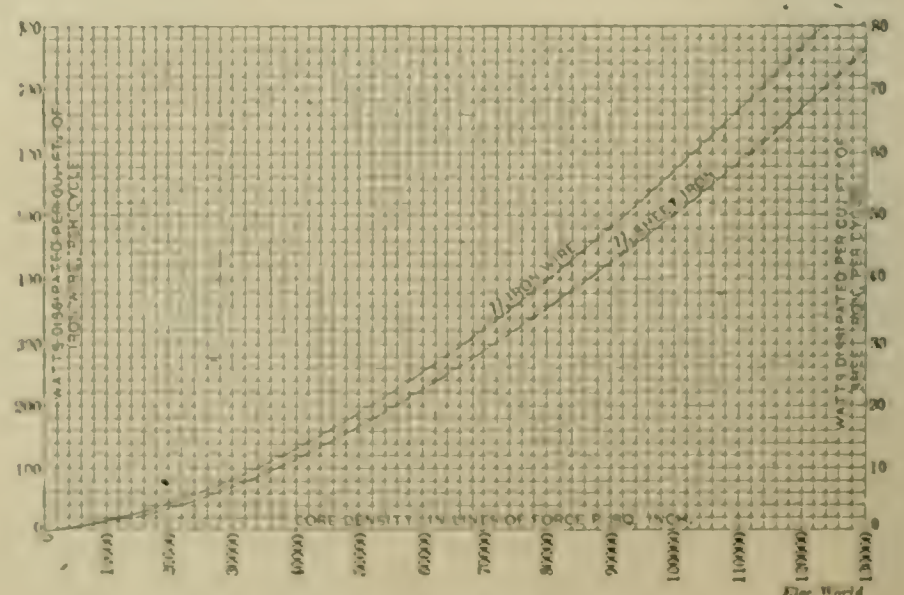


FIG. 14.

cent investigations has found that it varies at different mag-

¹U. A. Ewing and Miss Helen G. Klaassen, Philos. Trans. Roy. Soc. "Electrician" (London), volume XXXII., pages 636, 668, 713; XXXIII., pages 6, 38 (April and May, 1894); The Electrical World, XXXIII., pages 569, 573, 614, 680, 714, 740 (April and May, 1894); "Electrical Engineer," XVII., page 417 (May 2, 1894).

netizations. In the case of thin sheet iron (.0185 inch), for instance, the hysteretic exponent ranged as follows:

TABLE XXV.—HYSTERETIC EXPONENTS FOR VARIOUS MAGNETIZATIONS.

Magnetization.		Hysteretic Exponent.
In Lines per c. m. ² (Gausses).	In Lines of Force per sq. inch.	
200 to 500	1,300 to 3,000	1.9
500 " 1,000	3,000 " 6,500	1.68
1,000 " 2,000	6,500 " 13,000	1.55
2,000 " 8,000	13,000 " 50,000	1.475
8,000 " 14,000	50,000 " 90,000	1.7

Although Ewing thus has shown that no formula with a constant exponent can represent the hysteretic losses within anything like the limits of experimental accuracy, he concludes that Steinmetz's exponent 1.6 gives values which are nowhere so grossly divergent from the truth as to unfit them for use in practical calculations. This conclusion holds particularly good for the densities applied in dynamo-electric machinery, as from the table given above can be seen that for densities between 4 and 14 kilogausses (25,000 and 90,000 lines per square inch, respectively), see Table XVII., chapter 12, the hysteretic exponent, according to Ewing's experiments, varies from 1.475 to 1.7, the average of which is 1.59, indeed a good agreement with Steinmetz's value.

Experiments on the variation of the hysteretic loss per cycle as function of the temperature have been made by Dr. W. Kunz,¹ for the temperatures up to 800 degrees C. They

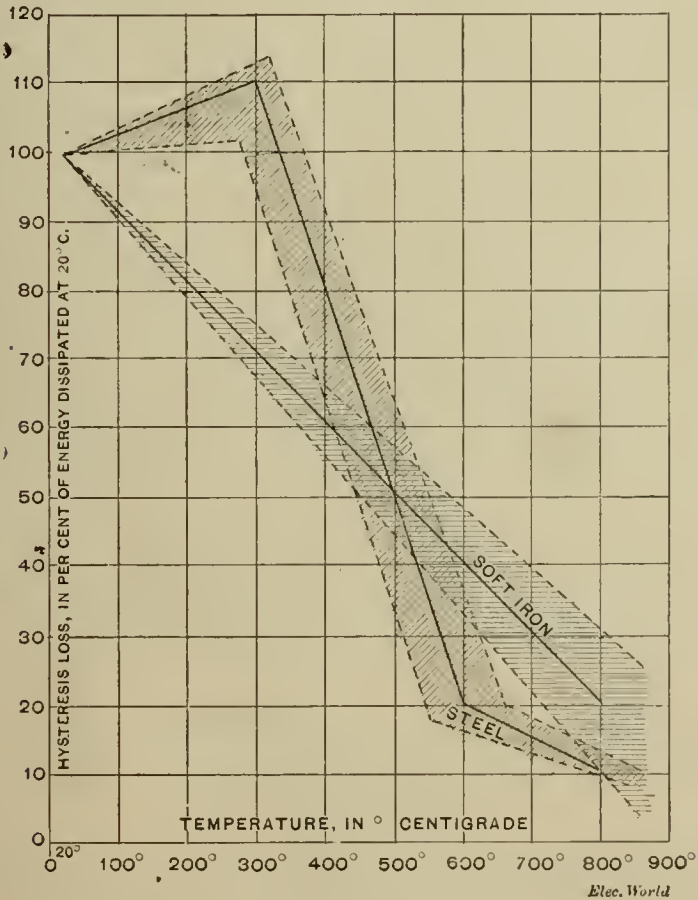


FIG. 15.

show that with rising temperature the hysteresis loss decreases according to a law expressed by the formula

$$H = a + b t,$$

where H = hysteresis loss per cycle, in ergs;
 t = temperature, in centigrade degrees.
 a and b = constants for the material, depending upon the temperature and on the maximal induction.

The decrease of the hysteretic loss, consequently, consists of two parts: one part, $b t$, which is proportional to the increase of the temperature, and another part, a , which becomes permanent, and seems to be due to a perma-

¹Dr. W. Kunz, "Elektrotechn. Zeitschr.," volume XV., page 194 (April 5, 1894); The Electrical World, XXIII., page 647 (May 12, 1894).

nent change of the molecular structure, produced by heating. This latter part, in soft iron, is also proportional to the temperature, thus making the hysteretic loss of soft iron a linear function of the temperature, but is irregular in steel.

The curves in the latter case show a slightly ascending line to about 300 degrees C., then change into a rapidly descending straight portion to about 600 degrees C., when a second "knee" occurs, and the descension becomes more gradual.

The writer has refigured all of Kunz's test results, basing the same upon the hysteresis loss at 20 degrees C. as unity in every set of observations. In Fig. 15 dotted lines have then been drawn, enclosing all the values thus obtained, for soft iron and for steel, respectively, and two full lines, one for each quality of iron, are placed centrally in the planes bounded by the two sets of dotted lines, thus indicating the average values of the hysteretic losses, in per cent. of the energy loss at 20 degrees C. Arranging the same in form of a table, the following law is obtained:

TABLE XXVI.—VARIATION OF HYSTERESIS LOSS WITH TEMPERATURE.

Temperature in Centigrade Degrees.	Energy dissipated by Hysteresis in per cent. of Hysteresis Loss at 20° C.	
	Soft Iron.	Steel.
20°	100	100
100°	90	103
200°	80	106
300°	70	110
400°	60	80
500°	50	50
600°	40	20
700°	30	15
800°	20	10
20°	70	40

The last row of this table, which gives the hysteresis loss at 20 degrees C., at the end of the test, shows that the energy required to overcome the hysteretic resistance is reduced to about 70 per cent. in case of soft iron and to about 40 per cent. in case of steel, after having been subjected to magnetic cycles at high temperatures. Kunz further found that the hysteretic energy loss can thus be considerably reduced by repeatedly applying high temperatures while iron is under cyclic influence.

For soft iron a set of straight lines was obtained in this way, each following of which had a lower starting point, and descended less rapidly than the foregoing one, until, finally, after the fourth repetition of the heating process, a stationary condition was reached.

For steel, already the second set of tests with the same sample did not show the characteristic form of the, at first ascending, then rapidly, and finally slowly descending steel curve, but furnished a rapidly descending straight line. For every further repetition, the corresponding line becomes less inclined, and for the fifth test is parallel to the axis of abscissae. Steel, therefore, after heating it but once as high as 800 degrees C., loses its characteristic properties, and with every further repetition becomes a softer, less carbonaceous iron.

c.—Energy Dissipated by Eddy Currents.

From his experiments Steinmetz also derived that the energy consumed in setting up induced currents in a body of iron increases with the square of the magnetic density, with the square of the frequency, and in direct proportion with the mass of the iron:

$$H_2 = \epsilon_1 \times B^2 \times N_1^2 \times M_1;$$

H_2 = energy dissipated by eddy currents, in ergs;

B = density of lines of force, per cm² of iron;

N_1 = frequency, in cycles per second, $= \frac{N}{60} \times P$;

M_1 = mass of iron, in cm³;

ϵ_1 = constant, depending upon the thickness and the specific electric conductivity of the material:

$$\epsilon_1 = \frac{\pi^2}{6} \times \delta_1^2 \times \gamma_1 \times 10^{-9} = 1.645 \times \delta_1^2 \times \gamma_1 \times 10^{-9}.$$

δ_1 = thickness in cm;

γ_1 = specific conductivity in mhos;

for iron: $\gamma_1 = 100,000$ mhos;

for copper, $\gamma_1 = 700,000$ mhos.

Inserting the value of ϵ_1 , with reference to iron, into the

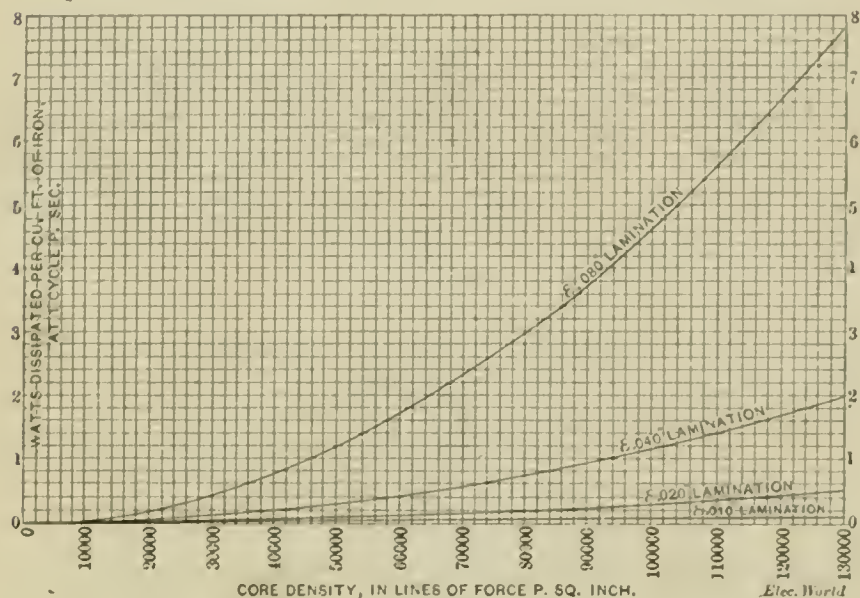


FIG. 16.

above formula, and transforming into practical units, the eddy current loss in an armature, in watts, is obtained:

$$w_e = 10^{-7} \times 1.645 \times (2.54 \delta)^2 \times 10^{-4} \times \left(\frac{\mathfrak{B}_a}{6.45} \right)^2 \times N_1^2 \times 28,317 \times M \pi = 7.22 \times 10^{-8} \times \delta^2 \times \mathfrak{B}_a^2 \times N_1^2 \times M. \quad (40)$$

TABLE XXVII.—EDDY CURRENT FACTORS FOR DIFFERENT CORE DENSITIES AND FOR VARIOUS LAMINATIONS.

Magnetic Density in Armature Core, Lines of Force per sq. in.	Watts dissipated per cubic foot of iron at a frequency of 1 cycle per second.				Magnetic Density in Armature Core, Lines of Force per sq. in.	Watts dissipated per cubic foot of iron at a frequency of 1 cycle per second.			
	Thickness of Lamination, δ					Thickness of Lamination, δ			
	.010"	.020"	.040"	.080"		.010"	.020"	.040"	.080"
10000	.0007	.003	.012	.046	66000	.0315	.126	.503	2.013
15000	.0016	.007	.026	.104	67000	.0325	.130	.519	2.075
20000	.0029	.012	.046	.185	68000	.0335	.134	.534	2.137
25000	.0045	.018	.072	.288	69000	.0345	.138	.550	2.200
30000	.0065	.026	.104	.416	70000	.0355	.142	.566	2.265
31000	.0070	.028	.111	.444	71000	.0365	.146	.582	2.330
32000	.0074	.030	.118	.472	72000	.0375	.150	.599	2.396
33000	.0079	.032	.126	.503	73000	.0385	.154	.616	2.463
34000	.0084	.034	.134	.534	74000	.0396	.158	.633	2.530
35000	.0089	.036	.142	.567	75000	.0407	.163	.650	2.600
36000	.0094	.038	.150	.600	76000	.0418	.167	.668	2.670
37000	.0099	.040	.158	.633	77000	.0429	.171	.685	2.740
38000	.0104	.042	.167	.667	78000	.0440	.176	.703	2.810
39000	.0110	.044	.176	.703	79000	.0451	.180	.721	2.883
40000	.0116	.046	.185	.740	80000	.0462	.185	.740	2.958
41000	.0122	.049	.194	.777	81000	.0474	.190	.758	3.033
42000	.0128	.051	.204	.815	82000	.0486	.194	.777	3.108
43000	.0134	.054	.214	.855	83000	.0498	.199	.796	3.184
44000	.0140	.056	.224	.896	84000	.0510	.204	.815	3.260
45000	.0146	.059	.234	.937	85000	.0523	.209	.835	3.340
46000	.0153	.061	.245	.979	86000	.0535	.214	.855	3.420
47000	.0160	.064	.256	1.022	87000	.0548	.219	.875	3.500
48000	.0167	.067	.267	1.066	88000	.0560	.224	.895	3.580
49000	.0174	.070	.278	1.110	89000	.0573	.229	.916	3.662
50000	.0181	.072	.289	1.155	90000	.0586	.234	.937	3.745
51000	.0188	.075	.300	1.200	91000	.0599	.240	.958	3.830
52000	.0195	.078	.312	1.248	92000	.0612	.245	.979	3.915
53000	.0202	.081	.324	1.297	93000	.0625	.250	1.000	4.000
54000	.0210	.084	.337	1.346	94000	.0638	.255	1.021	4.085
55000	.0218	.087	.349	1.397	95000	.0651	.261	1.043	4.170
56000	.0226	.091	.362	1.448	96000	.0665	.266	1.064	4.257
57000	.0234	.094	.375	1.500	97000	.0679	.272	1.086	4.345
58000	.0242	.097	.389	1.555	98000	.0693	.277	1.109	4.436
59000	.0251	.101	.403	1.610	99000	.0707	.283	1.132	4.528
60000	.0260	.104	.416	1.665	100000	.0722	.289	1.156	4.622
61000	.0269	.108	.430	1.720	105000	.0797	.319	1.274	5.095
62000	.0278	.111	.444	1.776	110000	.0875	.350	1.398	5.593
63000	.0287	.115	.458	1.833	115000	.0955	.382	1.528	6.113
64000	.0296	.118	.473	1.891	120000	.1040	.416	1.664	6.655
65000	.0305	.122	.486	1.951	125000	.1128	.451	1.806	7.222

δ = thickness of lamination, in inches;

$\mathfrak{B}_a$ = core-density, in lines of force, per square inch;

N_1 = frequency, in cycles per second;

M = mass of iron, in cubic feet.

Uniting again $7.22 \times 10^{-8} \times \delta^2 \times \mathfrak{B}_a^2$ into one factor, in this case the *Eddy Current Factor*, ϵ , we have the simplified formula:

$$w_e = \epsilon \times N_1^2 \times M. \quad (41)$$

The values of ϵ for core-densities from 10,000 to 125,000 lines per square inch and for laminations of thickness, $\delta = .010''$, $.020''$, $.040''$ and $.080''$, are given in Table XXVII.

Curves corresponding to the values of ϵ in the above table are plotted in Fig. 16.

(To be continued.)

Woven Wire Brushes.

To the Editor of The Electrical World:

I greatly dislike making claims for priority, and I do so in the present case merely in the interests of the public.

I observe that it is being claimed that certain "broad fundamental" U. S. A. patents, dated 1889 and 1891, control "all forms of woven wire dynamo brushes," or, as we call them in England, wire gauze brushes. Permit me, therefore, to announce to all whom it may concern, that in the British patent 12,372 of Oct. 16, 1885, in the names of L. S. Crossley, W. T. Godden and myself, for "Improved means for regulating the action of dynamo-electric machines," the following passage occurs: "The brush or rubber may be composed of fine wire gauze rolled into a flat mass of the requisite thickness, and to prevent the fraying of the edges, we cut the gauze from the sheet diagonally." The late L. I. Crossley's share of the patent relates to the governing of a shunt wound dynamo running at a variable speed and occasionally in reverse directions, as in train lighting. The other details of the patent were invented by me, and Mr. Godden's name appeared as senior partner of my firm. I did not recognize, at the time, the importance of wire gauze brushes, though they worked excellently from the first. This was, perhaps, because even in 1885 my dynamos were practically sparkless. Unfortunately for me, no claim was made in the patent for wire gauze brushes, and the invention is and always has been public property. For this reason I write this letter.

A somewhat similar claim was set up in this country some time ago, and I was obliged to stop it privately, as I was unable to do so publicly, because professional etiquette in England strictly forbids all direct advertising by consulting engineers.

London, England.

ALEXANDER P. TROTTER.

The Antwerp Exhibition.

One of the features of interest in the Antwerp Exhibition will be a number of exhibits illustrating the history and progress of the various forms of artificial illumination. All kinds of lights, from the early Pompeian and Roman lamps down to the most modern forms of electric lamp, will be represented. To electrical engineers a complete series of exhibits of this character would be both an interesting and instructive sight, and it is to be hoped that every effort will be made to make it as complete as possible.

Underground Electric Railway for Paris.

Work will soon be begun on the underground electric railway from the Bois de Boulogne to the Porte de Vincennes, which will have a length of 11.2 kilometres and the tunnel a diameter of 6.3 metres. The speed of trains will be 20 kilometres per hour, and the voltage of the electric current 500.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

COMPILED FROM
PRINCIPAL FOREIGN
ELEC. WORLD, N.Y.

ELECTRICAL JOURNALS
BY CARL HERING

ELECTRO-PHYSICS.

The Work of Hertz.—The first part of a Royal Institute lecture by Prof. Lodge is published in the Lond. "Elec.," June 8. A portrait of Hertz and a complete list of eighteen of his papers, which are not incorporated in his book, are given. In the lecture he gives experimental demonstrations of the outcome of Hertz's work; the present portion is somewhat elementary, starting with analogies of electrical and other waves, and a brief description of the vibrator. The lecture is discussed in the leading editorial, where the apparatus as made by Dr. Lodge is briefly described; the oscillating sphere and the sparking apparatus are enclosed in a wooden box, the waves set up being allowed to escape only in one direction through a circular aperture in front, thus forming a sort of electrical lantern, which was here exhibited for the first time; the present apparatus is said to simplify greatly the demonstration of Hertz's researches.

Flow of Electricity from Points.—An article by Mr. Precht from the "Ann. Phys. u. Chem.," volume XLIX., page 150, on the absolute measurement of the flow, is abstracted in the "Foreign Abstracts of the Inst. of Civ. Eng.," volume CXV., Part I.; the voltage at which flow began was quite different for the positive than for the negative conductor and differed also very greatly with the materials and their conditions; among other things he found that there was less discharge from a bundle of points than from a single one; to produce a charge of 100×10^{-9} amperes, from one particular needle, an average voltage of 8,188 was required; in the paper some calculations are given of the quantity dispersed silently by an ordinary lightning conductor during a storm.

Electric Waves.—A correspondence of Mr. Deeley is published in the Lond. "Elec.," June 8, and is discussed editorially; the question involved refers as to whether electric and magnetic fields can exist independently.

Electro-Magnetic Properties of Parallel Conductors.—The article by Mr. Steinmetz, mentioned in the Digest last year, is abstracted in the "Foreign Abstracts of the Inst. of Civ. Eng.," volume CXV., Part I.

Electricity and Its Connection with Other Physical Phenomena.—An article by Mr. Schwartze on this subject is published in the "Elek. Anz.," May 31.

Electricity from Waterfalls.—A note in "Cosmos," June 9, refers to experiments of Mr. Lenard made with waterfalls in the Alps, showing that the water is charged positively and the air surrounding it negatively.

MAGNETISM.

Intense Magnetic Fields.—A translation of the article of Prof. Du Bois, mentioned in the Digest April 7, May 5 and May 19, is published in abstract in the "Phil. Mag." for June. A large ring was used, made of the best Swedish iron, 50 centimetres mean diameter and 10 centimetre thick; a

magnetomotive force of 108,000 ampere turns could be used; the highest value of the inductance was about 180 henrys, corresponding to a time ratio of 75 seconds. He found that the absolute leakage diminished considerably as the current was increased, and that it was therefore a fallacy to assume that leakage must always increase when saturation is being approached; the leakage was also considerably diminished by the ampere turns near the air gap, which fulfilled the function of keeping the flux from spreading; the strong fields were produced by concentrating the flux through properly shaped pole pieces, the shape of which was determined empirically; a truncated cone of a semi-vertical angle of 60 degrees was found best; for a diameter of the field of 5 millimetres, $\mathcal{H}$ was equal to 36,800 C. G. S. units and for 3 millimetres, 38,000; the induction in a piece of thin iron wire was found to be 60,000, which corresponds to a tension of 144 kilograms per square centimetre. He thinks that it is possible to obtain fields of 40,000 with such magnets, but that above this it would require apparatus out of proportion with the purpose in view.

Magnetization at High Frequency.—The paper abstracted in the Digest June 16 is abstracted more fully in the "Phil. Mag." for June.

Magnetic Action of Cathode Rays.—The Lond. "Elec.," June 8, contains an article discussing Lenard's experiments, more particularly the fact that cathode rays are deflected by a magnetic force.

Alternate Current Magnets.—The article abstracted in the Digest June 2 is published in full in the "Phil. Mag." for May.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Polarity Indicator.—In the "Zeit. fuer Elek.," May 15, Mr. Kratzert states that with litmus paper, curcuma paper and pole-reagent paper, the positive electric pole acts like an acid and the negative like a base (alkali); if litmus paper is moistened with acid the positive pole will color it black and the negative blue; if moistened with a base the reaction is the same as with ordinary paper.

Hummel Meter.—A translation of the description of this meter, referred to in the Digest June 9, is given, together with the illustrations, in the Lond. "Elec. Rev.," June 8.

Physical Units.—An article by Mr. Maclean is begun in the Lond. "Elec. Eng.," June 8.

DYNAMOS AND MOTORS.

Non-Synchronous Motors.—A mathematical paper on motors with short circuited armatures, by Prof. Potier, is published in the "Bul. Soc. Int." for May; fundamental formulas are deduced and their application illustrated by numerical examples. In the discussion, Mr. Boucherot gives a summary of the results, in the form of curves, of the measurements mentioned in the Digest June 23, under "Transmission of Power."

Polymorphique Generators.—The classification given in Mr. Hospitalier's article (see Digest, June 16), together with the list of installations where the various types are used, is published in the Lond. "Elec. Eng.," June 8.

Cail-Helmer Generator.—A translation of the descriptive article mentioned in the Digest, Nov. 18, 1893, is given in the "Foreign Abstracts of the Inst. of Civ. Eng.," volume CXV., Part I.

ARC AND INCANDESCENT LIGHTS.

Multiple-Filament-Lamp Base.—A base is described and illustrated in the "Elek. Anz.," June 3, in which all three filaments are connected with one end to one pole and the other ends with three metallic rings on the base, connection to which is made with three concentric milled head keys.

Investigations with the Alternating Current Arc.—An abstract of the article by Mr. Blondel, mentioned in the Digest Oct. 14 and 28, 1893, is given in the "Foreign Abstracts of the Inst. of Civ. Eng.," volume CXV., Part I.

TRANSMISSION OF POWER.

Power Distribution by Electricity, Water and Gas.—A paper by Mr. De Segundo is reprinted in part in the Lond. "Elec. Eng.," June 8; it is devoted entirely to the mechanical engineering features of the problem.

Polyphase Transmission.—A short abstract of the article mentioned in the Digest May 19 is given in the Lond. "Elec. Eng.," June 8.

ELECTRIC RAILWAYS.

Electric Traction.—The criticisms of Mr. Lea of the views of Prof. Kennedy, abstracted in the Digest May 19, are contained more in detail in London "Engineering," April 27. Mr. Lea calls attention to the fact that no allowance was made for the dead weight of the locomotive, which does not exist in electric trains; he works out the efficiency of 69 per cent. from the indicated horse power to that exerted at the wheels; in addition, the ratio between the fuel efficiencies of stationary locomotive engines will be at least five to three, if not more, the final ratio based on coal bills being, therefore, as 34.5 to 24, which is quite different from the figures of Prof. Kennedy; in conclusion, he calls attention to the fact that no system is best for all cases, and that there is a proper place for cable lines, as also for oil and gas motors.

In a communication to the Lond. "Elec. Rev.," June 8, Mr. Sellon criticises a recent statement in that paper (see Digest, June 23), claiming that it, as well as the statement of Prof. Kennedy, are erroneous; he suggests that the working cost of the South Staffordshire, the Liverpool and the Blackpool systems will show figures which will compare favorably with any single form of traction in that or any other country. In the same issue Mr. Dickenson criticises the same statements and claims that electric lines are operated 6 cents per mile cheaper than steam tramways.

Corrosion of Pipes.—The Lond. "Elec. Rev.," June 8, in an editorial, gives a brief synopsis of the discussion of Mr. Farnham's paper, read at the American Institute of Electrical Engineers, and claims that the term electrolysis was misapplied in this discussion, and that it was not electrolysis but electro-chemical effects on metals which was under discussion. With platinum plates it requires about 1.5 volts to decompose acidulated water, but between lead plates a much smaller voltage is required, between iron still smaller and between zinc still less, as the affinity of the metal enters into the reaction; metal pipes in moist earth are already just on the point of corrosion, so that the slightest additional force in the form of electrical voltage at once determines vigorous action, the various extraneous voltage being added to their own; electrolysis might be confined to the splitting up of compounds between electrodes which are not acted upon themselves, while in chemical action one or both electrodes enter into the action.

Mountain Railway.—The Lauterbrunnen-Muerren railway (the electrical part of which is not really a steep grade road)

is described and illustrated in "Cosmos," June 2; a short abstract of the article is published in the Lond. "Elec. Eng.," June 8.

Guernsey.—An illustrated description of the railway on this island installed by Siemens Brothers, of London, is given in the "Bull. de l'Inst. Montifiore," May 31; it includes some working drawings, switchboard and car wire diagrams and a diagram of the currents during a trip.

Lyons.—An illustrated article by Mr. BIRTHON is begun in "L'Elec.," June 2; he discusses in general the calculation of the motive power for electric railways, the line, etc.

Newcastle.—A report for the proposed railway is published in detail in the Lond. "Elec. Eng.," June 8.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Portsmouth.—The greater part of the issue of the Lond. "Elec. Rev.," June 8, is devoted to a long and well illustrated description of the recently inaugurated plant in this city. It is of interest partially because it is the first plant in England in which the flywheel of the engine is formed of the fields of the alternator and that currents used for street arc lighting are obtained from rectified alternating currents; it is claimed that this station has departed more than any other in England from the recognized engineering practice; also that Ferranti can claim the honor of being the first to use commutated currents in actual work. The commutators, or rectifiers, are described and illustrated; there are five circuits, each for 20 arc lamps at 12 amperes; the current is commutated by a simple four-part commutator, running at 1,500 revolutions and driven by a synchronous self-starting alternating current motor; there is said to be no more sparking than with a Brush machine; the current for these circuits is supplied by a special transformer, in which the E. M. F. varies according to the load on the secondary, the current being automatically kept constant, thus forming a constant current transformer; this result is obtained by means of a movable primary coil, suspended and balanced so that it will be floated by the secondary coils, any increase in current in the latter causing repulsion and a consequent motion of the primary coil, which decreases the voltage, thus keeping the current constant. The transformers for the incandescent light circuits may be adjusted for full or half load by means of a key, which connects the two halves of the primary either in series or in parallel and the same with the two halves of the secondary; it is the intention to do this automatically. There is also a Parsons condensing steam turbine of 100 kilowatts, having a range of about 300-fold expansion and a speed of only 3,000; it is chiefly remarkable as being the largest of its type ever built. A description of this station, but without the illustrations, is given in the Lond. "Elec. Eng.," June 8. A briefer description, containing some different cuts, is given in the Lond. "Elec.," June 8.

London "Lightning" publishes an illustrated description in the form of a supplement.

Burton.—An illustrated description of this station is given in the Lond. "Elec. Eng.," June 8; a very short one is given in the Lond. "Elec.," the fuel for the electric plant consists of the refuse of the neighboring gas plant, both being under the same management.

Christiania.—A short abstract of the article mentioned in the Digest, June 28, giving a number of the figures, is published in the Lond. "Elec. Eng.," June 8.

Earning Capacity of Incandescent Lamps.—The following figures are given in the Lond. "Electrical Industry," June 1, attention being called to the fact that they should be used cautiously, as such statistics are often misleading. In a large central station supplying an important part of the West Central district of London, the number of kilowatt hours (per annum) per 8-c. p. lamp installed is as follows: Private houses, 5 to 26; stores, 15 to 30; hotels, 30 to 60; churches, 3 to 13; theatres, 8 to 20. In another district the averages are as follows: Club houses, 44.14; hotels, 41.97;

stores, 13.78; restaurants, 27.42; churches, 6.11; hospitals, 10.46; banks, 22.55; staircases in flats and chambers, 38.

Storm Indicator.—The Lond. "Elec.," June 8, suggests editorially that a metallic microphone might be used to give warning of an electrical storm long before the storm is near enough to do any damage to the line; it is based on the statement of Prof. Lodge that the metallic microphone is so delicately constituted that it will respond to feeble electric oscillations propagated at enormously great distances from the place where it is stationed.

Laval Steam Turbine.—A very complete description by Mr. Sosnowski, with a large number of illustrations, is published in the "Bull. Soc. Int." for May.

WIRES, WIRING AND CONDUITS.

Cause of Short Circuits.—The Lond. "Elec.," June 8, in an editorial on Hertzian waves, calls attention to the fact that the surging caused by electrical disturbances in the neighborhood of wires is sufficient to give rise to a small spark between the wires, which will be followed by an arc if those wires are used for conveying currents, and it is claimed that some cases of assumed short circuits in electric light leads have been caused in this manner; it is suggested that for this reason the positive and negative leads in a building should be separated for some distance.

Couplings for Underground Wires.—The coupling mentioned in the Digest June 16 is described and illustrated in the Lond. "Elec. Rev.," June 1.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Long Distance Telephony and Rapid Telegraphy.—In referring to Prof. Pupin's recent invention (see The Electrical World, May 19), the Lond. "Elec. Rev.," June 8, states that the arrangement is old, is founded on fallacies, and instead of increasing the working speed tends to do exactly the reverse; it suggests that inventors should try their inventions before patenting or publishing them.

Microphone.—A microphone made in Germany, consisting of powdered carbon between a carbon plate and a carbon diaphragm, is described and illustrated in the "Elek. Echo," June 9; one of the chief claims of novelty is the method of adjusting the rear plate; the loudness and clearness are claimed to be better than in any other microphones and the consumption of current exceedingly small, being from 0.02 to 0.005 amperes.

Telegraph and Telephone Line Construction.—An article on the recent German practice, published last year, is abstracted briefly in the "Foreign Abstracts of the Inst. of Civ. Eng.," volume CXV., Part I.

Telegraphs in Persia.—A Society of Arts paper by Mr. Wells is published in abstract in the Lond. "Elec. Rev.," June 8.

Fire Alarm System in Vienna.—The paper by Mr. Stern is concluded in the "Zeit. fuer Elek.," May 15.

Pacific Cable.—Another letter on this subject is published in the Lond. "Elec. Eng.," June 8.

ELECTRO-CHEMISTRY.

Copper Zinc Accumulator.—The history of this accumulator is given in a continued article in the "Elek. Anz.," May 20 and June 3.

Electrolysis of Fused Salts.—The Vautin process for obtaining sodium or caustic soda and chlorine is described in Lond. "Electrical Industry," June 1. (See Digest June 2 and 23.)

MISCELLANEOUS.

Electricity in Plants.—Mr. Hill in Lond. "Elec.," May 18, claims to have obtained sufficient current to ring a bell from a battery of 12 melons connected in series by platinum wires inserted at the top and bottom; the melons should be nearly ripe and should be placed on glass. He claims to have been the first to discover the fact stated in a French journal (see Digest March 31), that an electric current can be noticed be-

tween the eye and the stem, and also between other parts of fruits.

Electric Log.—A log for indicating the speed of vessels, which was recently tested, is described and illustrated in "La Nature," May 19; an electric bell is rung on the completion of a certain number of revolutions of the cup shaped wheels which are constructed.

Compass for Automatic Steering.—The device described in the Digest June 2 is described in detail, including a number of illustrations, in "La Lum. Elec.," May 26.

Suggestions for Transit Systems—III.*

BY S. D. MOTT.

I send herewith several suggestions of what may appropriately be called a gravity system of electric street traction, as, in the colloquial language of the times, gravity pushes

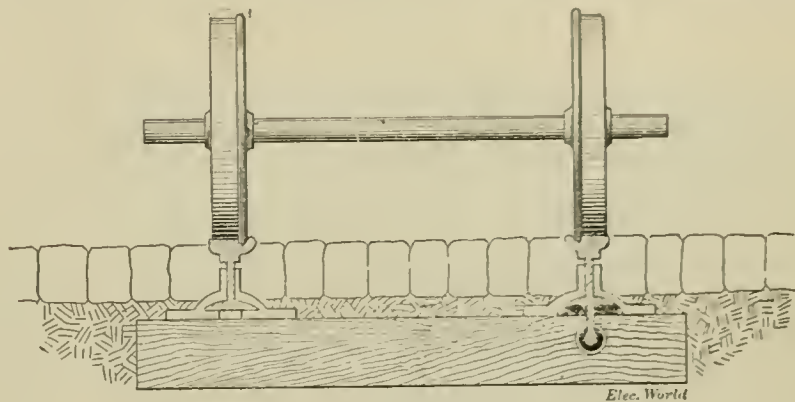


FIG. 1.

the button and the electric current, acting conjointly with the ordinary car equipment, does the rest.

Fig. 1 shows a cross-section of track arranged with posi-

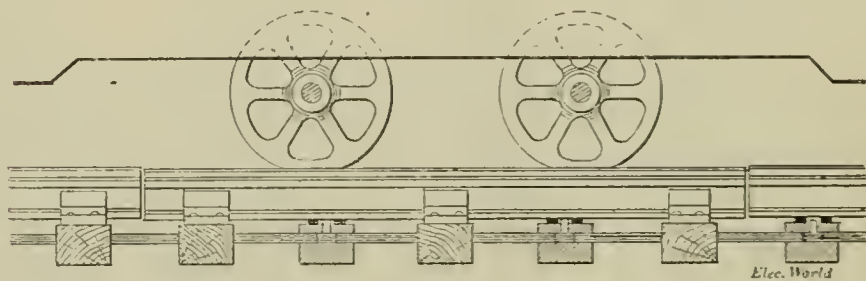


FIG. 2.

tive track conductor on right, together with negative rail or ground return on left, and Fig. 2 is a horizontal elevation in part section of track arrangement. The idea involved is a depressionable rail or rails, divided into car lengths, cushioned by washers, and which are normally out of the circuit. A slight depression given by the weight of the car, say one-eighth of an inch or less, will cause the rail to make electric contact with the well-insulated sub-surface conductor, closing the circuit through the usual car equipment. At say three points of each rail length contacts are arranged from a sealed underground main, which, when brought into contact with the rail or a depressionable groove of the rail, charges it with the current, so that only the rails immediately beneath the car are energized.

The rails may be prevented from creeping by properly

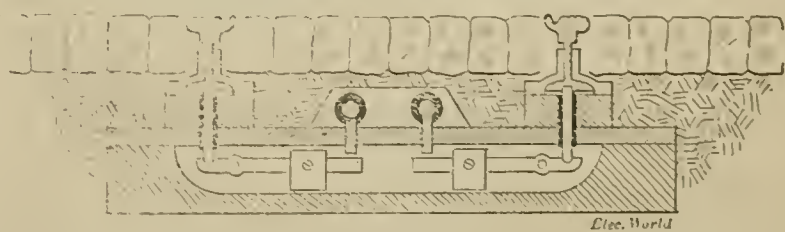


FIG. 3.

disposed spikes or other fastenings in the usual manner. When operated with an E. M. F. not to exceed 500 volts there would be no danger to man or beast, even if by any possible means the circuit could be closed through them; with around

* For parts I. and II. of this article see The Electrical World of April 28, 1894, page 576, and May 26, 1894, page 719.

200 volts E. M. F. the current in any event would not be disagreeably perceived. As with all electric street systems, except the return circuit conduit, the rails in bad weather should be kept clean by proper car accessories, such as re-

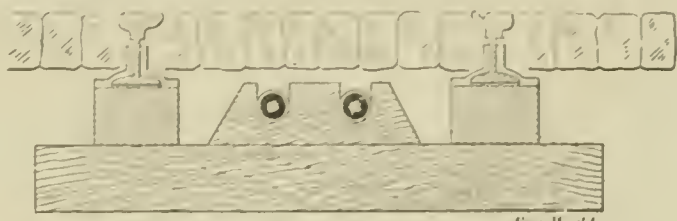
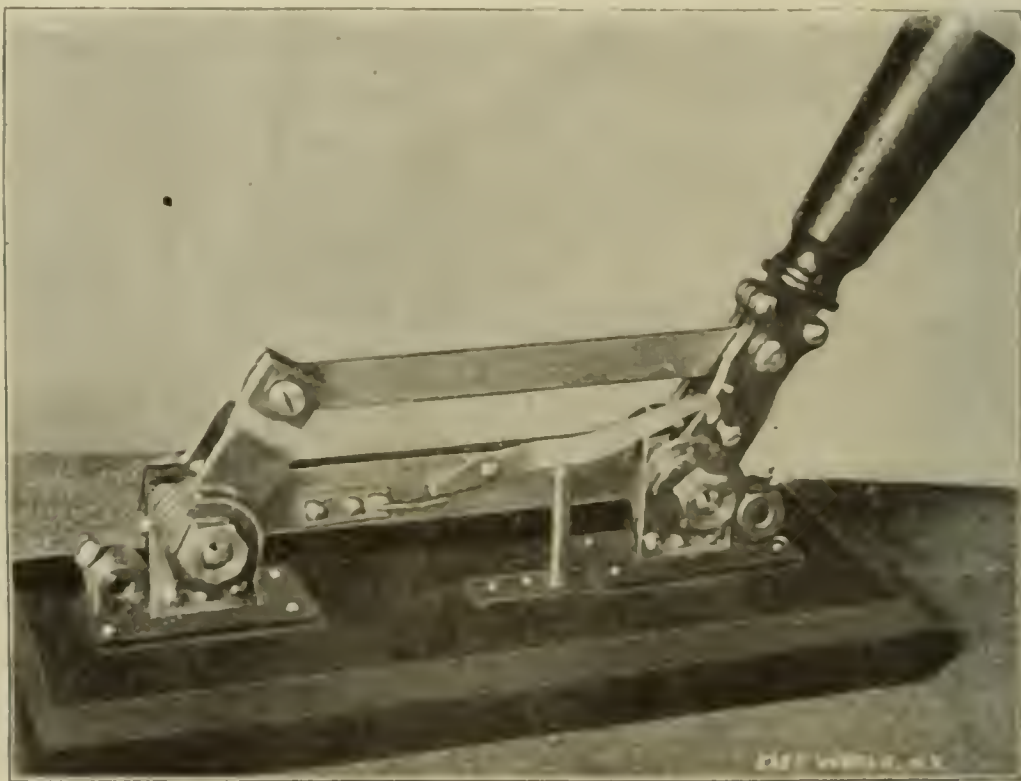
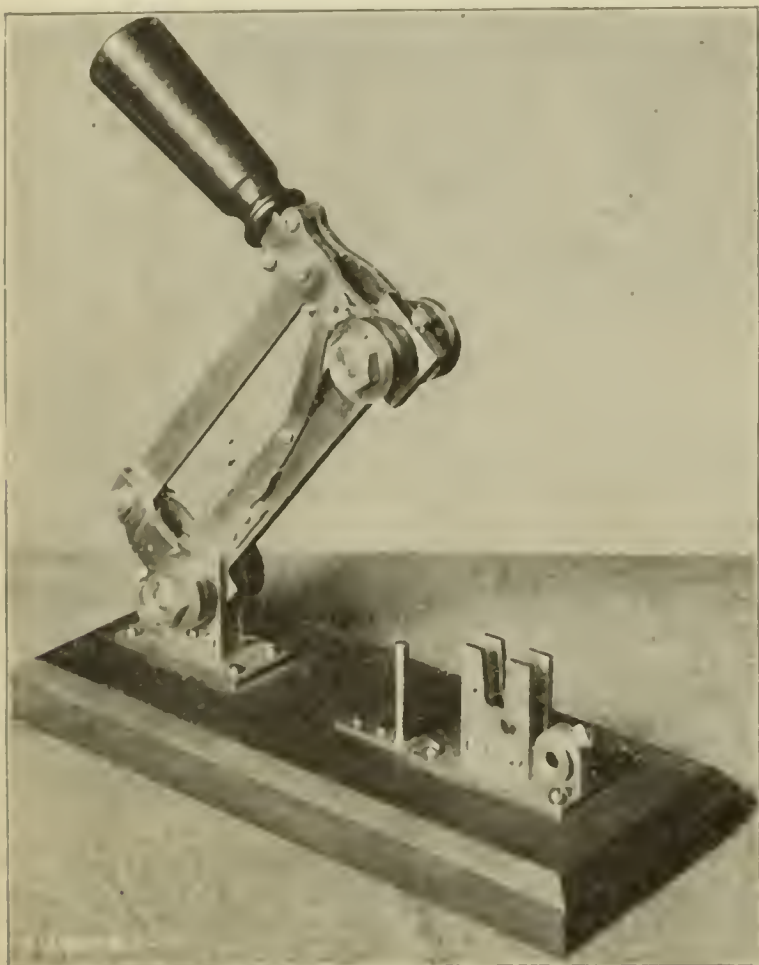


FIG. 4.

volving brushes in front of the wheels. In Figs. 1 and 2 the rails are kept in horizontal alignment by the elasticity of rubber or its equivalent. In Fig. 3 gravity is substituted for retractile devices, and the weight upon the track sufficient to depress the rail or rails to make contact with conductor is



KNIFE SWITCH, ESPECIALLY ADAPTED TO CIRCUITS OF LARGE CAPACITY.

adjustable. Fig. 3 is a cross-section of track at point of making contact, and Fig. 4 is an intermediate section.

The favorable features of such a system are the cheapness of construction when compared with open underground work, requiring some sort of slot, and necessarily the expensive cable yoke to support it; unobstructed streets, freedom from complication, springs, switches, magnets, etc., conventional appearance, and ordinary rails. Any thoroughly protected underground conductor, like the Edison street mains, may be used, making contacts therewith as shown. This contact may be water and air-tight and should reduce the loss from leakage to the lowest possible degree.

Automatic Starting Switch.

To the Editor of The Electrical World.

In your issue of the 26th of May you describe White's automatic starting switch for motors, which is geared to and operated by the armature shaft of the motor. As this is merely a modification of my form of control, patented both in this country and abroad, and described by me in your issue of Nov. 18, 1893, I take the liberty of calling your attention to my patent.

Baltimore, Md.

G. H. WHITTINGHAM.

A New Knife Switch Especially Adapted to Circuits of Large Capacity.

Perhaps the losses due to the use of the ordinary knife switch were never more emphatically stated than at the last convention of the National Electric Light Association, held at Washington, D. C., Feb. 27 to March 2, when Mr. Edward Weston referred to the fact that "in one case a single switch and instrument involved an annual loss of \$5,000." He further stated that "all resistances should be made as low as possible and great attention given to joints," and that "the switches must be made very differently from what they are now."

The switch shown in the engraving, which reduces the loss at the switch joints to the minimum, has since been patented by F. G. Bolles, 180 Decatur street, Brooklyn, N. Y. When the switch is to be opened the handle is brought to a position at right angles with the base, and while in this position the friction between the blade and clips is only sufficient to remove any possibility of arcing, and is so small that the switch can be opened almost instantly with but a slight effort. On closing the switch the handle is thrown slightly forward, causing the cams, located on the yokes, to act upon each

other, thereby compressing the joints. This pressure is something enormous and the contact is in every way equal to any other bolted joint of the circuit.

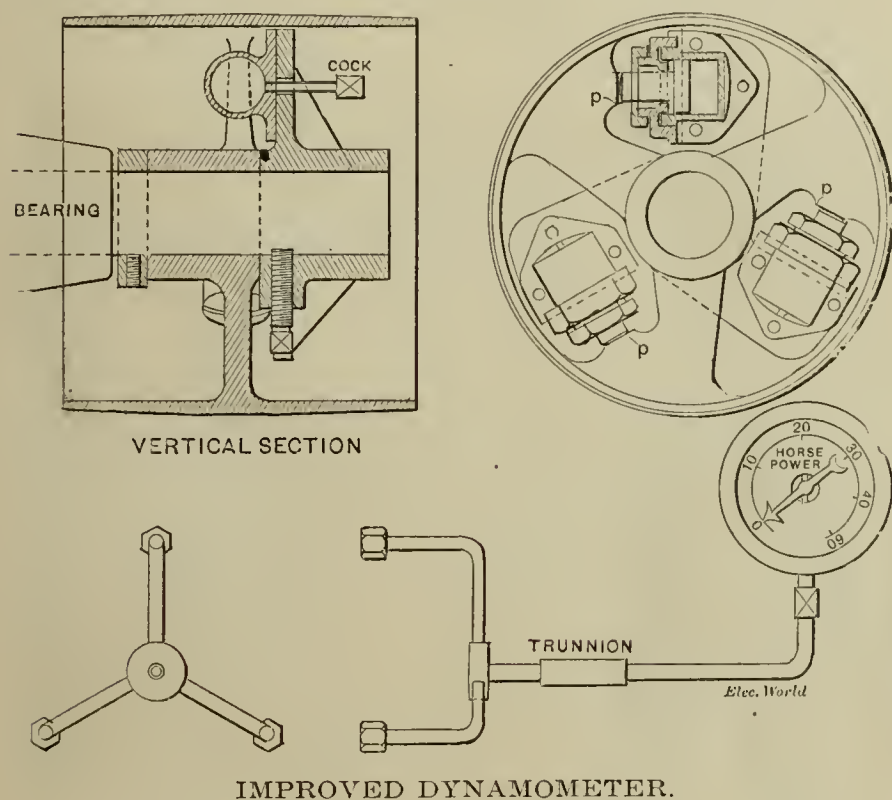
A New Type of Dynamometer.

A patent has recently been issued to J. A. Cross, of Geneva, N. Y., for an improvement in dynamometers. As in many previous instances the design was made to overcome difficulties and inaccuracies actually encountered. In this case the patentee was making a test of an electric lighting plant, using a spring dynamometer, and the readings of the instrument were proved to be wrong and the test was repeated with another dynamometer.

The main feature of the improved instrument is that instead of springs being used to transmit the power, a liquid is inserted between the two parts of the instrument and the pressure is recorded. Dynamometers which rely upon springs to transmit the power are necessarily subject to a limiting speed, and this necessitates the use of a countershaft and the subdivision of belting, thus increasing the liability to error. As the instrument illustrated is not affected by the ordinary speeds met with in practice, it requires no countershaft nor change of belting, and can be arranged within the

diameter of an ordinary driving pulley. The illustration shows an instrument capable of transmitting 75 h. p. at 10,000 revolutions per minute inside a 12-inch pulley.

The apparatus consists of a pulley having arms specially shaped, which is placed on the shaft absorbing the power to be measured, and is free to revolve on it. One half of the base of the pulley is cut away, and it does not project beyond the arms on one side, in the line of the shaft. Next to this pulley on the shaft, and securely fastened to it, is a casting having a similar number of arms to those in the pulley. Each arm carries a small cylinder having a piston with piston rod projecting through one end. The ends of the piston rods engage with the arms of the pulley. The cylinders are connected by pipes to a chamber located in line with the centre of the common shaft. Beyond this chamber is a transmission joint, permitting the pipes and chamber to rotate, while the recording apparatus, which is beyond the joint, remains stationary. The recording apparatus consists of a pressure gauge graduated in pounds or for a standard speed in horse-powers. The gauge may be located in any convenient place, and a number of separate instruments may be



IMPROVED DYNAMOMETER.

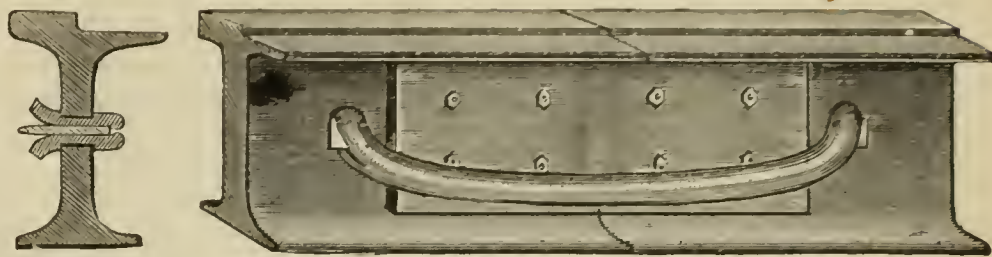
connected to one gauge. The cylinders and pipes are filled with a liquid and the pressure exerted through it is recorded by the gauge.

The advantages of this instrument are that it is simple, not affected by ordinary speeds found in practice, and requires no countershaft and no change in the regular driving belt. It takes the place of the ordinary driving pulley and is operated by the same belt. It may be connected to a recording gauge, and a continuous diagram of load obtained without attention. It does not have to be displaced after a test is made, as by closing a valve the recording apparatus may be removed if desired, and the remainder left in place instead of the regular pulley.

Rail Bond.

The bond shown in the accompanying illustration is made by the Technic Electrical Works, 129 Broad street, Philadelphia, and is designed to give a simple and reliable rail connection with a minimum of labor. The bond is simply a soft copper rod of the same diameter as the hole in the rail, bent and split at the ends, with a steel wedge slightly larger than the slot driven into the bond at the bend sufficiently to enable the metal to be closed over it, thus preventing the wedge from backing out. The action of the wedge is to spread the soft copper over the edges of the hole in the rail, thereby accomplishing the same result as riveting, and also obtaining a perfect and permanent contact with the rail, un-

affected by any vibration. As shown in the cut the bond is inserted in the web of the rail, but where the fishplate will admit it the flange can be used. The work of bonding with



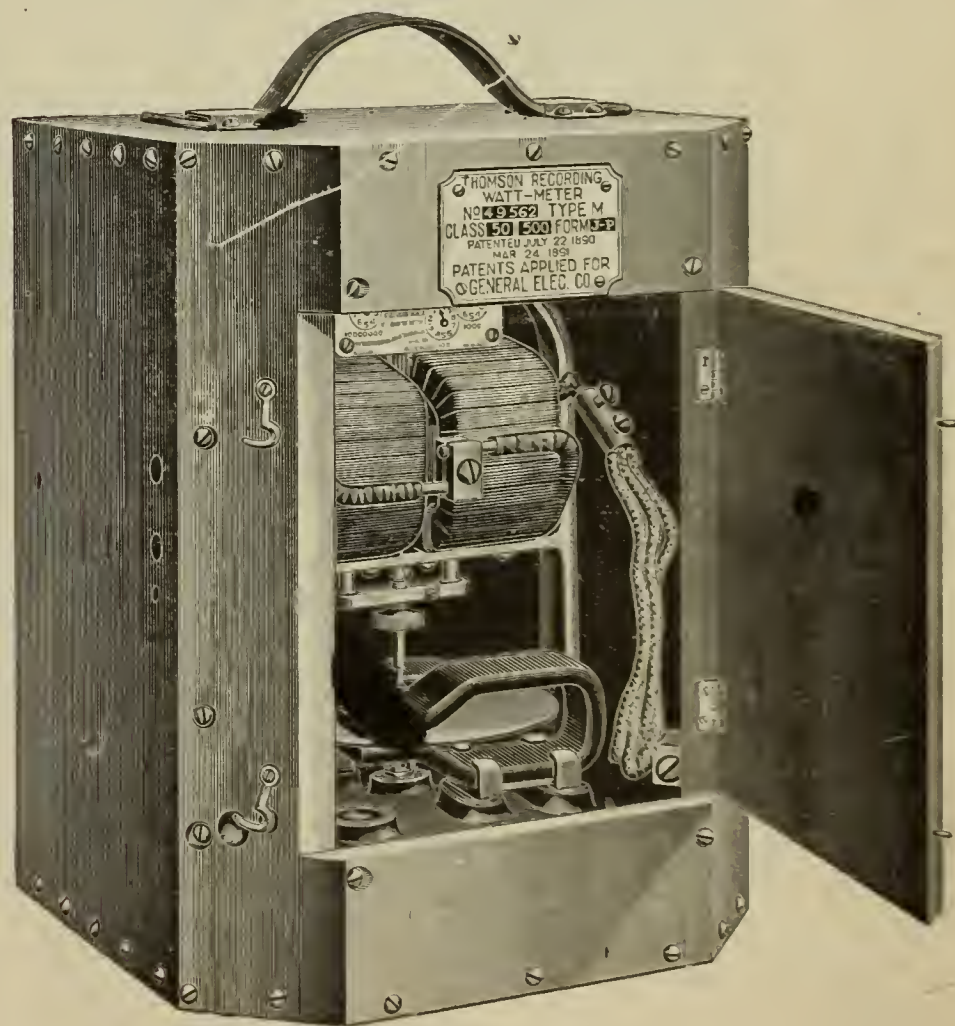
RAIL BOND.

the above device can be done very rapidly, and only a hammer and a cold chisel to open the slot at the bend in the bond are necessary.

Portable Recording Wattmeter.

The latest development in the electrical meter line is the new Thomson portable recording wattmeter, which, identical in general character with the standard meter of that type, is constructed with special provision for transportation from place to place, and for use where it is exposed to jarring and rough shaking. While it may, of course, be used for any and all classes of testing work in which a portable recording meter is requisite, its special use is for the testing of street car work, and in this field it will be found most valuable.

The meter is mounted on a skeleton frame suspended between strong elastic rubber nettings within the case. Detrimental shocks and vibrations become absorbed



PORTABLE WATTMETER.

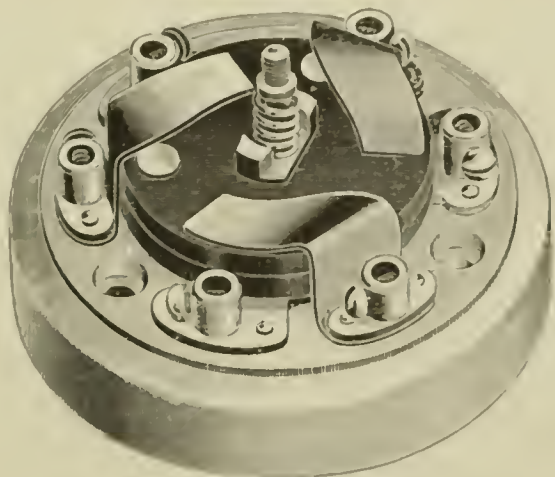
in these nettings, and no interference with the movement of the meter occurs. Its accuracy is unaffected even when placed on the floor of a rapidly moving car. The meter is mounted in a handsome polished wood case. The 25-ampere size will be found the most suitable for general car testing, as it will stand and accurately record extreme overloads for short intervals.

This meter is the result of long and careful experiment on the part of the General Electric Company. It should not be confounded with the rigidly mounted and bulky portable meters, formerly used for car testing in default of a superior device. This meter is the outcome of a demand from the

street car companies for a meter which would enable them to check the efficiency of every car equipment and the average number of horse power hours needed to take any car over any route of their systems. They are manufactured in the following sizes: Three amperes, 11-2 h. p.; 15 amperes, 7 1-2 h. p.; 25 amperes, 15 h. p.; 50 amperes, 30 h. p.; all for 500-volt circuits. They can also be made for any other voltage according to order.

Three-Circuit Switch.

The new Gibbs three-wire or three-circuit switch we illustrate is just being introduced on the market by the Perkins Electric Switch Manufacturing Company, of Hartford, Conn., and is especially designed to meet the requirements of underwriters' rules. The switch is positive in action, has a quick break and a double break on each circuit, and ample carrying capacity for the current it is rated to carry. The porcelain is of a high grade and non-absorbent and the mechanical con-



THREE-CIRCUIT SWITCH.

struction is of the best, in keeping with the excellent work heretofore done by this company in the direction of switches, sockets and similar useful devices for use in incandescent lighting. The general principles of this device were described in our issue of March 31. The present switch, however, combines all the advantages there referred to and is yet well adapted to three-wire service.

A New Arc Lamp.

A new type of arc lamp, the invention of Mr. William Jandus, is being placed on the market by the Manhattan General Construction Company, New York, for which a number of claims of superiority are made, including a great saving in trimming, simplicity of mechanism and the use of ordinary carbons for all purposes.

Fig. 1 shows the lamp complete and Figs. 2 and 3 illustrate the details. All of the mechanism and parts are concentric to the central stem, and the arc is inclosed by a globe, which is made air-tight at the top by an asbestos packing and at the bottom is closed by the yielding pan, *H*, and thus the consumption of carbons so reduced that the lamp illustrated will burn one week on half-night service without retrimming.

In Figs. 2 and 3 *A* is the magnet, *B* the armature carrying the clutch pan, *C*, and engaging, through suitable slots in the armature, the clutch rings, *D*, which have radial play within the slotted tube, *K*. In the upward travel of the armature *B*, the flaring pan, *C*, engages the clutch rings, *B*, against the inserted upper carbon, raising it to form the arc. *J* is a cast iron box containing brushes for conveying current to the upper carbons. *J*¹ is a sectional view of the box and *J*² shows the box with cover removed and carbon inserted, showing gravity contact of the brush rings against the carbon surface. *E* is the negative terminal casting, having an embossed cut-out seat, *P*. A cut-out ring, *N*, held out of contact with seat, *P*, by an insulated spring, *O*, is secured in the

negative terminal casting, *E*. The negative carbon frame, *F*, threads into the lower part of casting, *E*. The slotted tube, *K*, passes through the opening in casting, *E*, the brush box, *J*, being screw threaded to the end of slotted tube, *K*, and insulated from casting, *E*. *G* is the negative carbon clamp, suitably insulated from a dust pan, *H*, which has yielding contact against the lower opening in air tight globe. *L* is the upper carbon holder or sheath, removable with the carbon. *M* is a resistance path to cut-out ring, *N*. *M*¹ (part of same resistance coil) is a shunt on the main coil of magnet to regulate the length of arc.

The circuit through lamp is as follows: The current passes from the positive terminal through the main coil of magnet into the magnet, *A*, and slotted tube, *K*, to the brushes, *J*, and clutch rings, *D*, to the upper carbon, to the lower carbon and out through the negative terminal. It is provided with two paths, one through the main coil and carbons and the other through the resistance, *N*, to the spring, *O*, and cut-out ring, *N*, to the seat, *P*, of the casting, *E*, and



FIGS. 1 AND 2. ARC LAMP.

out through the negative terminal. An insulating washer separates the armature, *B*, from the cut-out ring, *N*, the contact between the ring, *N*, and seat, *P*, being effected by the weight of armature, *B*. The spring, *O*, allows the beveled ring, *N*, to seat itself adjustably on the embossed seat, *P*, insuring a sliding contact thereon.

The cut-out is only called into service in cases of obstruction to the prompt descent of the upper carbon, which is a

rare occurrence. In all other cases the cut-out is effected through the carbons themselves, after being consumed to the predetermined point.

To shorten the lamp the customary carbon rod has been dispensed with and a carbon sheath or holder feeding through the clutch rings with the bare carbon substituted, and though the diameter of the sheath is appreciably larger than the carbon carried, they both feed through the clutch rings without any variation in voltage. This is due to a cushioned clutch fed without the characteristic "jumps" of other lamps. If preferred, the carbon holder or sheath may be dispensed with and the carbon fed direct.

The lower carbon is secured in a socket fixed to the yielding pan. To trim the lamp the yielding pan is unscrewed, when the upper carbon follows down after the lower and is removed; to place new carbons in the lamp the upper carbon is simply shoved up into place on the point of the lower carbon through the brush rings into the slotted tube, when the pan is screwed on and the lamp is ready to burn. The clutch rings grasp the carbon radially at the upper part and the brush rings centre it at the lower, thus insuring a perfectly vertical feed and preventing wedging of carbons. The

the carbons are required to feed about one-fifth as often as an arc lamp burning in the open air, and are consequently that much more regular and steady in burning.

The main line circuit runs through a switch in the cap. To take down the lamp it is only necessary to give the lamp a quarter turn, when it drops out of the cap, leaving the circuit to pass uninterrupted. The wires enter the cap through inclined insulated openings, which exclude the weather.

Interior Telephones.

The Interior Telephone Company, 203 Broadway, New York, which controls the Colvin system, has provided telephonic arrangements and apparatus to meet the various requirements of interior service and also for long distance work. Their "System No. 1" provides for a cheap and efficient short private line service with battery call. By combining any efficient magnetic calling apparatus with the same wall instruments, a long distance set is made up, which is known as "System No. 5."

The "No. 2" system is designed for speaking tube service in offices, buildings, factories, etc., where a central office or

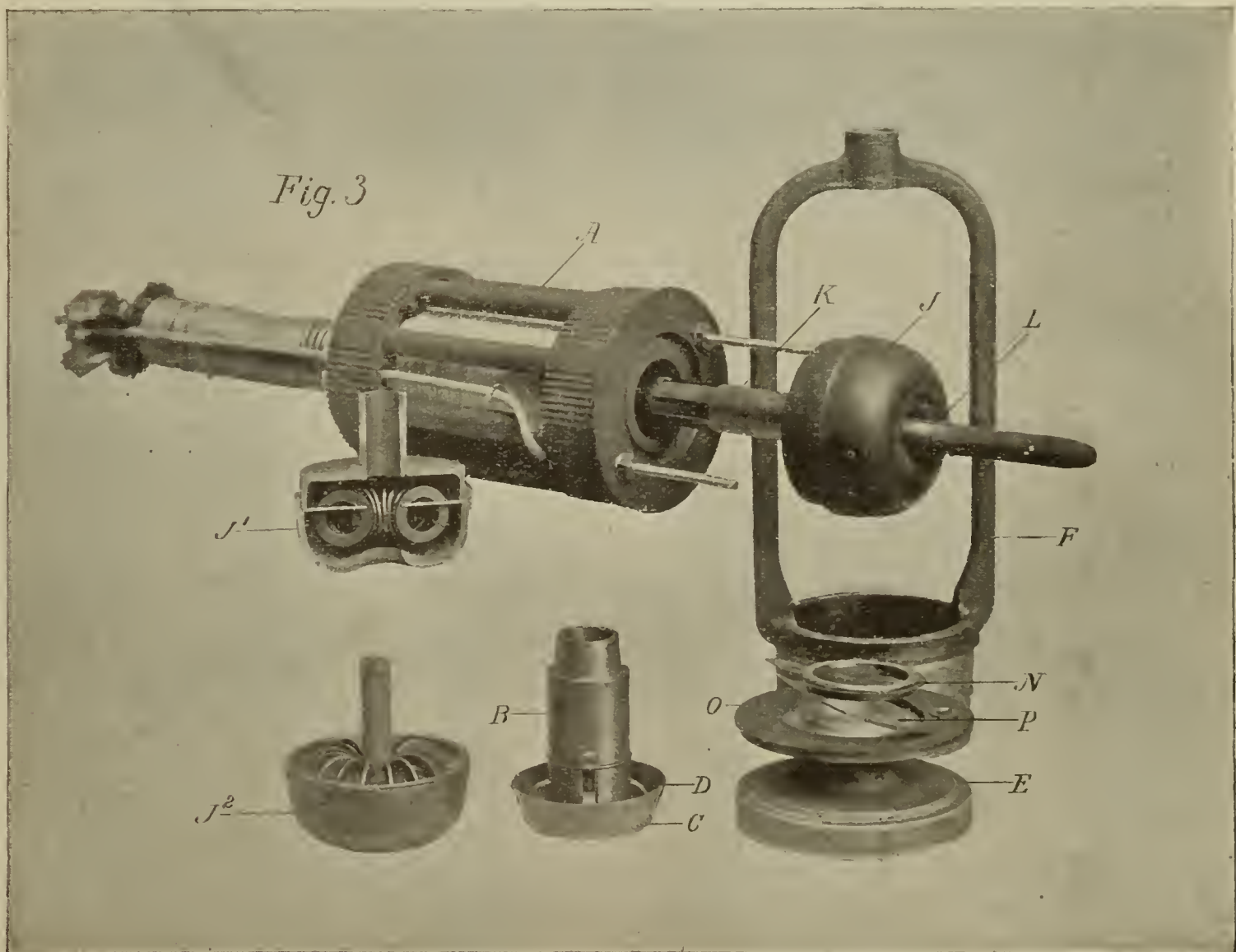


FIG. 3.—DETAILS OF ARC LAMP.

distance between the brush rings conveying current to the top carbon and the socket holding the lower is only about 8 inches, which is constant and therefore avoids variation in resistance. It will be noted that the space between the top of the globe and the mechanism has been done away with, which not only greatly reduces the length of the lamp, but makes it particularly susceptible to decoration.

It has been found that in this inclosed chamber it is possible to successfully burn a longer arc than in the open air, and, when desirable in series arc work, a 2,000-c. p. lamp can be run at about 75 volts and 6 amperes. As the 1-2-inch carbons are only consumed at about the rate of one inch in four hours, it will be seen that the lamp seldom feeds, so that aside from the feature of the sneak feed provided in this lamp

manager's desk wishes to call up and talk to any number of outer points in the factory, these points also to call up and talk to the office, but not to talk among themselves, except in rare cases where the manager permits them to do so.

System "No. 3" permits intercommunication between all the stations; each station can call up instantly and direct any other station, and all hands can be talking at once without interference. System "No. 4" gives the same service as does "No. 3," using wall sets instead of desk stands. These two systems can be combined. "System No. 6" provides for the use of any number of telephones along a single grounded outdoor line or a metallic circuit of any length. It is so arranged that the service is equally good with twenty instruments cut in on the line as with only three, or even two; it is

particularly appreciated by railroad companies where an immense amount of service can be gotten out of a single iron wire. This company also has a large demand for subscribers' instruments for exchange service. As no induction coil is used by the Colvin transmitter, no battery whatever

the generation of Foucault currents, the slots being cast and not milled. These pole pieces have slipped over them a compound coil of copper wire, which is composed of four layers of comparatively small wire connected in series with the exciting dynamo, and over these two layers of heavy wire,

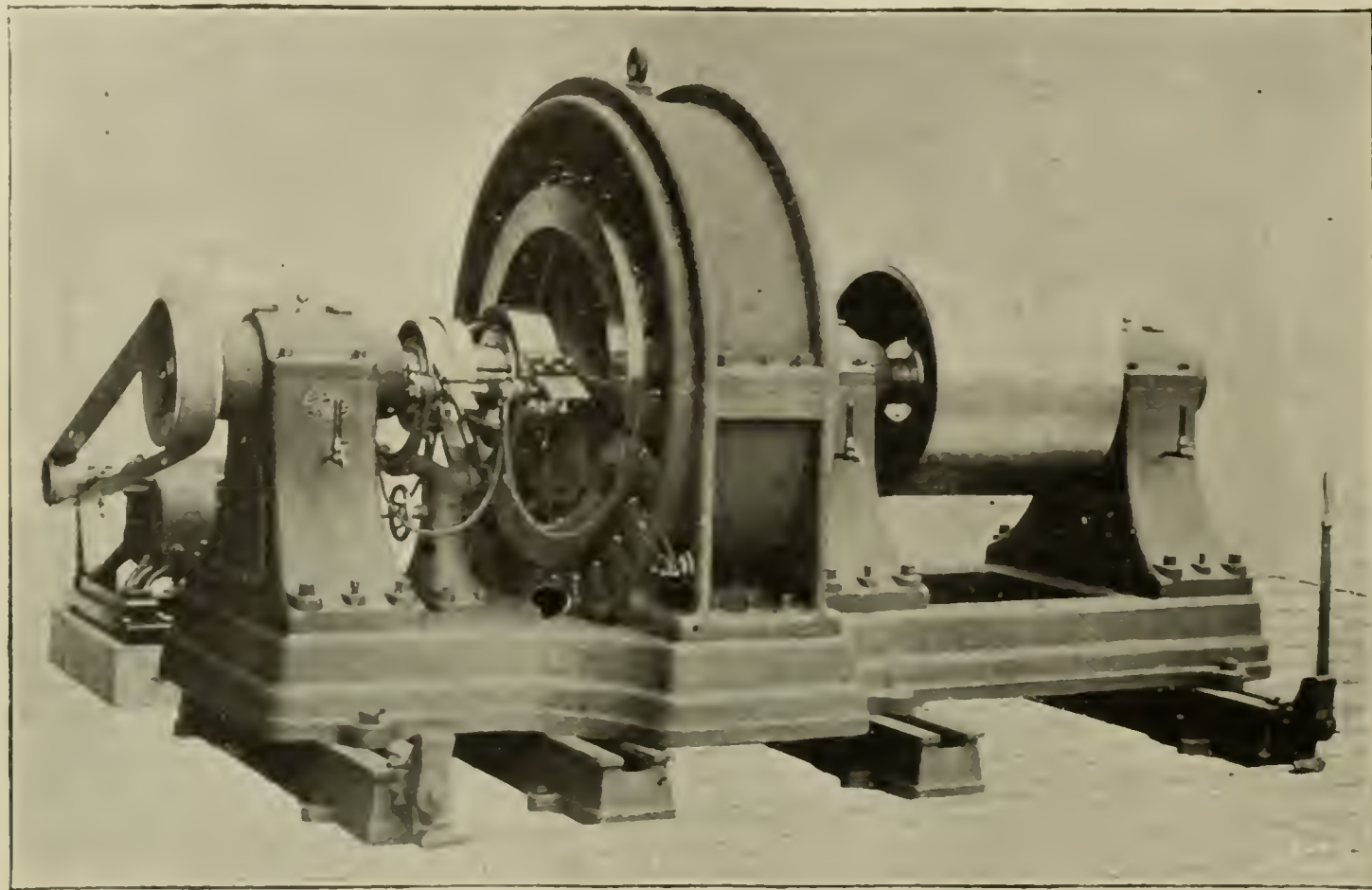


FIG. 1.—160-KW. WOOD ALTERNATOR.

is required at subscribers' stations. Such a system, if employed in New York City, where there are 10,000 subscribers, would dispense with the use of 30,000 cells of pri-

through which the rectified portion of the main circuit passes. By this method compensation or over compounding for any line loss is made good, automatically and instantaneously.

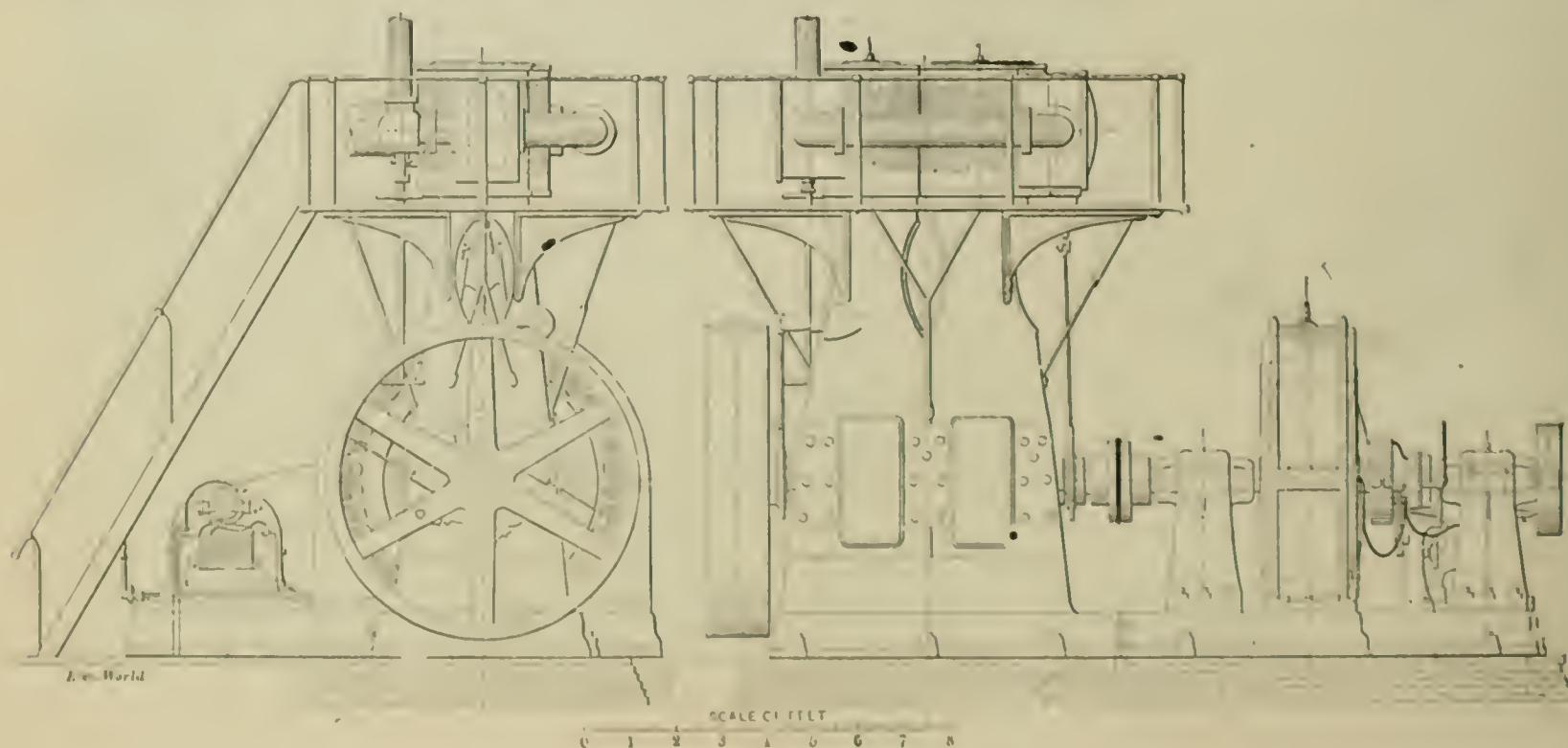


FIG. 2.—DIRECT-COUPLED WOOD ALTERNATOR AND BALL ENGINE.

mary batteries. The transmitter is said to have talked over 800 miles of No. 6 iron wire, using about 50 volts on the main line. It has worked over a 150-mile circuit, using only 8 volts.

New Wood Alternating Apparatus.

We illustrate herewith types of Wood alternating apparatus made by the Fort Wayne Electric Corporation. The alternating machines range in capacity from 37.5 to 300 kw., and we give a view, Fig. 1, of the 160-kw. Wood machine of this type. In the alternators the entire magnetic frame is cast, the pole pieces being slotted near their tips to prevent

The armature of this alternator is made up of C-shaped stampings; it is of the ironclad type, the teeth of which are wound with a very few turns of copper ribbon. The induction in the teeth is about 8,000 lines per square centimetre, and the length of the conductor on the armature is 3.6 inches per volt. The electrical efficiency of the machine is 95 per cent. The initial excitation is produced by a small exciter driven from a pulley on the end of the main armature shaft.

The converter complete, and also taken apart, showing its interior construction, is illustrated in Figs. 3 and 4. The coils, after being wound, insulated with mica and baked, are tested to 5,000 volts, alternating between primary and sec-

ondary. They are then stacked; that is, the iron core is inserted.

After the core is in place semi-cylindrical wooden pegs of maple, boiled in special compound, are driven in to set up the coil and keep the iron core in place. This method of clamping the iron core does away with the necessity of all bolts, screws or special clamping plates. After the stacking is finished, the coil is again subjected to the 5,000-volt test; if found in good condition it is put in the iron case, the line



FIG. 3.—WOOD CGNVERTER.

wires soldered to it, and the case hermetically sealed. The coils are again tested for contact between primary and secondary and then for contact between primary and secondary, and core and frame. They are then run 10 hours at full load at their normal potential.

In the new design of transformer Mr. Wood has made



FIG. 5.—WOOD DOUBLE-POLE PRIMARY FUSE BOX.

special provision for ventilation. As will be seen, the inside of the transformer case is provided with little offsets, against which the transformer core rests and which thus leave an air space between the core and casing. The bottom and top of the case are provided with openings, that at the top being covered by a weatherproof cap. Owing to this construction a continuous stream of air can pass through the transformer without leading to any deterioration of its insulation. It will also be noted that by this construction the case is made part of the magnetic circuit, and, far from seeking to insulate the core from the casing, the coil and the core both are held in place by the case bolts.

Attention has also been given to a small but important detail, that is, the handling of the converter on pole lines, side walls, etc. In the first place, the converter case is provided at the top with an eye bolt, by which it can be readily lifted to the desired point. That point being reached, as, for instance, the cross-arm of a pole, the converter can then be immediately lowered to its final position and its suspension maintained by two special swivel suspension hooks. Resting on these hooks the final securing with lag screws can be done at the convenience of the linemen. For temporary work the converter can be placed in position solely by means of these suspension hooks and be moved in the shortest



FIG. 4.—DETAILS OF WOOD CONVERTER.

possible time. The converters are also provided with feet so that they can be stood up on the floor when desirable.

The Wood double-pole primary fuse box, shown in Fig. 5, is designed with special reference to safety for the lineman, and ease in inspecting and replacing a burnt-out fuse. As will be seen, the fuses are mounted on the cover in porcelain block and in such a way that they can be readily slid out for renewal. The very act of opening the cover breaks the circuit on both sides of the line, so that there is no danger of shock from a possible ground.

The porcelain fuse blocks, as will be noted, are hollowed out at the middle point of the fuse, and the object of this

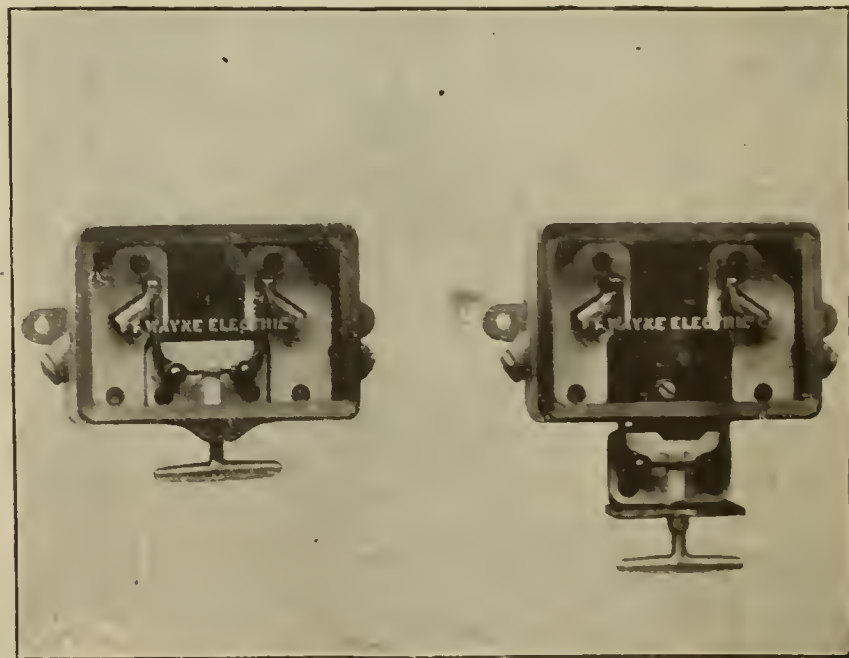


FIG. 6.—WOOD SINGLE-POLE PRIMARY FUSE BOX.

air chamber is to cause the fuse to blow at that point, owing to the porcelain keeping the fuse cooler in its contact at the ends on either side of the air chamber than in the free central part. By blowing at the centre the contact terminals are preserved intact.

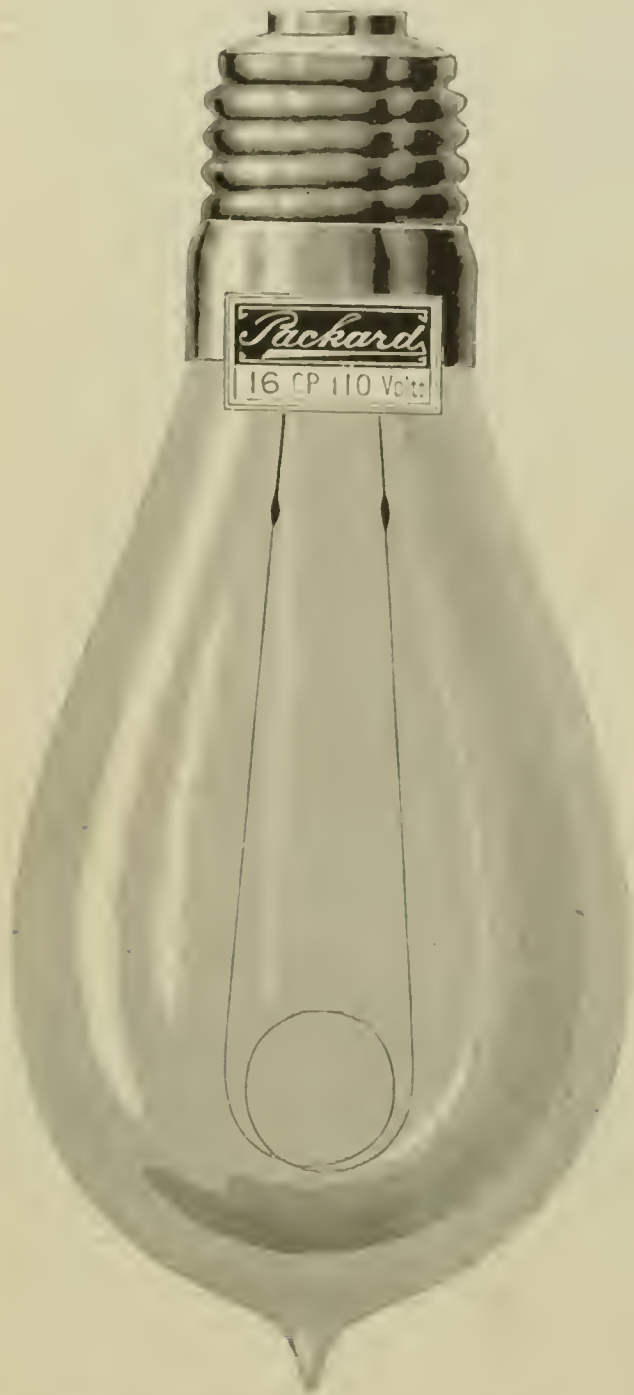
Special provision has also been made to secure good contact between the fuse and the line terminal, and this is accomplished by stiff springs placed under the clamping nuts in the switch box. It will also be noted that arcing across from one side of the line to the other is prevented by a rib in the box between the fuse blocks, which fits into a corresponding groove on the cover.

The Wood primary branch single-pole fuse box and the manner of withdrawing the fuse block for renewal are shown in Fig. 6, the contacts being made automatically.

The new Wood 160-kw. compound alternator and exciter, coupled to a 300-h. p. vertical cross-compound engine, built by the Ball Engine Company, of Erie, Pa., and running at 240 revolutions per minute, is shown in Fig. 2.

New Packard Lamp.

The latest departure in the Packard lamp line is the coiled filament Packard lamp, shown herewith. The cut is an exact representation of the lamp as to size, shape, etc., and shows the graceful outline and general symmetry of the lamp, which are among its features. The New York and Ohio Company, Warren, O., the manufacturers of the coiled



NEW INCANDESCENT LAMP.

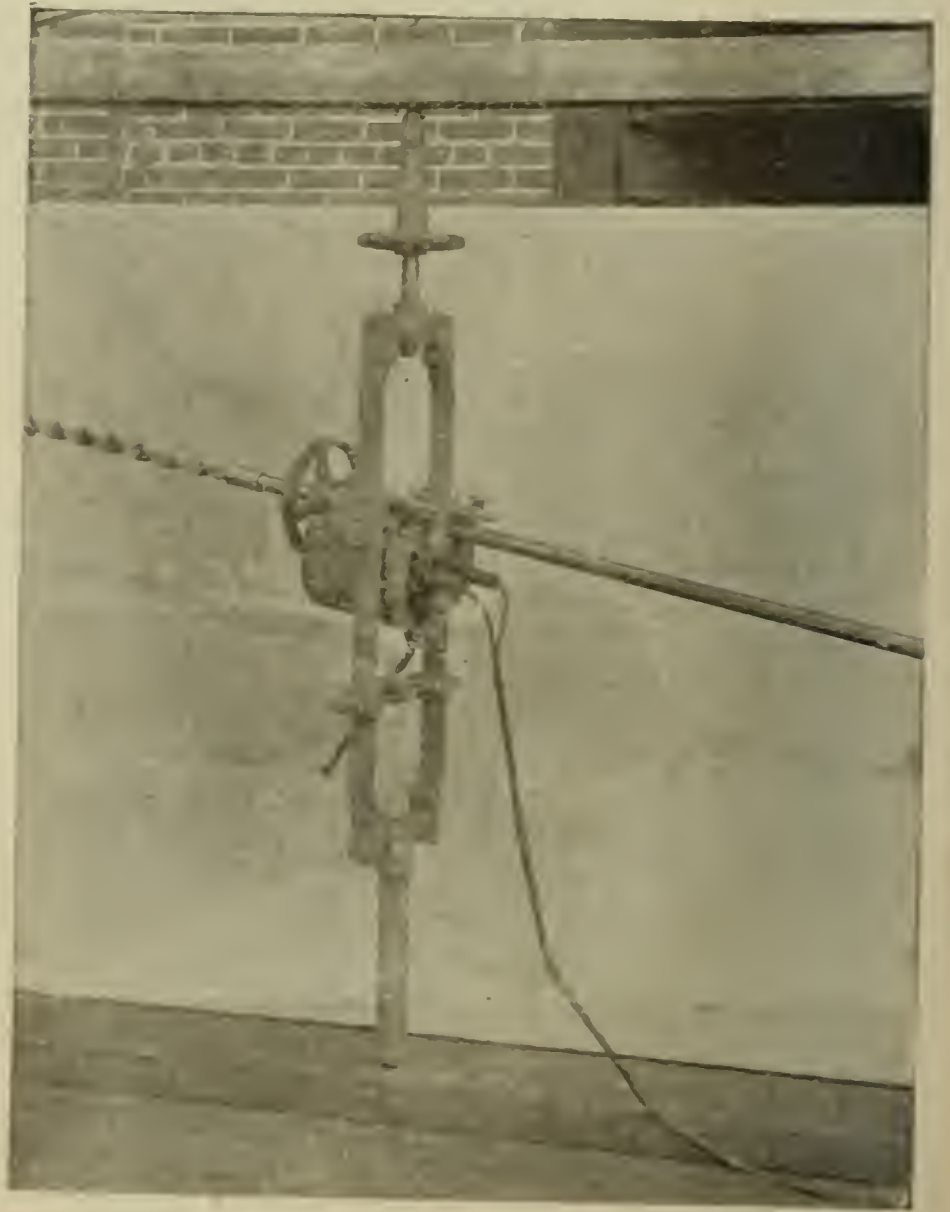
filament lamp, has moved slowly in bringing out a lamp of this kind, preferring to wait until it had fully satisfied itself that it was the more desirable lamp under certain conditions. When convinced of this fact, it proceeded to make a coiled filament lamp that would be in every way efficient and sightly. The lamps are particularly adapted to high voltages, and at present are furnished only in lamps of from 100 to 110 volts. The coil, in addition to concentrating the light, also prevents the filament from falling against the bulb and shortening the life of the lamp. Further than this it renders the filament more rigid and less likely to be affected by the jarring of the building or its support, and gives a longer life in buildings which are subject to vibration from the operation of machinery or other causes.

An Electric Power Drill.

An electric auger drill has been brought out by the Jeffrey Manufacturing Company, Columbus, O., whose experience with electric and other mining machinery insures that all the necessary points involved have secured careful attention in the design.

The drill complete for bituminous mines, including post for 6-foot mine, foot bar, adjusting clamps, girth, etc., weighs 160 pounds and is capable of developing from 4 to 5 h. p. at the auger. This power is rarely required, not more than 2 to 2 1/2 h. p. being, as a rule, used, but as the drill must be capable of doing a great variety of work, this machine was designed to take at times 7 to 8 h. p. without excessive strain or injury. It had been tested thoroughly under this heavy load and showed no signs of sparking or excessive heating.

The largest size drill, which looks practically the same as the one illustrated herewith, has a normal rating of 4 mechanical horse power. It has been tested in rock and sandstone up to 9 h. p. without undergoing any strain. This machine was designed with a special view to the requirements of anthracite mining, for trimming gangways, taking down roof and general rock work. The advantages of having a



ELECTRIC POWER DRILL.

machine of this class in an anthracite mine will be appreciated by the fact that this machine will drill a 2-inch hole 6 feet deep in the hard "boney" found in anthracite mines in from two to two and a half minutes' time, taking an average of 17 amperes at 220 volts. Drilling in the coal proper this machine will drill a 2-inch hole 6 feet deep in 50 seconds.

The motor, as will be seen from the illustration, is well protected by being enclosed in a steel casing on the sides and by a steel plate on the side facing the coal or material to be drilled. This plate is carefully fitted on the motor, so that it is practically impossible for pieces of dirt to get inside the frame and injure the armature or field coils. The rear end of the motor is covered by the switchboard. The armature is perfectly waterproof, drum wound, with slotted, lami-

nated discs. The commutator has a large number of segments, which reduces the tendency to spark; it has also large surface for brushing contact, insuring freedom from repairs. The motor has two spools, one on the top and one at the bottom, the top spool having about twice as many turns as the lower spool. This arrangement allows a much lighter machine to be constructed, and at the same time there is a well balanced field, which cannot be obtained where only one spool is used. The efficiency tests of these machines showed that the smaller size had 77 per cent. commercial efficiency and the larger size 80 per cent.

Armature Winding.

The depreciation and cost of repairs of electric light and power apparatus are a most important item, and it is essential therefore that great care should be taken in their construc-



FIG. 1.—ARMATURE WINDING.

tion. This is particularly true of the armatures of the machines. In the winding of drum armatures the coils are often put on in an unsystematic manner, with large quantities of canvas and paper, intended, oftentimes, to present a good appearance rather than provide for good insulation. In order to produce a drum armature that should be perfectly

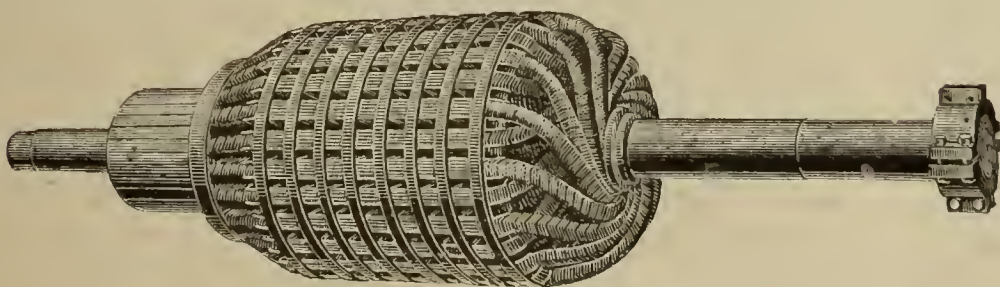


FIG. 2.—ARMATURE WINDING.

balanced mechanically and with plenty of ventilation, Mr. S. W. Rushmore, 126 Liberty street, New York, has designed the system of drum winding shown in the accompanying illustrations.

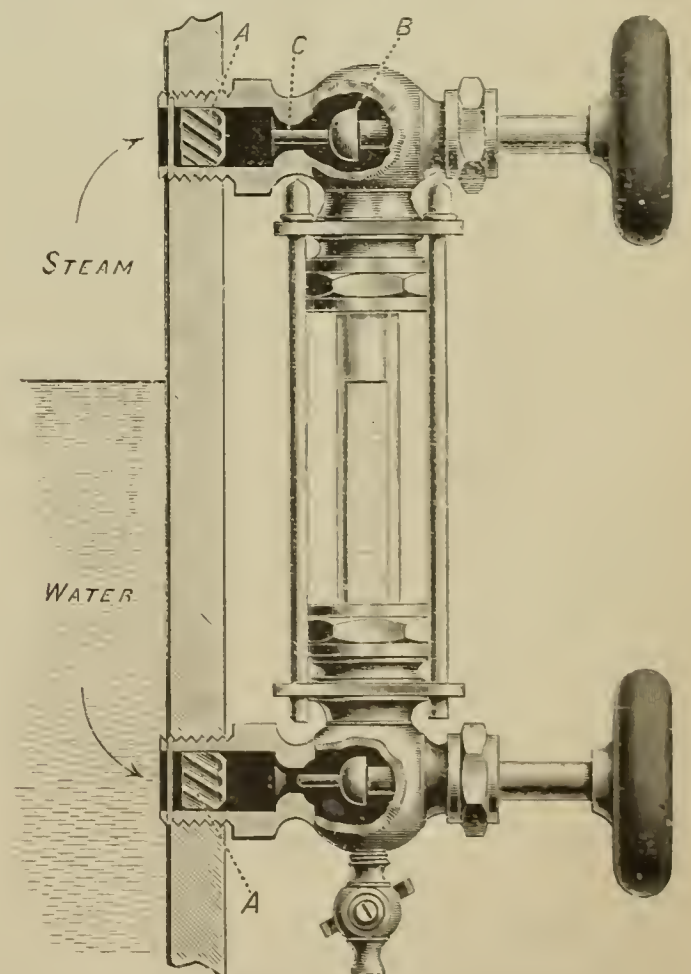
In this winding the coils are first all cut to the required length and are placed upon the armature in equal positions while standing vertically, and are shaped upon each other in such a way that they all cross the heads in a peculiar spiral

manner, so that every coil is of exactly the same shape and none of the wires cross, but gradually lap past each other.

It will be seen that the coils are practically independent on the heads and that they lay in such a manner that should the insulation become charred, there is no mechanical strain to produce a short circuit. It will be readily understood that with the coils exposed to the air at nearly all points, an armature wound on this system will carry a much larger current with safety and that having the coils exactly alike in shape and position on the core cannot but be an advantage, mechanically as well as electrically.

Automatic Water Gauge.

The accompanying illustration is a sectional view of a new automatic water gauge, manufactured by the Ashley Co-operative Engineering Company, 136 Liberty street, New York, which, in case the glass breaks, obviates danger from scalding or lowering the level of water, should this occur at night with banked fires. In the pipe leading to the glass gauge is a round plug or valve, *A*, having on its outer radius spiral wings or flanges. As long as the glass in the gauge remains whole the water on the lower end of the gauge is balanced at the water line by the steam in the upper part of the gauge. As soon, however, as the glass breaks from any cause the rush of steam and water to the atmosphere carries the sliding valve to the seat, as shown. Should sediment lodge in the pipes by the valve it can be immediately removed by partially closing the valve, *B*, which governs the entrance of water to the glass, and opening the pet cock at the bottom of the gauge; this allows the revolving valve to start for its seat, but the face of the valve coming against the pin, *C*, before it reaches the seat and the steam having a vent through the pet cock to the atmosphere, rapidly revolve the valve, thus cutting loose any sediment which may



AUTOMATIC WATER GAUGE.

have lodged there and blowing it through the gauge into the air. By adjusting the pin on the end of the outer valve so that the steam gets a vent through the valve seat and alternately opening and closing the outer valve the steam rapidly revolves the inner valve or rotating valve; and as it comes to its seat revolving it regrinds the valve seat each time the process is repeated and at the same time cleans the valve chamber completely from sediment.

Financial Intelligence.

The Electrical Stock Market.

New York, June 23, 1894.

THE ELECTRICAL STOCK MARKET has had few manifestations of activity during the week ending to-day, and its course has been unattended by any development of consequence to any one stock.

GENERAL ELECTRIC has been strong at various times on buying that was mainly for the bear account. The inability to depress prices even upon the many detrimental rumors attending the Fort Wayne Electric's connection, demonstrated to the bear traders the great strength inherent to the stock at the present moment, and they have hastened to get out with as little loss as possible of the trades on the down tack made when the Fort Wayne entanglement was first made public. Some items of gratifying interest to friends of the property were announced this week. The most important fact in connection with the General Electric Company that has made its appearance in recent days is the practically official promulgation that the General Electric Company has paid off its last outstanding note, amounting to some \$120,000, and, after thus liquidating the last of its floating debt, with the exception of indirect liabilities, amounting to less than \$300,000, of endorsements on its bills receivable, it had on hand \$600,000 cash, with collections reported improving every day. Then business is constantly getting better. Both the Lynn and Schenectady payrolls are getting larger, and some important contracts have been secured. The largest is to furnish the electrical equipment for the Metropolitan Elevated Railroad, of Chicago, which will be operated by the system so successfully experimented on on the Intra-mural Elevated Railway, exhibited at the World's Fair last summer. The successful employment of this system on the Chicago road has in it much of promise in the way of the extended introduction of the General Electric's transit patents. Then the company is arranging to do away with the expensive habit of owning controlling interests in subsidiary companies by their sale upon much the same plan as the Cleveland, Ohio, property was disposed of, where the bonds were sold to bankers with certain voting powers for a number of years, while the General Electric retains a controlling interest in the stock, which is temporarily disfranchised. A number of negotiations of this character are about ready to be announced. Construction work for the proprietary companies will, of course, continue to be done by the General Electric Company. The bears endeavored to make some capital out of the statements of a Boston capitalist, who issued the following as the results of some recent travels in the Northwest: "About the worst connection of the General Electric Company is the Northwest General Electric Company. In the boom towns on the Northern Pacific road and in the far Northwest, the Northwest General Electric Company constructed electric railroads, and it has now taken up entire plants, including the rails, and placed them on storage, as the roads did not earn their operating expenses." When it is remembered, however, that the entire holdings of Northwest stock were valued in the recent annual report at \$1, this kind of talk does not have much effect. The directors meet soon to elect a successor to General B. F. Peck, who resigned his position as treasurer this week, because he has been offered a better position; some say because "he is not in accord with the policy of removing the company's forces from this city to Schenectady."

WESTINGHOUSE ELECTRIC common stockholders do not, after all, it seems, receive a dividend at present. The directors have met and declared the regular dividend of 1½ per cent., payable July 2, on the preferred stock, but no mention was made of any distribution of profits among stockholders. The directors may meet again this week, but all hope of a common stock dividend at present has been dissipated. There has been no movement in the stock for weeks. It hangs quiet around 36½@37, and, if a dividend were seriously expected any more, it would long ago have discounted the matter by crossing 40. Some damage has been done by the recent floods to the new works near Pittsburgh, but the new factories, which are expected to enable the company to turn out electrical equipment far below ruling prices, are to be ready anyhow by the fall.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES' Trustees are fast retiring the issue of preferred stock. They purchased this week another lot of 512 shares at an average price of \$97.50, as against an average price of \$97.41 June 5 for 513 shares, \$96.09 for 624 shares on May 20, \$97.33 for 627 shares April 27, and \$97.54 April 2 for 2,054 shares, making a total of 10,980 shares of preferred stock purchased to date, and they have set aside another \$50,000 for similar purchases, thus showing the big profits they are reaping from last year's investment.

THE EDISON ELECTRIC ILLUMINATING companies have been busy this week declaring dividends. The New York company ordered a payment on Aug. 1 of a quarterly distribution of 1½ per cent. The Brooklyn company has declared a quarterly dividend of 1½ per cent., payable July 16, and the Philadelphia people make a similar payment of 2 per cent. on June 30. The stocks of all three companies rule very strong.

AMERICAN BELL TELEPHONE advanced a couple of points this week on the passage a week ago by the lower branch of the Massachusetts Legislature of the bill to increase the capital stock

to \$50,000,000, and the investment buying that has since set in has served to hold the stock firm at the higher quotations.

WESTERN UNION TELEGRAPH for the moment is neglected. Not that the dullness affects its quotation unfavorably, as the declaration last week of the regular quarterly dividend has more than ever disposed small investors in its favor. But just at present nothing is doing.

THE MEXICAN TELEGRAPH COMPANY has declared a dividend of 2½ per cent., payable July 7. There is a surplus for the quarter after paying the dividend of \$16,978, making the total surplus on hand \$388,298.

THE CENTRAL AND SOUTH AMERICAN TELEGRAPH COMPANY also declared a quarterly dividend of 1½ per cent., payable July 2. After paying this dividend there is left out of the quarter's earnings a surplus of \$20,562, making a total surplus of \$550,583.

ELECTRICAL STOCKS.

	Per.	Bid.	Ask.
Brush Ill. New York.....	50	10	30
Cleveland General Electric Co.....	100	80	90
Detroit Electrical Works.....	10	3	4
East River Electric Light Co.....	100	—	50
* Edison Electric Ill. New York.....	100	90	100
" " " Brooklyn.....	100	101	102
" " " Boston.....	100	116	118
" " " Chicago.....	100	135	145
" " " Philadelphia.....	100	128	130
Edison Electric Light of Europe.....	100	1	3
Edison Ore Mining.....	100	10	15
Electric Construction & Supply Co., com.....	15	15	17½
" " " " pref.....	15	15	17½
Fort Wayne Electric.....	100	1	2
General Electric.....	100	35	37½
Interior Conduit & Ins. Co.....	100	45	55
Mount Morris Electric.....	100	25	30
Westinghouse Consolidated, com.....	50	36	37
" " " " pref.....	50	52	53

BONDS.

Edison Electric Ill. New York.....	100	106	107
Edison Electric Light of Europe.....	100	75	85
General Electric Co., deb. 5's.....	100	86½	87½

TELEGRAPH AND TELEPHONE.

American Bell Telephone.....	100	198½	199
American District Telegraph.....	100	—	—
American Telegraph & Cable.....	100	88	89
Central & South American Telegraph.....	100	—	—
Commercial Cables.....	100	125	—
Gold & Stock Telegraph.....	100	—	—
* Mexican Telegraph.....	100	—	—
* Western Union Telegraph.....	100	82½	83½

* Ex. div.

New Incorporations.

THE BI-METALLIC ELECTRIC TRANSMISSION COMPANY, Plainfield, N. J., capital stock \$100,000, has been formed.

THE NASHVILLE TRACTION COMPANY, Nashville, Tenn., has been incorporated by Francis W. Hunter and others.

THE COLUMBIA MOTOR COMPANY, Chicago, Ill., capital stock \$1,000,000, has been incorporated by Walter E. Sparks and others.

THE DIAMOND ELECTRIC COMPANY, Peoria, Ill., capital stock \$60,000, has been incorporated by John H. Francis and others.

THE CITIZENS' ELECTRIC LIGHT AND POWER COMPANY, Norway, Mich., capital stock \$10,000, has been incorporated.

THE MUTUAL TELEPHONE COMPANY, Wichita, Kan., capital stock \$100,000, has been incorporated by Geo. W. Dixon and others.

THE BERKELEY ELECTRIC LIGHTING COMPANY, Berkeley, Cal., capital stock \$100,000, has been incorporated by Walter E. Sell and others.

THE NEW ORLEANS CONSTRUCTION COMPANY, New Orleans, La., capital stock \$50,000, has been incorporated to do electrical and other construction work.

THE DANVILLE TELEPHONE COMPANY, Danville, Va., capital stock \$20,000, has been incorporated by W. A. Taylor and others, and will establish a telephone system.

THE LOUISIANA AUXILIARY FIRE ALARM COMPANY, Limited, New Orleans, La., capital stock \$100,000, has been formed for the manufacture of electrical apparatus.

THE CITIZENS' ELECTRIC LIGHT AND POWER COMPANY, Pensacola, Fla., has been incorporated to erect an electric light and power plant. T. E. Welles is among those interested.

THE SOLAR ARC LAMP COMPANY, New York, capital stock \$25,000, has been incorporated by Jacob Rice and others, and will manufacture electrical appliances and machinery as well as arc lamps.

THE EAGLE GROVE ELECTRIC COMPANY, Eagle Grove, Iowa, capital stock \$30,000, has been formed to supply electric light, heat and power. A. T. Hess, J. A. Inuls and W. H. Carman, all of Des Moines, Iowa, are interested.

THE FREDERICKTOWN ELECTRIC AND MANUFACTURING COMPANY, Fredericktown, Mo., capital stock \$6,000, has been formed to erect an electric light and ice plant. Michael Deguire, H. Otto Thost, W. R. Nifons, all of Fredericktown, are interested.

THE MONTEREY POWER COMPANY, Monterey, Cal., capital stock \$100,000, has been formed to generate and furnish electric and

other power. The promoters are P. Oyer, O. S. Trimmer, Pacific Grove; H. A. Greene, J. S. Metteir and Juan Malarin, Monterey, Cal.

THE GORDON-BURNHAM BATTERY COMPANY, Portland, Me., capital stock \$1,000,000, has been incorporated to do a general electric light, heat and power business. W. G. Burnham, R. W. Gordon and C. L. T. Stedman, all of Boston, Mass., are the promoters.

THE DOBBS FERRY LIGHT, HEAT AND POWER COMPANY, Dobbs Ferry, N. Y., capital stock \$150,000, has been incorporated by Geo. C. Todd and others. This is a consolidation of the Irvington and Greenburg Gas Company and the Dobbs Ferry Lighting Company.

THE FLORIDA ENGINEERING AND CONSTRUCTION COMPANY OF CHICAGO, Chicago, Ill., capital stock \$150,000, has been formed to construct railway, telegraph and telephone lines, electric lighting and power plants, etc. Daniel E. Ryan, A. T. Otto and Morgan Cowan are the promoters.

THE GOLIAD WATER POWER COMPANY, Goliad, Tex., capital stock \$30,000, has been formed to supply that town with electric light, heat, water and ice. The interested parties are W. E. Campbell, I. P. Kibbe, G. W. Simmons, C. H. Baker, H. Linburg, F. R. Starr, Jr., Goliad, Tex.

THE TREMONT AND PINEGROVE ELECTRIC LIGHT, HEAT AND POWER COMPANY, Pinegrove, Pa., capital stock \$33,000, has been formed to supply light, heat and power by means of electricity. The promoters are J. E. Wernts, A. Gilbert, Pinegrove, and W. M. C. Hack, Tremont, Pa.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, New York, June 25, 1894.

NIKOLA TESLA has received from Columbia College the degree of LL. D.

HOUSTON & KENNELLY have been appointed electrical engineers to the Cataract Electric Company, of Buffalo.

MR. E. A. LOWE, the genial manager of J. Jones & Son, 67 Cortlandt street, is spending his honeymoon at present with his bride of a few days. Mr. Lowe has our best wishes for a long and happy career.

REV. AND MRS. CHARLES HENRY BUCK, of Brooklyn, have issued cards for the marriage of their daughter Sara to Dr. Albert C. Crehore, Assistant Professor of Physics, Dartmouth College, on Tuesday evening, July 10.

MR. O. FARSTAD, of the General Electric draughting force, at Schenectady, spent Saturday in this city. Mr. Farstad has for some time been closely identified with the power station appliances recently perfected by the General Electric Company.

LIEUT. MANNING K. EYRE, assistant to the selling manager of the General Electric Lamp Works, at Harrison, N. J., has started on a business trip through Ohio, Tennessee and Kentucky. Lieutenant Eyre, besides his business qualifications, is thoroughly conversant with the technical details connected with the manufacture and economical operation of incandescent lamps. Two articles by him on the latter subject, which appeared in our columns, were reprinted in several of the European technical journals, and as he has made this feature a subject of special study, his advice in regard to a point of increasing importance in central station economy will be found useful by station managers whom he may visit.

NEW YORK ELECTRIC CLUB.—About 30 gentlemen connected with the electrical industries met at dinner on Thursday evening of last week in a private dining room of the Imperial Hotel to discuss the question of reviving in some form the New York Electric Club. Mr. H. Ward Leonard presided, and Mr. T. C. Martin acted as toastmaster. The subjects of toasts extended beyond the objects of the meeting, and the happy responses assisted in rendering the occasion a very enjoyable one. Among those who enlivened the evening with remarks besides the two just named were Major D. T. Everts and Messrs. R. T. Lozier, C. D. Shain, S. L. Coles, C. O. Baker, H. L. Webb, P. H. Alexander and B. E. Greene. The desirability of re-establishing the Electric Club, but in a somewhat different shape from what it was originally, was generally acquiesced in, and a committee to devise ways and means to accomplish that object was appointed, consisting of Messrs. Bartlett, Shain, Alexander, Porter, Webb, Everts and Baker. Among others in attendance besides those mentioned were, E. G. Bernard, W. J. Cook, F. R. Chinnock, George Cutter, W. J. Johnston, L. H. Orr, T. C. Perkins, E. F. Peek, H. N. Powers, F. W. Royce, H. H. Reece, P. Rosenstamm, H. J. Smith, C. E. Carpenter and C. E. Chapin. A number of others subscribed to the dinner, but were prevented from being present.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., June 23, 1894.

THE PHILLIPS INSULATED WIRE COMPANY, of Pawtucket, R. I., is kept busy running day and away into the night in its en-

deavors to keep up with orders for its "Ideal" insulated copper wire and other manufactures.

MR. A. A. KNUDSON, of the New York office of the Phillips Insulated Wire Company, of Pawtucket, R. I., was in Boston this week. His visit was in connection with some special and quite large orders for "Ideal" wire, and while he did not say that he was victorious, he looked it.

THE BOSTON INCANDESCENT LAMP COMPANY, will continue to manufacture series lamps with rod-like burners, which it claims do not infringe. Mr. H. L. Merritt, selling agent for the company sailed for Europe on the 23 inst. for the purpose of disposing of the English, French, German and Belgium patents held by the company.

THE EASTERN ELECTRIC CABLE COMPANY, of Boston, announces its regular semi-annual dividend of 3 per cent. on its preferred stock, payable July 2, to stockholders of record June 25. Good articles always lead to good business, good business to dividends, and this is the tribute that may be justly awarded this company and its manufactures.

THE AMERICAN TOOL AND MACHINE COMPANY, 84 Kingston street, Boston, is very busy at the present time, its offices presenting unusual activity. President Huxley and Superintendent Hoffman believe in energetic and effective work, and it is needless to say that Messrs. Barker, Whipple and Lincoln, old officials of the company, are seconding them most heartily. There appears to be a general unanimity all around, which must produce only one result—brilliant success for this old veteran corporation.

THOMAS SMITH & CO., 14 Cypress street, Worcester, have recently added to their equipment a complete line of punches and dies for dynamos and motor armature discs, and are now ready to furnish discs of any desired thickness in diameters from 1 to 12 inches. But few concerns, aside from dynamo manufacturers, have previously been equipped to turn out armature discs in a proper manner, and it will, no doubt, be a considerable convenience to many makers of dynamos to be able to obtain finished discs of any desired dimensions at short notice.

MESSRS. HUXLEY & HOFFMAN, the former agents of the Buckeye engine, have transferred their business to Mr. W. D. Hoffman, formerly of the Standard Oil Company, who will represent the Buckeye engine for the New England district. Mr. Hoffman has had lengthy experience with the Buckeye, extending over the period during which it was built at Hartford, Conn., and will make his headquarters at 84 Kingston street. Several satisfactory contracts have already been secured, and a number of others are now being estimated upon. The agency has at its office a complete working model of the engine, showing the valves and cylinder in section, and thus enabling parties to secure a perfect idea of the many advantages the Buckeye contains for all classes of power plants.

MR. CLINTON IRVING HAGUE, of the New Haven Insulated Wire Company, was accidentally drowned at Whitney Lake, near New Haven, on Saturday, the 16th. Mr. Hague was exactly 33 years old, and was well known by a large circle connected with electrical industries. Any one who has had business relations with him will testify to his upright character and his electrical and mechanical attainments, and the many friends who had the pleasure of an intimate acquaintance with him will grieve over the untimely end of a gentleman whose endearing qualities were of the highest order. His death is deplored by many New Haven local organizations, including the New Haven Yacht Club, the New Haven Naval Reserve and other social clubs in which he was prominent.

THE PERKINS ELECTRIC SWITCH MANUFACTURING COMPANY, of Hartford, Conn., with its usual promptness to meet the demands and requirements of the public and the underwriters, has designed a triple break switch, which it submits as being excelled by none, if, indeed, it is equalled by any. The well known lamp made by this company—the Waterhouse-Gambie arc lamp, for incandescent circuits, is rapidly finding its way to public favor. Among the recent installations, the Union station plant, in Boston, is important. In that case notably the pure merits of the lamp and its economy of operation led to its selection and adoption from out of a number of other and well known lamps. The constancy and regularity of the lamp are great points entitling it to consideration.

Pittsburgh Notes.

PITTSBURGH, June 23, 1894.

THE PITTSBURGH AND MANSFIELD RAILROAD COMPANY has been granted the right by the War Department in Washington to build a bridge across the Monongahela at Pittsburgh.

THE CORAOPOLIS ELECTRIC LIGHT COMPANY was chartered a few days ago with a capitalization of \$5,000. Directors, W. H. Guy, George A. Lashell, H. W. Burns, A. Rose and Chas. A. Cooper, of Pittsburgh.

THE ANNUAL COMMENCEMENT exercises of the Keystone Electrical College were held last night at Carnegie Hall, Allegheny City. Mr. Leon Le Pontois, of the Westinghouse company, lectured on the subject, "What May be Accomplished by Electricity Ten Years Hence."

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY has contracted with the East Pittsburgh Improvement

Company for 23 additional acres of land at Brinton, Pa., which makes 40 acres in all, to be used for the new electric plant. The machine shop is now under roof, and it is expected to begin the installation of machinery early in August.

THE EMPLOYEES of the Westinghouse Electric and Manufacturing Company held their annual picnic last Saturday at Aliquippa Grove, near Pittsburgh. The outing was a very enjoyable one. A very large crowd was in attendance, and all the popular outdoor sports were indulged in. A baseball game between the "office nine" and the "shop nine" was especially interesting.

THE MONONGAHELA AND ALLEGHENY RAILROAD COMPANY has obtained a charter. The capital is \$60,000. It will be about six miles long, and is intended as a connecting link between the Baltimore & Ohio Railroad and the Allegheny Valley Railroad. The directors are G. T. Richards, James Doig, L. H. Partridge, James Duncan, Jr., Wm. Smith, C. H. Sackrider and R. S. Fraser, all of Pittsburgh.

Canadian Notes.

OTTAWA, Ont., June 16, 1894.

TORONTO. The Toronto Street Railway Company may probably extend its route to Oakville.

THE CANADIAN MINISTER OF INLAND REVENUE has recently introduced a bill in the Dominion Parliament respecting units of electrical measure, which is similar to the one before the United States Congress.

MONTREAL.—The directors of the Bell Telephone Company, acting upon the power conferred upon them by the shareholders at the last annual meeting, have decided to increase the capital of the company from \$2,640,000 to \$3,168,000.

HAMILTON, ONT. On application of Dr. Bingham, on behalf of a Hamilton syndicate interested in a new street railway system, a meeting of the Board of Works has been called. The syndicate will ask permission to lay a piece of track on Herkimer street, near Locke street, the street railway company having agreed to furnish power to make a test. If the invention proves successful, it will do away with the necessity of trolley wires, a third rail being used for the transmission of electricity.

News of the Week.

Telegraph and Telephone.

OCALA, FLA. Address the mayor concerning the company organizing to build and operate a telephone line.

MIDDLEBROOK, VA.—The Middlebrook Telephone Company, Middlebrook, Va., wants to purchase a complete telephone equipment.

DANVILLE, VA.—W. A. Taylor, Danville, Va., promoter of the Danville Telephone Company, is open for bids for a complete telephone system.

CHESTER, S. C.—The Chester Telephone Company, Chester, S. C., wants to purchase a telephone equipment. Address A. W. Love, manager.

GREENSBURG, PA.—An independent telephone company, having for a circuit Greensburg, Mt. Pleasant, Irwin, Scottdale, Connelville and Latrobe, has been organized.

BOSTON, MASS.—The Massachusetts House has passed, to be engrossed, the bill permitting the American Bell Telephone Company to increase its capital stock to \$50,000,000.

LEXINGTON, VA.—A company has been organized to erect a telephone line between Staunton and Middlebrook. J. H. Bowman is president. This company will probably, in the future, extend its line to Greenville, Moffett's Creek and Lexington.

Electric Light and Power.

ODESBOLT, LA.—The city has decided to put in an electric light plant.

MORRISVILLE, N. Y.—Morrisville is to have the electric light. The wires are being put up.

CUBA VILLAGE, N. Y.—Address the town clerk concerning a proposed electric light plant.

NORWOOD, N. Y., has closed a contract for an electric light plant to be run by water power.

KEOKUK, IOWA.—J. C. Hubinger contemplates erecting a commodious addition to his power plant.

VICKSBURG, MISS.—The Vicksburg Electric Transit and Light Company will erect an electric light plant.

SCOTLAND NECK, N. C.—S. F. Dunn and Geo. W. Coughenour intend to put in an electric light plant.

BALTIMORE, MD.—Address Hon. F. J. Latrobe, mayor, concerning an electric lighting contract for five years.

PARIS, TENN.—A \$40,000 electric light plant is contemplated, and the city clerk may be addressed in relation to it.

OTSEGO, MICH.—A proposition will soon be submitted to the citizens for the establishment of an electric light plant.

SPRINGFIELD, MASS.—Address the city clerk concerning the contemplated erection of an \$80,000 electric light plant.

CHATEAUGAY, N. Y., is to have a water power electric light plant, and ground has already been broken for the same.

WESTMINSTER, MD.—The Carroll Electric Light and Power Company, Westminster, Md., wants a 750-light dynamo.

BAY CITY, MICH.—The City Council proposes to enlarge the city electric light plant. It is proposed to expend \$12,000 in improvements.

ATLANTA, GA.—The Atlanta Waterworks has installed a 150-light Kester incandescent machine, and a 35-light standard arc machine.

ALEXANDRIA, LA.—The clerk to City Council, Alexandria, La., has been instructed to advertise for bids on lighting the city by electricity.

BESSEMER, ALA.—The Howard-Harrison Iron Works will improve and enlarge its iron works, and substitute electricity for steam power.

COLUMBUS, OHIO.—The city clerk has been authorized to secure estimates as to the cost of putting electric fans in the Council chamber.

WINONA, MINN.—The Winona General Company will extend its line and make improvements in the electrical machinery. Andrew H. Hill is manager.

BATH, N. Y.—The Hornellsville Common Council has granted a franchise to the Canisteo Electric and Fuel Gas Company to lay pipes in the streets of that city.

BLOOMFIELD, NEB.—Horace McGregor, of Yankton, has been granted a franchise by the village of Bloomfield for an electric light plant, which he agrees to have in running order within 60 days.

MARSHALL, MINN.—An election has been called for July 3, to vote on village bonds of \$25,000, to put in waterworks and electric lights. It will, without doubt, carry, and work will be done this summer.

JOLIET, ILL.—Mayor Stassen recommends that the committee on street lighting be instructed to advertise for sealed proposals for an electric light plant of 300 lights of 2,000-c. p. each, and report on Monday, July 2.

WHITE RIVER JUNCTION, VT.—The Mascoma Electric Light and Gas Company intends to make extensive improvements this summer, and will be in the market for an engine, boiler, alternator, line shafting, coupling, etc.

KNOXVILLE, LA.—The plant of the Knoxville Electric Light and Power Company has been damaged by fire. The building is destroyed, one dynamo ruined and much of the other machinery rendered worthless. Loss, \$5,000; insurance \$2,000.

READING, PA.—The contract for the reconstruction of the wires of the fire alarm system has been awarded to the Reading Electrical Construction Company. The contract includes 22 miles of hard-drawn copper wire and 7 miles of insulated wire.

KANSAS CITY, MO.—The business building occupied by Bernheimer Bros. & Co. will be enlarged and improved. An electric light plant will be established, and the entire building throughout will be lighted with a system of some 1,600 incandescent lamps. Geo. Schafer, Westport, Mo., is the owner.

CHICAGO, ILL.—Sealed proposals will be received by the city of Chicago until July 2 for furnishing and delivering to the city boulevard lamps, and to place the same in position upon the lamp posts along such streets and thoroughfares as ordered by the City Council. H. J. Jones is commissioner of public works.

PHILADELPHIA, PA.—The electrical committee of City Councils has granted privileges to maintain underground conduit systems and do business in the Mutual Automatic, the Central, the Drawbaugh and the Bell Telephone companies, all of which are required to place telephones free in public offices and in each school section.

KEARNY, N. J.—Sealed proposals will be received by the Board of Township Committee of the township of Kearny, Hudson County, N. J., for lighting the streets of said township for a term of five years, with electric arc lights. Bidders will estimate separately on lights of 1,200 and 2,000 c. p. There will be from 80 to 100 lights required. Gabriel B. Reld is township clerk.

NEW WHATCOM, WASH.—Sealed proposals will be received at the office of the city clerk, at the city hall of New Whatcom, Wash., for furnishing 50 lights or more, at the discretion of the City Council, for a period of three years or longer, as the Council may elect at the time of letting contract, the term to commence Oct. 17, 1894. The lights are to be of 2,000 c. p. J. K. Appleby is city clerk.

SIoux CITY IOWA.—The city's contract with the Sioux City Electric Company expires in August, and the light committee is of the opinion that a much better contract ought to be made. The Council is considering the question of municipal lighting. Alderman Chesley, chairman of the committee, reports that a plant could be put in for \$75,000.

DENVER, COL.—The County Board received the report of the committee to consider the matter of putting electric plants in the various county buildings, recommending the placing of a dynamo of 130 16-c. p. in the court house, at a cost of \$1,075, and a 60-h. p. engine to cost the same amount. For the jail they recommended

a 270 16-c. p. dynamo, to cost \$896. The first is a standard dynamo and the latter an Edison.

MILLERSVILLE, PA.—Sealed proposals will be received for an electric light plant by the board of trustees of the First Pennsylvania State Normal School, Millersville, Pa., until 3 P. M., July 16, 1894. Specifications and drawings will be delivered to bidders between the hours of 9 A. M. and 3 P. M. on and after June 25, 1894. Security will be required before specifications and drawings are delivered. For particulars address Dr. W. A. Drysdale, consulting engineer, Hale Building, Philadelphia.

The Electric Railway.

CRISFIELD, MD.—A company is being formed to build an electric railway.

CRISFIELD, MD.—Address the mayor concerning the proposed electrical railroad.

JACKSON, TENN.—The Jackson and Suburban Street Railroad Company will erect a new electric plant.

ALVIN, TEX.—Address W. A. Rowan concerning the construction of an electrical railroad to Velasco.

CHERRY CREEK, N. Y.—An electric railway between Randolph and East Randolph is being again talked of.

TAMPA, FLA.—J. Rush Ritter, of Philadelphia, Pa., has purchased the Tampa Electric Railroad for \$70,055.

BALTIMORE, MD.—The City Passenger Railway Company will soon commence extending its road to Clifton.

ALPENA, MICH.—The City Council has granted a 30-year franchise for operating an electric railway to Andrew L. Comstock.

NEW ORLEANS, LA.—The St. Charles Street Railway Company will change its motive power to electricity, and has applied for a franchise.

PAINESVILLE, OHIO.—The Painesville, Fairport and Richmond Street Railway Company has increased its capital stock from \$50,000 to \$150,000.

WHITE PLAINS, N. Y.—A franchise has been granted to the White Plains, New York and Mamaroneck Railroad for a trolley road from White Plains to the Sound.

ATLANTIC CITY, N. J.—Mr. E. C. Woodward is interesting capitalists in an electric railway to run to New York on the same plans as the Chicago and St. Louis electric line.

BALTIMORE, MD.—A new electric road company is being formed to build a line from Chevy Chase to Kensington, Md. It is suggested that the line be extended to Sandy Springs, Md.

LITITZ, PA.—Work on the proposed electric railway from Lancaster to Lititz will begin before July 1, and will be completed in September. The road will eventually be extended to Manheim.

LORAIN, OHIO.—The Lorain Street Railway Company has been reorganized with a capital stock of \$50,000. Thos. L. Johnson, A. J. Moxham, Max M. Suppes, F. B. Vernam and W. F. Bien are interested.

LANSFORD, PA.—The borough Council of Lansford has passed a resolution giving to the Inter-county Street Railway Company a franchise to erect, construct and maintain an electric road through that borough.

NEW BRUNSWICK, N. J.—A petition is now pending before the Raritan township committee of Middlesex County, N. J., from the New Jersey Traction Company, asking for the privilege of passing through the township.

SHENANDOAH, PA.—There is considerable discussion in regard to an electric line between Shenandoah and Ringtown. Surveys have been made, and at a meeting of citizens in the latter town \$10,000 was pledged to give the movement a start.

BALTIMORE, MD.—The Baltimore City Passenger Railway Company has received a permit to construct and maintain and operate in perpetuity a double-track electric railway from North avenue, in the city of Baltimore, to Laurelville.

TOLEDO, OHIO.—Hon. Parks Foster, of Elyria, Ohio, is at the head of a local syndicate which has practically completed all arrangements for an electric line between this city and Maumee and Perrysburg, which will be in operation between July 15 and Aug. 1.

HARRISBURG, PA.—A charter was granted on June 20 to the Ambler Electric Railway Company, of Montgomery County. The line covers the principal streets of Ambler, and its entire length is two miles. Capital \$12,000. The incorporators are James W. Shepp, Daniel B. Shepp and Edgar A. Murphy.

ELWOOD, IND.—The Elwood Electric Street Railway Company will at once issue bonds to the amount of \$50,000 and place the same with Chicago capitalists. The money will be used to extend the lines to connect the city with all the factories, and put on new cars; also to build a line to Franklin, a distance of five miles.

DETROIT, MICH.—The Detroit Suburban Street Railway Company will build an electric street railway three miles in length, with double tracks, using girder grooved rails and paving between tracks with brick. Estimated cost \$70,000. Address J. D. Hawkes, general manager, 12 Woodward avenue, Detroit, Mich.

HARRISBURG, PA.—The city will soon be connected with Carlisle by an electric railway. On June 7, at a meeting of the stockholders of the Electric Railway Company of Harrisburg and Me-

chanicsburg, at the board of trade rooms, negotiations for the sale of its franchises to the Cumberland Valley Traction Company were closed, and the transfer was made. The gentlemen interested are: President E. Z. Wallower, Hon. B. F. Myers, H. C. Ross, H. B. Mitchell and Nandain Hamilton, of the Harrisburg and Mechanicsburg company, and S. R. Ickes, president, and O. A. Ormsby, of the Cumberland Valley Traction Company.

Miscellaneous Notes.

HERBERT LAWS WEBB has an interesting and well illustrated article in the June number of the "New England Magazine" on "The Telephone of To-day."

ELECTRIC QUACKS.—The latest developments in the prosecution of electric quacks in England is that these gentlemen have turned on their persecutors, and are now bringing actions against various people for malicious prosecution, claiming damages for the injury done to their valuable characters.

THE TELEGRAPH IN INDIA.—A "weather and famine" code has recently been prepared by a registrar in the Indian Revenue and Agricultural Department, and some weeks ago a special line was run to the site of an obstruction which, blocking up a river, is in some danger of giving way and flooding the adjacent country. As soon as this natural dam shows sign of collapse, it is proposed to warn the threatened villagers by wire.

THE COMMISSION OF THE UNIVERSAL EXPOSITION OF PARIS FOR 1900 has adopted a general classification of exhibits, which are divided into 17 groups. Group 5 is devoted to electricity, and comprises five classes; class 23 is for apparatus for the production and utilization of electricity, class 24 for electric railways, class 25 for electric lighting, class 26 for telegraphy and telephony, and class 27 for miscellaneous applications of electricity.

NEW ELECTRICAL DEFINITIONS.—The Scranton "Republican," in a report of a trial for damages from an electric shock, gives the following as part of the testimony by experts: "'Ohm' is the term used to show the resistance. 'Ampere' is the term used to describe a volt; a voltage of 1,500 would be styled an amperage of 10. A voltage of 6,000 would be required to propel an ampere three-quarters of an inch in length through a horse into a man under those conditions."

THE ASSASSINATION OF PRESIDENT CARNOT.—While The Electrical World has never been an advocate of electrocution, to the assassin of President Carnot, and to the whole body of Anarchists whose principles lead to such a frightful crime, it would mete out the most acute punishment that electricity could be made capable of producing. The terrible suffering of the criminals first electrocuted in New York ought to be a bagatelle to what these greater criminals should be made to undergo, and the inventor who discovers some electrical method of excruciating torture for such monsters will find in us an advocate for its use.

ANew DISCOVERY.—"Electric Power--New Discovery of Vast Economic Importance—The Earth as a Gigantic Electric Storage Battery—An Investigation Which May Revolutionize Old and Expensive Methods of Generating Power." Under the above headlines the San Francisco "Post," after a half column of similar "fireworks," gives the following description of the wonderful discovery, which by the way, has interested several local capitalists: "In the ground generator, they simply insert zincs and carbon directly in the ground without any containing vessel or cell, and saturated with a very weak solution of acids. Then when the power of the generator begins to run down, all that is required to restore full electro force is to add another supply of the fluid. By this means the carbons are depolarized without removing them from the ground, consequently the generator can be run day and night until the zincs are worn out."

THE NEW YORK ELECTRICAL SOCIETY closed a successful season on Tuesday, the 19th inst., by an inspection of the new quarters of the Postal Telegraph-Cable Company, at the corner of Broadway and Murray street. About 180 members of the society and visitors were present. The inspection was preceded by the annual meeting of the society, at which the following officers were elected: President, C. O. Mailloux; vice presidents, Dr. W. J. Morton, Dr. M. I. Pupin, Luther Stieringer, F. A. Pickernell, W. J. Barstow and C. S. Bradley; treasurer, H. A. Sinclair; secretary, Geo. H. Guy. The treasurer's report showed a balance of \$107, and the secretary's report an increase during the year of 40 members, making a total membership of 350. The retiring president, Mr. Joseph Wetzler, was presented with a number of electrical books as a testimonial to his labors in behalf of the society. President Seth Low, of Columbia college, was elected an honorary member.

THE INSTITUTE FOR HOME STUDY OF ELECTRICITY has issued a catalogue descriptive of its course, and of electrical apparatus for students, schools, colleges, experimental laboratories, etc. We learn from the catalogue that there are complete intermediate and elementary courses in applied electricity, and also a business course, which are addressed to the following classes: Electrical workers, engineers and all mechanics; men with business ability and capital, large or small, or ability only, who wish to organize and manage a business enterprise; men without an entirely satisfactory trade or occupation; young men who have not chosen a business; boys who desire to acquire a knowledge of the arts and sciences, especially those that enter largely into daily life and commerce; professional and business men, particularly those who have

or represent interests directly or indirectly connected with electrical industries. The courses are in charge of Mr. N. S. Amstutz and of Mr. J. C. Lincoln, of the Elliot-Lincoln Electric Company, and a graduate of the Ohio State University. The proprietors of the Institute are the publishers of the "Scientific Machinist."

PRESIDENT FRANCISCO RETORTS.—The merry war continues between Mr. M. J. Francisco, president of the National Electric Light Association, and what appears to be a Tammany-esque electric light company in Rutland, Vt., which by a political "pull" took the street lighting from Mr. Francisco's company. In a recent letter to the Rutland "Daily Journal" Mr. Francisco pays his compliments to the enemy as follows: "In answer to the puerile and personal attack of Mr. F. M. Butler in yesterday's paper, I have to say: This man, as city judge, sits in the city court room day after day sending men to the workhouse for violating the law, and pocketing the fees that their violation gives him a chance to secure; when, however, he is called to task for violating laws, which, in order to judge others justly he should be fully conversant with, the excuse offered is that others are guilty also of a like violation. The parties he cites pay their bills honestly and conduct a legitimate business, not trying to conceal their identity to defraud creditors. The statement that his concern has complied with the law he knows is utterly false, and is simply made with the idea of bluffing through an intentional omission by putting on a bold front." Mr. Francisco charges that the rival company, notwithstanding a recent order from the Supreme Court, is still damaging and destroying property of his company by intentionally "crossing" its wires, and concludes that "the opinion or personal flings of this weak city judge is of little importance."

AN ELECTRICAL HUMORIST.—The Knoxville, Tenn., "Sentinel," relates the history of an electrical experiment by the manager of a local street railway company, which consisted in connecting a wire fence with a trolley circuit in order to keep his neighbor's geese from trespassing on his property. To follow the reporter's amusing account: "A dead cow, a flock of lifeless geese and a community of frightened, indignant people are an aspect presented by West Knoxville this morning. And all this is the work of J. C. Duncan, the alleged electrician, who has, unaccountably enough, been acting in the capacity of receiver for the Knoxville street railroad since that concern went into bankruptcy. While the public knew, in a general sort of way, that electricity in Duncan's hands is as dangerous as a small boy with a pistol, yet his amiable smile and jolly disposition kept him so enshrined in the public heart that his inefficiency has been obscured somewhat by his many good qualities. That the innumerable wires hanging over every street in the city, and put up under such clumsy direction, are a constant menace to life and property is another well known fact, but Dunk long since received a title to the city as a prize for the most popular man, and the public has grown accustomed to staring electrocution in the face. It is generally supposed that the popular receiver—for with all his faults people love him still—had perpetrated about all the outrages known to street railroad management or discovered by electrical science. But Dunk's resources are, practically, without limit in this direction." According to the reporter, a Mr. Himshaw had "the sox knocked off him" in attempting to disconnect the wire, and the fears of the thoroughly aroused neighborhood were increased by a supposed additional danger from an approaching thunderstorm, when finally Professor Ferris, of the University of Tennessee, "bravely ran forward with a hatchet, during the volley of lightning flashes, and cut the wire, thus breaking up Dunk's death trap and putting an end to one of the most outrageous outrages ever perpetrated in a civilized community by a man who is allowed to go around daily without a guardlan." The owner of the cow sued for and obtained damages, and at the trial some interesting facts about the killing qualities of electricity were related by Mr. Duncan. He stated that only three amperes of current were on the fence, and that three amperes would not kill a cow nor a man. All of his "motor-men and linemen," he said, "had taken over four amperes without its hurting them," and his line foreman "had received the full current from three T-H, 500-volt generators at the power house, without its injuring him further than burning his hands a trifle."

Trade and Industrial Notes.

THE CHERRY CHEMICAL COMPANY, manufacturer of the Red Seal boiler compound, has removed its main offices to the Betz Building, Philadelphia.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., has closed a contract with the Metropolitan Electric Company, Reading, Pa., for the iron roof and travelling crane of a new power station.

THE MILLER MANUFACTURING COMPANY, Philadelphia, Pa., on account of the large number of orders on hand and unexpected delay in manufacture, will be unable to supply any of its gauges to the trade before July 1.

THE BELKNAP MOTOR COMPANY, Portland, Me., has received the contract for the electric light plant for the Marine Hospital. The contract called for one 20-h. p. engine, one 26-h. p. boiler, feed-water heater, boiler feed pump and two dynamos of 100 lights each.

THE MIAMISBURG ELECTRIC COMPANY, Miamisburg, Ohio, reports that it is having excellent success with both the Imperial dry battery and the Burnley cartridge battery, which are being

largely adopted for use by telephone companies. An addition to its factory for the battery department has just been completed. The tempered copper department has also been rushed with orders for commutator parts, showing that the trade appreciates the fact that segments made by this company's process are not only all to gauge, but both harder and smoother than others.

THE BALL & WOOD COMPANY, of New York, has just completed the installation of a steam plant in the new building of the Lawyers' Title Insurance Company, on Maiden lane, New York, and the attention of engineers is invited particularly to its method of building the foundation in this instance. This company has also furnished the additions for the steam plant for the Yonkers Railroad Company, and for the Morris County Electric Light Company, Morristown, N. J. Three of its tandem compound engines have also just been installed with the Flatbush Gas Company, Flatbush, L. I.

QUEEN & CO., INC., Philadelphia, Pa., report that the Siemens dynamometer is meeting with a largely increasing demand. It being the standard by which most alternating current ammeters are calibrated, the very rapid growth in the employment of alternating current apparatus accounts for a great part of this increase. Many users want them for transformer testing, and to measure the primary currents specially low ranges down to .03 ampere have been designed. For the secondary currents, instruments are made up to 500 amperes. They are also used very largely for calibrating direct current instruments, being equally accurate for alternating and direct currents.

THE OHIO BRASS COMPANY, Mansfield, Ohio, reports large orders on its material from the following roads since the 1st of June: Consolidated Street Railway Company, Toledo, Ohio; Columbus Street Railway Company, Columbus, Ohio; Marion Street Railway Company, Marion, Ohio; Calais Electric Street Railway Company, Calais, Me.; Dallas and Oak Cliff Electric Railway Company, Dallas, Tex.; South Covington and Cincinnati Railway Company, Covington, Ky.; Fort Wayne and Belle Isle Electric Railway, Detroit, Mich.; Tiffin and Interurban Street Railway Company, Tiffin, Ohio; Akron Street Railway Company, Akron, Ohio; Cleveland Electric Railway Company, Cleveland, Ohio; Omaha Street Railway Company, Omaha, Neb.; Middletown-Goshen Traction Company, Middletown, N. Y.; Montgomery Street Railway Company, Montgomery, Ala.; La Crosse City Railway Company, La Crosse, Wis.

MR. S. W. RUSHMORE, 126 Liberty street, New York, has met with encouraging success in his system of armature winding, having wound armatures for a number of the largest Edison and other stations throughout the country, including machines as large as 250 h. p. In addition to this special drum armature winding, Mr. Rushmore is making a specialty of every class of heavy central station repairs, and has fully equipped his factory, at the foot of Morris street, Jersey City, N. J., with the heaviest class of machine tools required for this work, and for the building of large low tension dynamos for copper refining and depositing. He also has a number of orders for overhauling and rebuilding generators, including an order for two stations that have been partly burned, comprising some 15 machines. Mr. Rushmore is about to place on the market a new series of machine for street lighting, that is especially adapted to meet the requirements of long and rough service.

STERN & SILVERMAN, of Philadelphia, report business as very active. In the railway department they have contracts for the reconstruction of the Brigantine Transit Company's road, at Brigantine, N. J., seven miles in length, on trestle construction; at Altoona the Bellwood extension of the Logan Valley road for the Pennsylvania Railroad, eight miles in length; also the Roxborough Inclined Plane and Railway, six miles long, running from Philadelphia to Barren Hill. In the steam department they report a 600-h. p. boiler plant for the Roxborough road, and two 300-h. p. Ball & Wood compound condensing engines; one 10 inch by 11 inch direct connected Ball & Wood engine for Doorer's Hotel, Philadelphia; one 10 inch by 11 inch direct connected Ball & Wood engine for the Mann Building, Philadelphia, and one 8 inch by 10 inch engine for the boat Havana. In the lighting department they have contracts under way for the central station at Overbrook, Pa.; the lighting of the Episcopal Hospital, Philadelphia; electrical equipment of the river boat Havana, and an arc plant for the pleasure pavilions at Brigantine Beach, N. J.

MR. H. WARD LEONARD, 136 Liberty street, New York, the president of the Carpenter Enamel Rheostat Company, has quite recently had granted to him a very important patent upon electric heaters, after a contest of two years, and after two appeals in the Patent Office. His patent will issue on July 10, and is a fundamental patent of the greatest importance in electric heating, and is likely to mark an era of rapid extension of the application of electricity to all kinds of heated tools. It is a fact but little appreciated that almost every trade in existence necessarily uses certain tools which have to be heated, some of them to merely a low temperature, and others to an extremely high temperature, and in many trades there is a great demand for a tool which could be heated to a bright red heat, heretofore impossible, and work of this nature, such as hard soldering in the manufacture of silver and other metal wares, has heretofore necessarily been done through the agency of a blowpipe. By Mr. Leonard's invention he expects to be able to economically heat not only all such tools as are at present in use, but also to supply an entirely new line of tools to replace the application of blowpipes, gas flames, charcoal stoves, etc., in all the various trades.

THE CARPENTER ENAMEL RHEOSTAT COMPANY, 136 Liberty street, New York, has quite recently moved into its new factory building at Hoboken, N. J., and is now in a position to supply the rapidly increasing demand for goods of its manufacture in its various lines. The growth of this company's business is surprising even to those who appreciated the merits of its rheostat when it was first offered to the public. These rheostats were first placed upon the market only two years ago, but on account of the sustained effort of the Carpenter company to maintain the highest standard of excellence, and on account of its liberal policy, giving to its customers the benefit of all reductions in cost, made possible by numerous improvements in the business, they have practically become the standard throughout the United States, and are to-day used by almost all manufacturers of dynamos and all of the best informed contractors. The Carpenter company has developed a very fine line of all kinds of rheostat switches for all possible uses. One of the most important of its recent pieces of apparatus is its new

automatic switch, the demand for which shows the great need of a simple and reliable switch of this nature at a moderate cost.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden Carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 DeKalb street, St. Louis, Mo.

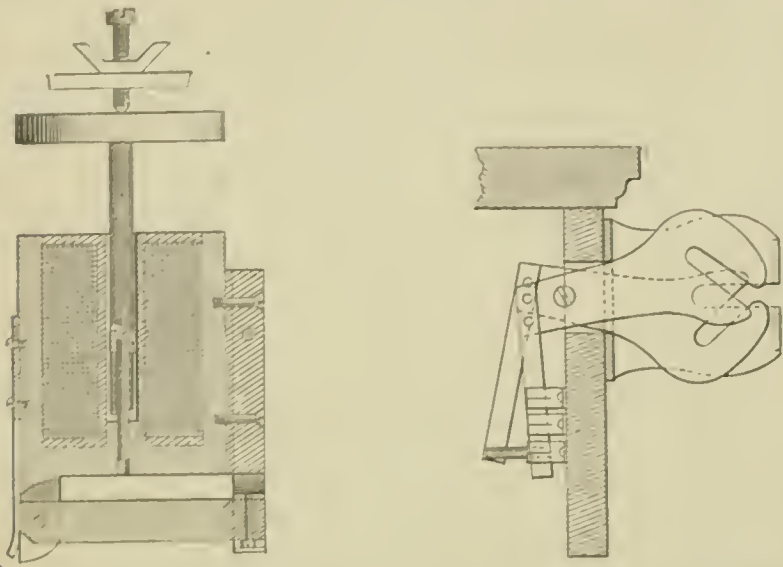
Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED JUNE 12, 1894.

(In charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

- 521,163. **CONTACT TROLLEY**; R. W. Hawkesworth, East Orange, N. J. Application filed March 15, 1894. The combination with the standard of a railway car, of a trolley bar consisting of two arms connected by an intermediate spring plate or bar.
- 521,168. **THERMO-ELECTRIC BATTERY**; E. W. Jungner, Skara, Sweden. Application filed March 9, 1894. This comprises plates composed of two strips of different metals, the elements connected in series, the strips of one kind of metal alternating with those of the other kind, and having alternate joints insulated by means of a non-conductor of heat.
- 521,170. **PRINTING TELEGRAPH**; O. L. Kleber, Pittsburgh, Pa. Application filed April 13, 1893. A telegraph instrument in combination with a rock shaft, a projecting finger attached to the shaft, a spring for drawing the same in one direction, and a revoluble cam that will at proper intervals force the shaft and finger back to its original position or starting point.
- 521,183. **POLICE SIGNAL TELEGRAPH SYSTEM**; C. A. Rolfe, Chicago, Ill. Application filed Oct. 22, 1892. This comprises a signal transmitting instrument, a lever for operating the same, and a setting device adapted to set the signal transmitting mechanism for a special signal and comprising a vibratory lever subject to and operated by the first lever.
- 521,188. **MAGNETO TELEPHONE**; A. Stromberg and A. Carlson, Chicago, Ill. This comprises a cap, a diaphragm resting against the under side thereof, a threaded ring adapted to be screwed within the cap against the diaphragm, and a casing provided with threads adapted to engage threads upon the cap.
- 521,220. **ELECTRIC TELEPHONE**; W. L. Richards, Malden, Mass. Application filed Dec. 14, 1893. This comprises a hollow block of slate forming the casing and side walls of the resistance containing chamber, the block containing a fixed electrode at the rear of the chamber, a vibratory electrode mounted and adapted to vibrate within the front opening of the chamber, and finely divided conducting material placed within the chamber and between the electrodes.
- 521,238. **BOND FOR ELECTRICAL CONDUCTORS**; J. Herr, Philadelphia, Pa. Application filed May 11, 1894. This comprises a tapered hole in the conductor, a split bolt having a head and conical shank externally threaded and a hole passing longitudinally through said head and shank, a nut adapted to be screwed up on said conical shank of the bolt, and a wire adapted to enter and be grasped by the sides of the hole in the bolt.
- 521,239. **BURGLAR ALARM**; C. R. Hoopes, Ogontz, Pa. Application filed April 5, 1894. This comprises a movable door, a bolt to limit the movement thereof provided with a circuit closing device, and means to normally hold the movable bolt in a fixed position to maintain the circuit open.
- 521,260. **ELECTRIC BATTERY**; F. Dubero and P. Mohrdieck, San Francisco, Cal. Application filed Jan. 15, 1894. This comprises an exterior tank containing an excitant, a positive element submerged therein, a shaft extending across the containing tank and a cylinder composed of perforated sides and rim, and adapted to contain a pulverized element, which acts as a negative in the battery.
- 521,269. **CORE CONTRACTING SOLENOID**; W. R. Michl, Wetter-on-the-Ruhr, Germany. Application filed April 26, 1892. A solenoid composed of convolutions of a single insulated wire, the number whereof decreases in the consecutive sectional portions of the solenoid from one end to the middle and then increases again toward the other end.
- 521,274. **TELEPHONE SWITCH**; J. B. Smith, Manchester, N. H. Application filed April 27, 1894. This consists of a pair of slotted pivoted rocker arms having secured thereto respective switch levers combined with electrodes, and a detachable hand telephone. (See illustration.)
- 521,303. **BUSY TEST FOR MULTIPLE SWITCHBOARDS**; J. A. Wotton, Atlanta, Ga. Application filed April 20, 1894. A head-phone circuit, a circuit-maker included therein, a test plug, a circuit therefor, a galvanometer included therein, the needle of the galvanometer being connected operatively with the circuit-maker.
- 521,311. **TROLLEY WIRE FENDER**; T. E. Gressle, Indianapolis, Ind. Application filed Oct. 28, 1893. The combination with a trolley support and trolley, of directing bars adapted to be elevated by movement upon the axis of the trolley, and a double free ended spring attached to one of the bars.
- 521,322. **INCANDESCENT LAMP SOCKET**; L. R. Peck, St. John's, Mich. Application filed Feb. 23, 1894. This comprises an upper disc to which the conductors are secured, contacts thereon, a second disc carrying the lamp contacts, a switch, and posts forming a part of the circuit, detachably engaging with the contacts on the upper disc.
- 521,325. **TELEPHONE TRANSMITTER**; J. B. Smith, Manchester, N. H. Application filed April 27, 1894. A multiple electrode made in sections, the alternate insulated layers of which are connected together combined with a cup containing finely divided conducting material supported on a diaphragm and adapted to vibrate in unison with the latter.
- 521,326. **CONDUIT SUPPLY SYSTEM FOR ELECTRIC RAILWAYS**; H. Alexander, New York, N. Y. Application filed Jan. 9, 1894. A current collector of channel form with flaring ends and interior contact springs.
- 521,362. **ELECTRIC ARC LIGHT FOR MAGIC LANTERNS**; C. Beseler, Jersey City, N. J. Application filed March 16, 1894. A light for magic lanterns provided with a carbon carrier, comprising a tube supported on a rack, a rod fitted to slide in the tube and provided with a clamp for the carbon, and a screw rod turning in the tube and screwing in the rod.
- 521,394. **APPARATUS FOR MEASURING AND RECORDING ELECTRIC CURRENTS**; W. Thomson, Glasgow, Scotland. Application filed Feb. 8, 1893. The combination of a fixed solenoid carrying a scale, a movable magnet carrying an indicator and a yielding support for holding the magnet normally in elevation and in proper relation to be attracted by the solenoid.
- 521,396. **ELECTRIC CLOCK WINDING MECHANISM**; A. E. Vidal and G. Hervieu, London, England. Application filed Sept. 30, 1892. The combination with an arbor of a ratchet wheel mounted thereon, connected with a source of power, a solenoid core adapted to drive the ratchet wheel and having the same pitch as the first ratchet wheel, a contact piece actuated by the last ratchet wheel, a solenoid and an electric circuit including the contact maker and solenoid.
- 521,412. **TRACK CIRCUIT**; L. F. Johnson, Poughkeepsie, N. Y. Application filed April 7, 1894. This comprises a series of protected sections composed of two opposite lines of rails, intermediate sections composed of rails of high resistance, a battery and relay connected to each protected section and a connection between the opposite lines of rails at the end of each protected section.
- 521,422. **TELEPHONE CALL RECORDER**; W. F. Smith, San Francisco, Cal. Application filed May 5, 1893. This comprises a type wheel, setting wheel, setting lever, brake lever, coil springs, and a polarized relay having separately acting armatures and rods actuated by the armatures.
- 521,423. **AUTOMATIC ELECTROMAGNETIC CUT-OUT**; L. T. Stanley, Brooklyn, N. Y. Application filed July 18, 1893. This comprises an electromagnetic cut-out for automatically interrupting a circuit upon any abnormal increase in the current flowing therein, and a fusible conductor in shunt to the terminals of the cut-out. (See illustration.)
- 521,434. **DUPLEX ELECTRIC ARC LAMP**; G. F. Edens and J. B. Brewer, Xenia, Ohio. Application filed March 31, 1894. This comprises feed rods, a trip lever for each adapted to hold same in a raised position and having a portion thereof arranged in the path of movement of the adjacent feeding rod, the feed-rods carrying means for engaging a portion of the trip levers for releasing the adjacent feed-rods, whereby the arc may be completed in either set of carbons by the downward movement of the adjacent feeding rod.
- 521,435. **AUTOMATIC ELECTRIC SIGNAL LAMP**; J. R. Farmer, St. Louis, Mo. Application filed April 9, 1894. This comprises a hood containing electromagnets within a rectangular frame, a sliding armature connected by a plate to a crank, a suspended lantern and a shunt circuit connection.

521,436. SYSTEM OF ELECTRICAL DISTRIBUTION; T. J. Fay, New York, N. Y. Application filed Feb. 15, 1894. In a multiple series system of distribution, the combination of a main generating station, two main conductors leading therefrom, an intermediate or compensating conductor between the groups or sets of translating devices, two generators connected in series with each other



NO. 521,423. AUTOMATIC ELECTROMAGNETIC CUT-OUT.

NO. 521,271. TELEPHONE SWITCH.

and normally tending to augment the supply of current to the mains, but so connected as to supply extra current to either group of translating devices which require it in order to establish a balance between the two groups, and an electric motor driving both generators and supplied with current from the mains. (See illustration.)

U. S. PATENTS ISSUED JUNE 19, 1894.

521,455. ELECTRIC RAILWAY SIGNAL; C. R. Alsop, Middletown, Conn. Application filed Oct. 12, 1893. The combination with a rail in electrical circuit with a signalling device and a battery, of a laterally movable spring actuated contact bar, in the same circuit with the rail and normally spaced from the inner side of the rail, whereby the circuit is completed through the rail and contact bar by the interposition of the metallic flange of a car wheel.

521,461. COMBINED ANNUNCIATOR AND SPRING-JACK; H. M. Plisk, Chicago, Ill. Application filed May 14, 1894. The combination in a switchboard of a jack, and a drop adapted to swing in front of it, an electromagnet located in the rear of the jack and an armature having a connection for catching and supporting the drop when it is raised by the entrance of the connecting plug.

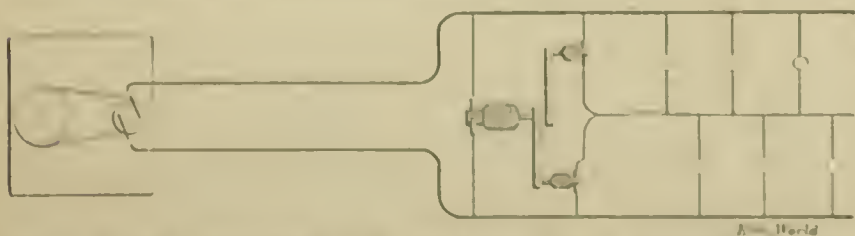
521,514. TELEPHONE SWITCH; A. Stromberg and A. Carlson, Chicago, Ill. Application filed Jan. 26, 1894. This comprises a hand telephone, movable contact element, a telephone line, two contact anvils, signalling apparatus and a telephone set. (See illustration.)

521,550. PRINTING TELEGRAPH; E. Pope, Quebec, Can. Application filed June 20, 1890. The combination with a magnet whose core serves as an anvil for the stroke of a printing lever, of a casing having slots through which the usual printing and paper rolls pass.

521,553. ELECTRIC RAILWAY SIGNAL; B. Samuels, St. Louis, Mo. Application filed July 26, 1893. In a train signalling mechanism, the combination with a signal carried by the train, and circuit closing devices between the train and the station, of a drop arm, spring, magnet and catch.

521,594. ELECTRIC BELT; E. M. Miles, Chicago, Ill. Application filed July 1, 1893. In a battery for electric belts, cells, in combination with a hinge device connecting adjacent cells and provided with an eye formed in the hinge itself for making connections.

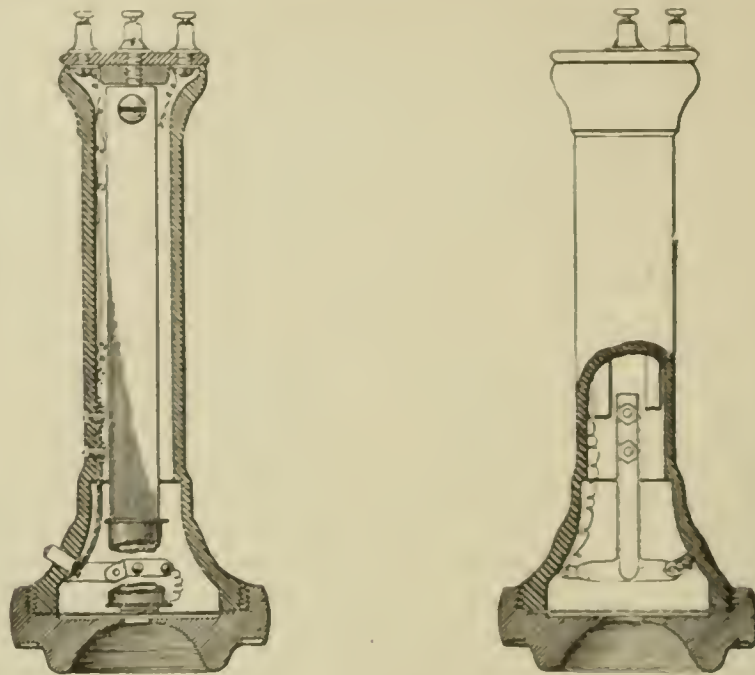
521,602. TROLLEY POLE CATCHER; O. G. Gates, Jr. Application filed March 12, 1894. The means for resetting a tripped trolley pole, comprising the combination with the spring bearing bar, of slotted links through which the bar passes, and a lever to which the links are connected.



NO. 521,436. SYSTEM OF ELECTRICAL DISTRIBUTION.

521,651. ELECTRIC RAILWAY CAR MOTOR; J. C. Henry, Westfield, N. J. Application filed Aug. 25, 1893. This comprises a motor having a shunt-wound multipolar field magnet, a rotating pole changer in the field circuit, a gear wheel on the armature shaft, and a pinion on the shaft of the pole changer.

521,666. ALTERNATING CURRENT REGULATOR; O. Offrell, Middletown, Conn. Application filed Dec. 12, 1892. This comprises two opposing electromagnets, a core without a coil pivoted between the common pole pieces of the magnets and adapted to be turned more or less transversely to the lines of force joining said poles.



NO. 521,514. TELEPHONE SWITCH.

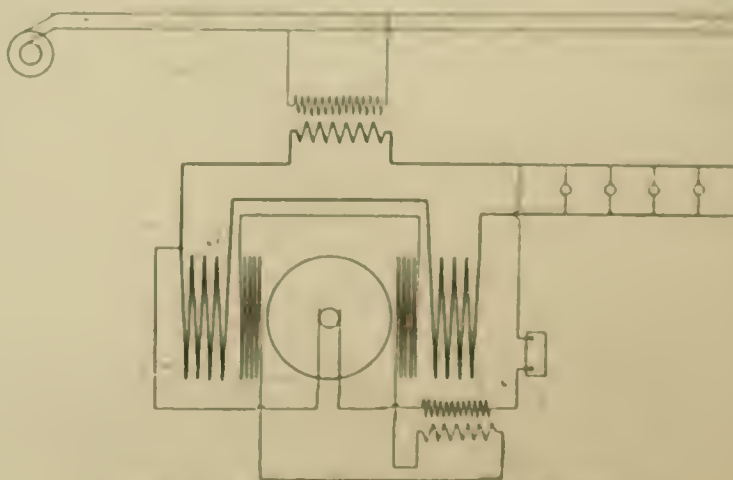
521,671. ARMATURE FOR DYNAMO ELECTRIC MACHINES; E. W. Rice, Jr., Schenectady, N. Y. Application filed April 19, 1894. An armature spider composed of a ring of diamagnetic material, provided with projecting arms having dovetailed ends and a lug projecting from each side of the arm adapted to engage with devices for keeping in place the core discs.

521,684. METER FOR RECORDING MEASUREMENTS OF ELECTRIC POWER; E. Thomson, Swampscott, Mass. Application filed Jan. 31, 1894. This comprises field magnet coils connected across the outer mains and disposed in sets, some of the coils of each set being upon opposite sides of the armature, an armature in shunt to the mains and a resistance in series with such armature.

521,685. ELECTRIC METER; E. Thomson, Swampscott, Mass. Application filed Feb. 21, 1894. In an electric meter and in combination, a coil in series with the mains, an armature in shunt to such mains, and a starting coil supplied with current by transformation from the armature circuit. (See illustration.)

521,721. ELECTRIC LAMP FOR BICYCLES; George Mayr, Brooklyn, N. Y. Application filed Nov. 7, 1893. In combination with a dynamo electric generator, composed in part of a gearing frame piece and a horizontal armature shaft carrying a pinion, a train of gearing machinery, disposed in the gearing frame piece, the initial driver thereof being carried by a shaft having a sprocket wheel mounted thereon, and the final driver thereof being adapted to mesh at all times with the pinion on the armature shaft.

521,741. SUPPLY SYSTEM FOR ELECTRIC RAILWAYS; Thomas Harris, Detroit, Mich. Application filed April 23, 1893. In an electric railway system, the combination with a continuous power line, of a working conductor composed of sections normally disconnected from the power line, a switch line and a return switch line extending along the working conductor from a stationary source of electricity, and electromagnet for each section of the working conductor, the armature of which is adapted to connect the section with the power line and with the switch line, two energizing circuits for each magnet, one connecting the sections of the working conductor with the return switch line through a normally open and normally closed break controlled by the next



NO. 521,685. ELECTRIC METER.

adjacent magnets, respectively, and the other connecting the two switch lines through the said normally closed break of the other circuit, and a normally open break controlled by the magnet itself, and a contact on the car adapted to connect two adjacent sections of the working conductor.

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